The Geodesic Works of Richard Buckminster Fuller, 1948-68
(The Universe as a Home of Man)

Volume One of Two

by

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1981

SUBMITTED TO THE DEPARTMENT OF ARCHITECTURE
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY
IN THE FIELD OF
HISTORY AND THEORY OF ARCHITECTURE
AT THE
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
June 1999

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ABSTRACT

The thesis investigates the geodesic structure and dome phase in the corpus of Richard Buckminster Fuller's artifactual production and writings. It offers a history of the meteoric rise of the geodesic structure, its production, deployment, reception and subsequent marginalization. The geodesic work, as a pinnacle of Fuller's life work, forms a multi-layered symbolic project with significance that extends beyond architecture. While the geodesic dome is an aspect of Fuller's many artifactual productions, it is studied here as a culmination of a set of ideas that Fuller developed and refined over a course of forty years, beginning with the 4D-Dymaxion House. These ideas represent a set of poignant observations and critique of design and design practices in particular, and of contemporary American culture in general.

At a cursory level, Fuller's invention of the geodesic dome in the late forties appears to be a historical aberration, given the traditional, deeply symbolic significance of the dome and the fairly entrenched modern aesthetic sensibility based on planes and asymmetry. Yet, over a period of twenty years, the geodesic invention reinvigorated a traditional archetypal form besides charging up new interests in all types of space-frame structures. The invention of the geodesic structure invention enjoyed professional attention and rallied public enthusiasm. However, with its swan-song at the Montreal Expo '67, it was quickly eclipsed and marginalized.

The thesis shows that Fuller's geodesic work is an attempt to create a seamless continuity between nature and society, following on the heels of his first attempt (in the 4D-Dymaxion House phase) to create a similar continuity between society and industry and between production and consumption. To understand any one of these aspects, one must posit the invention in the context of its inventor and the relationship of the desires he brought to bear on American society and culture in his time.

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Acknowledgments

This dissertation was sustained in countless ways by the support, assistance and encouragement of the following people:

1 **Prof. Emeritus Allegra Synder**, daughter of Richard Buckminster Fuller for her generosity and kindness in allowing me to peruse material from the BFI archives in Santa Barbara, Calif., without which this dissertation would be unrealizable.

2 MIT: My doctoral supervision committee **Prof. Stanford Anderson** (Chairman), **Prof. Francesco Passanti & Prof. Nancy Stieber** (U. Mass., Boston) for their intellectual guidance, support and comments during the course of my work. To them I owe my deep gratitude for inculcating in me the historical and critical sensibilities

3 Ms. **Bonnie Goldstein**, Mr. **Tony de Varco**, Mr. **John Ferry** & Ms. **Jackie Lohrske** of BFI-Santa Barbara, Calif. and **Tony Gwilliams**, **Bobby Jaber** and **George Potter** (all Friends of BFI) who provided constant companionship and assurance during my attachment to the Institute (1994-95). I am singularly indebted to Bonnie for leading to me many key documents which included "Lightful Houses."

4 Various individuals who had participated in the oral history interviews for this thesis: **Jay Baldwin**, co-editor of the *Whole Earth Catalog* and author of *Bucky Works* (1997) for his insights on Fuller. His own hands-on experience in building domes and his intimate knowledge of the DDM-Fuller House (or the Wichita House) was invaluable to my work. **Joseph Clinton** of 3-D Structures Inc. (Avondale, Pa.), who shared with me his experiences with Fuller while teaching at SIU-Carbondale, Ill., and his broad expertise in the subtleties of the geodesic dome design and geodesic mathematics. **Mr. Bernie Kirschenbaum** (New York City) who provided me accounts of the radome projects and his invaluable insights on working with Fuller and Konrad Wachsmann. **Mr. Bill Wainwright** (Boston-Mass.), who generously took time away from his studio work to provide me with details of the geodesic projects undertaken by Geodesics Inc. and Geometrics Inc., Cambridge-Mass. **Prof. Arthur Loeb** (Harvard University) for sharing his experiences on working with Fuller on the Synergetics project; especially his measured assessment of Fuller's unorthodox achievements as a self-taught scientist. **Shoji Sadao** (New York City), for sharing his insights on his experiences as a graduate architectural student at Cornell working with Fuller. **T.C. Howard** of Synergetics, Raleigh-N.C., who gave me almost two-full day of undivided attention, combing through the works he undertook as Fuller's architect in Synergetics and Geodesics Inc. He also generously offered me the use of numerous photographs and drawings. **Duncan Stuart** (Professor emeritus, University of North Carolina of Raleigh-N.C.) for his humanist reading of Fuller's project. He shared insights on his role in and contribution towards Fuller's Energetic Geometry project; and the general milieu of working with Fuller at the NCSC. **Margaret Fitzgibbon** (St. Louis-Mo.), widow of Prof. James Fitzgibbon (Washington University) for her recollections of Fuller, the works of her husband and his relationship with Fuller. I record my belated recognition and fond remembrances of Prof. Fitzgibbon. His critically rendered understanding of Fuller's vision and design left a deep impression on me during my studies at Washington University (1975-81). **Mr. Don Richter**, VP-emeritus (Tremcor-Los Angeles, Calif.), **Prof. René Motro** (Laboratoire de Mécanique et Génie Civil, Université Montpellier) and **Prof. Z. S. Makowski** (Prof. emeritus, University of Surrey, United Kingdom) for taking time from their busy schedule, during the IASS International Symposium '97 (Singapore), to fill me in on several missing details in Fuller's dome enterprises and standing controversies. **Michael Ben-Eli** (New York City), Donald Moore (Michigan) who offered me over telephone interviews, information and views of their respective collaborations with Fuller.

5 Special people: **Ed Applewhite** for his meticulous efforts in organizing a wide range of seminal notes on Fuller's early thoughts on the Energetic Geometry project. These documents, among other things, are filed under the endearing labels cited in this work as the "EJA Green" and "EJA Blue" trunks.

Datuk Lim Chong Keat (Penang) for his initiatives in organizing the "Fuller Forum," MIT-Cambridge, Mass. on 21 April '95, as part of Institute's Centenary remembrance of Fuller. That occasion, and the follow-up "Campuhan" gathering, provided me invaluable contacts with some of the close friends of Fuller. **Shirley Sharkey** (New Jersey), Fuller's personal secretary, who shared with me her material pertaining to Fuller's stint at Romany Marie Tavern in the thirties. She made available to me several invaluable manuscripts of habitué at the tavern. **Prof. Emeritus David Parks** (Williams College) who gave a significant piece of information to date Fuller's Dymaxion map.

6 **Kirk Simon & Karen Goodman** (award-winning New York film-makers) for their generosity in providing me transcripts of their interviews with notable Americans associated with Fuller. Their interviews were conducted as part of the film project, "Thinking Out Loud" (in the *American Masters* series) that was successfully aired in April 1997 on PBS.

7 **Martha Riley**, archivist Missouri Botanical Garden (St. Louis, Mo.), for leading me to a wide range of the archive resources directly and indirectly pertaining to the Climatron. Without her assistance, the section on the Climatron would not be possible. Librarians of **MIT Rotch** Library and Columbia University (Avery Special Collections) for general research supports.

8 Various teachers at MIT and elsewhere, particularly **Prof. Leo Marx, Akos Movransky, Benjamin Buchloch, Henry Millon** and **Alex Tzonis**.

9 MIT "Course 4" administrative staff: **Ms Renee Caso, Anne Simonuvic, Linda Laplante** who assisted me in countless ways, not the least, in straightening out the administration of my candidature.

10 At NUS, School of Architecture: **Mr. Ho Pak Toe** (ob. 1994), Director of the School (1991-94) for his confidence in supporting me on the OGS program. My gratitude also extend to all the subsequent Heads of the School who literally stuck out their heads for me, particularly **A/P Foo Ah Fong** & **A/P Milton Tan**. Personnel & Bursar's Offices of NUS for ensuring that my stipend, salary and other comforts were maintained during the entire course of study.

11 My colleagues at the NUS- School of Architecture: **A/P Pinna Indorf, Hee Limin, Tan Beng Kiang** and especially **Lai Chee Kien** for their invaluable comments and proofreading. Special thanks to **Siew Ling-Waller** for her effort to understand and evaluate the work from a "lay-person's" point of view.

12 To my friends in U.S.: **Bruce Stanhke, Erlynne Kitigawa & Sam** (Boston, Mass.); **Ed & Shannon Noland** (San Francisco, Calif.); **Robert Fu & family** (Maplewood, N.J.); **the Fagans** (Santa Barbara, Calif.); **Larry, Grace Corbin & Grace** (St. Louis, Mo.); **Laura Starr** (New York City) -- for all types of assistance and support which exceeded the nominal expectations of "friends." **Sandy Isenstadt**, my peer in "Course 4," for generously sharing his ideas and views on architecture with me during our course of study. **Chua Siong Huat** (ob.1995, Boston, Mass.) my childhood friend from Malacca, who continuously set my bearings to other possible purpose in life besides this dogged academic pursuit. His exemplary activities as an AIDs activist and his cheerfulness even in the most dire moments, remains an inspiration to me. I remember him as a warm and generous friend. **Ernest C. Pascuci** (ob. 1998) former associate editor of *ANY*, and a fellow-cohort in the MIT-HTC for encouraging me to publish my first essay on Fuller in *ANY17*.

13 To my friends and their children in Singapore: **Joseph Cheang, Ai Loon, Ai Mien, Tim Noland, Toon Ming, May Ling, Hwee Leng** and **Ricky** for "baby-sitting" my son Hee Jinn on countless occasions, to enable me to be left alone to work quietly. **Jeanette Gan** and my brother-in-law, **Fun Kian Chay** for bravely signing on the dotted lines and acting as my OGS grant-guarantors.

14 Finally, to my parents (**Wong Kia Min** and **Lim Meng Hwa** [ob.1998]), my family (**Siew Leng, Hee Jinn** and **Lu Yii**), and my in-laws, I owe apologies for not spending enough time with them. To them that I dedicate this work.

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Abbreviations used in this Dissertation

1 Terms particular to Fuller's Enterprises

4D	Fourth Dimension (Fuller's manuscript, precursor to *4D Timelock*)
BFI	Buckminster Fuller Institute, Santa Barbara-Calif.
CR	Chronofile
DCCT	Discontinuous Compression, Continuous Tension
DDM	Dymaxion Dwelling Machine
DDU	Dymaxion Deployment Unit
DTU	Dymaxion Transport Unit
EG	Energetic Geometry
FRF	Fuller Research Foundation
FSG	Fuller Study Group, Yale University, ca.1954
GC	Great-circle
HE	Hamilton Extract
IVM	Isotropic Vector Matrix
Mark-I, II or III	Generic label for the first, second and third prototype in a research series respectively
OMR	Old Man River Project, East St. Louis-Ill. (1968)
SSA	Structural Study Associates
TBI	Trial Balance Inventory
UTCC	Union Tank Car Company, Chicago-Ill.
UTLx	Union Tank Car Company Project, Baton Rouge-La
VE	Vector Equilibrium
RBF	Richard Buckminster Fuller
WDSD	World Design Science Decade
X-MC	Experimental City Project (University of Minnesota)

2 General

AA	Architectural Association, London
ALCOA	Aluminum Company of America
AIA	American Institute of Architects

SiU	Southern Illinois University, Carbondale-Ill.
ASM	American Society of Metals, Cleveland-Oh.
BEW	Bureau of Economic Warfare, Washington D.C.
BHG	Better Homes and Gardens (Des Moines-Io.)
BMC	Black Mountain College
BuAer	Bureau of Aeronautics (in United States Navy)
CAL	Cornell Aeronautical Laboratory, Buffalo-N.Y.
CBC	Canadian Broadcasting Corporation
CCA	Container Corporation of America
DEW	Distant Early Warning System
est	Erhard Seminars Training
FEA	Federal Economic Administration, Washington D.C.
ID	Institute of Design, Chicago-Ill.
IIT	Illinois Institute of Technology, Chicago-Ill.
LBSC	Long Beach State College, Calif.
MBG	Missouri Botanical Gardens, St. Louis-Mo.
MIT	Massachusetts Institute of Technology, Cambridge-Mass.
MoMA	Museum of Modern Art, New York City-N.Y.
MPM	Magnesium Products of Milwaukee Inc.
NAA	North American Aeronautics Inc.
NCSC	North Carolina State College, Raleigh-N.C.
OITF	Office of International Trade Fairs (Department of Commerce)
OSS	Office of Strategic Services (precursor of CIA)
RAFDC	Rome Air Force Development Center, Rome-N.Y.
RIBA	Royal Institute of British Architects
UIA	Union Internationale des Architectes (International Union of Architects)
USIS	United State Information Service
USAF	United States Air Force
USC	University of Southern California, Los Angeles-Calif.
USIA	United States Information Agency, Washington D.C.
USMC	United States Marine Corps
USN	United States Navy
VPI	Virginia Polytechnic Institute

Introduction

Richard Buckminster Fuller (1895-1983), publicly portrayed as an enigmatic and extraordinary American visionary-inventor, was a consummate autobiographer.[1] Starting with his first public presentation of the Dymaxion House in 1928 Fuller conscientiously constructed a self-history of both his life and his work, leavening them with his own brand of neologisms.

Two strategies assisted this process. The first was composed of the numerous public discourses and readily-dispensed interviews which he commandeered to refine his life mission and the explication of his experiences. The second was an extensive archive, privately maintained by Fuller himself until his death in 1983, that contained a wide assortment of manuscripts, letters, drawings, ephemeral and artifacts connected directly and tangentially to his life. The materials were collected with fanatical enthusiasm - the totality of which, he once explained, would represent an "involuntary diary and progressive documentation...plus good and bad, all included."[2] Fuller was so convinced of the potential interconnections and relatedness of his activities that he even created a private index to accompany the collection.[3] He would intermittently draw on these materials, organized like a ship captain's log, sometimes to rationalize decisions taken, and at other times to chart or to divine the future. Fuller's own writings were based on the incremental doses of homilies and experiences that he cannibalized and reworked from these records.

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[1] See Ian Stewart's review of Fuller's *Cosmography* and the Kroto-Smalley's naming the carbon C-60 atom as Buckminsterfullerene, "From Brilliance to Crackpottery", *Nature*, 16 April 1992, p.633.

[2] Ltr. 7/1/39 RBF to Joe Byrant in BFI-CR46.

[3] There are two extant editions of the index, billed the Dymaxion Index. The first executed on the eve of his corporate research entity, the Fuller Research Foundation (FRF), was subtitled "Bibliography and Published Items and Richard Buckminster Fuller, 1927-47." It contains three main sections: the first is a chronological index of published references to Dymaxion (Philosophy, House, Bathrooms, etc.), Buckminster Fuller & *Nine Chains to the Moon*; the second, "Public presentation of Fuller and Dymaxion Items" is basically Fuller's itinerary of activities; and the third, "Books making special mention of Dymaxion or B. Fuller." After a second revision of the Index, the entire holding of the items cited were consolidated into a final, full-blown version with expanded sections. This new index now forms the structure of Fuller's archives in Santa Barbara, California.

The majority of the extant writings on Fuller's work and the man Fuller, also shaped by the above sources, are popular and unremittingly apologetic. Essentially, these writings either reiterated or embellished the personal accounts that Fuller himself had advanced. These writings on Fuller are biographical and anecdotal. This is partly because the authors are enamored by Fuller the man, and partly because of the inherently biographical nature of Fuller's books and public discourses. The biographers also implicitly assumed and were persuaded by a theme of seamless consistency that ran through the life of their protagonist, his beliefs and his works. They are also generally written by his associates, friends and sympathizers. Alden Hatch's *Buckminster Fuller: At Home in the Universe* (1974) and Lloyd Sieden's *Buckminster Fuller's Universe: An Appreciation* (1989), and recently Jay Baldwin's *Bucky Works: Buckminster Fuller's Ideas for Today* (1996), are accounts of this genre. All are more inclined to portray Fuller's life and work as simultaneously selfless and overtly self-conscious. However, these works remained uncritical to the limitations and fundamental contradictions within his ideas and works. *Buckminster Fuller: An Autobiographical Monologue/Scenario* (1980), by R. Synder, Fuller's son-in-law, is another passionate and even closer-range "autobiographical" account. However, the work too, is presented with little analysis.

Robertson and Applewhite constituted a different class of Fuller's retainers. They were, for all intents and purposes, true confidants of Fuller, close to his creative enterprises and affected by his idiosyncrasies. Don Robertson was Fuller's formidable patent lawyer; his *The Mind's Eye of Buckminster Fuller* (1974) reinforced both the genius and the myth of Fuller the inventor by the its episodic accounts of the patent's process and the inventor's quirkiness. Ed Applewhite, on the other hand, was a family friend. He had earlier, as a young man, assisted Fuller on his ambitious Dymaxion Wichita House project (DDM-Fuller House, 1947), during which he was primarily responsible for editing one of Fuller's seminal tracts - "Designing a New Industry." It is a brilliant transcript of Fuller's open discourses to workers on the shop floor at Beech Aircraft (Wichita-Kans.) where the Dymaxion Wichita was assembled. It remains a succinct history of the industrialized house, as understood by Fuller. In subsequent years, after his retirement from the CIA, Applewhite was singularly instrumental in forging a literary milieu to make Fuller's ideas and writings as accessible as he could to the reading public. In *Cosmic Fishing* (1977), Applewhite recounted the unfolding of Fuller's *Synergetics: Explorations in the Geometry of Thinking* (1975), and recounted the compulsiveness with which Fuller worked through an idea. While Fuller's own "Basic Biography" (limited circulation through the BFI-Philadelphia, 1983) merely updated the resumé of the Dymaxion Index from the post-Wichita years, these two accounts by his close associates effectively heightened the legendary quality of his genius and vision.

Recently, J. Baldwin's *Bucky Works* (1997) revisited Fuller's projects. Though written in a personal way and with a view to making Fuller accessible to the post-Whole Earth Catalog generation, Baldwin's evaluation of Fuller and his artifacts remained cursory. Baldwin also carefully steered away from Fuller's involvement, in the fifties, with the military. The writing remains that of an apostate of Fuller's humanistic concerns, albeit circumscribing his broad design philosophies. Previously, Hugh Kenner's *Bucky* (1973) offered a measured dose of both acclaim and criticism of Fuller's project. However, this was still an account by a half-convert. Despite his skepticism of Fuller's approach, Kenner was quietly persuaded by his heroic stance and the substance of his mission. Collectively, these works tried to remedy the characterization, elsewhere in other journalistic accounts, of Fuller's production as "technocratic", "utopian", "futuristic", "politically naive" or Fuller the man as a "maverick", "rugged individualist", "megalomaniac" and "esoteric."

Only three writings attempted to place Fuller's contribution in the context of architectural history. Of these three works, it is ideologically significant that two are by Englishmen, closely identified with Reyner Banham. However, these works exhibited limitations similar to the biographies. Martin Parley's monograph, *Buckminster Fuller* (1990), like the writing of Reyner Banham before him, continued to perpetuate a heroic narrative of the master. This was despite Pawley's professed skepticism during his youthful, rebellious days of the technological optimism of Fuller. *R. Buckminster Fuller* (1962) by John McHale, another Englishman, is a more balanced presentation by a convert and advocate of Fuller's ideas. However, he depended heavily on the extant publicity material created by Fuller, even as he tried to construct the meaning of Fuller's overall project. McHale, himself a remarkable theorist of the future subsequently expanded the sociology of future engendered by Fuller's unique brand of future science: Anticipatory Design Science.

The first monograph on Fuller and his works, *The Dymaxion World of Buckminster Fuller* (1960) by Robert W. Marks, provided a neat chronological compilation of Fuller's work. However, it was based substantively on an autobiographical manuscript that Fuller himself had initiated in the fifties, when the notoriety of his geodesic invention was on the rise.[4] Though

[4]In 1951, Richard Hamilton of Bemis-Foundation of MIT and Carl Koch were commissioned by Progressive Architecture to undertake the earliest proposed biography on Fuller, tentatively titled "Work of R. B. Fuller." (subtitle,

accessible and technically competent, Marks confined his documentation, analysis, and explication to the visible and the unproblematic aspects of Fuller's works and ideas.

The only extant critical examination of Fuller is Karl M. Conrad's doctoral thesis, "Buckminster Fuller and the Technocratic Persuasion"(1973).[5] Basing his work primarily on deconstructing Fuller's aphoristic essay, *4D-Timelock*, Conrad turned his analysis to dismantle Fuller's self-history and to establish the pivotal influence of technocracy in Fuller's writings. The other extant doctoral dissertations on Fuller are particularly laudatory of the man as they respectively affirm and authenticate his special genius. Harold Drake's "Alfred Korzybski and Buckminster Fuller: A Study in Environmental Theories," (1972) interpreted the meanings of Fuller's artifactual production under the framework of Alfred Korzybski's General Semantic theory. He finally concluded, albeit in a rather forced manner, the uniqueness of Fuller's approach.[6] A. Gerber's "The Educational Philosophy of R. Buckminster Fuller"(1985), in attempting to articulate the holistic educational philosophy of Fuller ended in initiating Fuller into the emerging pantheon of New Age philosophers.[7]

There is also a marked absence of any detailed account or reliable factual reconstructions of Fuller's geodesic invention or critical assessments of its related enterprises, except for more heroic recounts of dome statistics in journalistic writings. Others are concerned with the number of domes built, how widely they have proliferated or their legendary performance standards and efficiencies. This is not at all curious in the least since Fuller singularly planted readings, via these monographs and his own publicity, to encourage and to direct public assessment of his work.

The Primary Contribution of this Thesis

This thesis offers the first factual reconstruction of a phase of Fuller's work, namely the geodesic artifacts, based directly and primarily on archival evidence. It is, in a sense, an

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"Design Initiatives and Prototype Engineering") Hamilton's poor health and death shelved the project. The structure of the manuscript was partly incorporated into Mark's subsequent book which started in 1959. Hamilton's manuscripts and notes are kept separately in the BFI-archives as Hamilton Extract (cited, in this thesis as BFI-HE, various volumes 1-26)

[5] Karl M. Conrad, "Buckminster Fuller and the Technocratic Persuasion," Ph.D. Thesis, University of Texas-Austin, 1973

[6] Harold Drake, "Alfred Korzybski and Buckminster Fuller: A Study in Environmental Theories," Ph.D. Thesis (SIU-Carbondale, Graduate School 1972) [Speech].

[7] A. Gerber, Jr. "The Educational Philosophy of R. Buckminster Fuller," Ph.D. Thesis (University of Southern California), Dec. 1985.

"internal" history of the geodesic structure, analyzed and written almost entirely as a biographical object within the life and enterprises of its inventor, Richard Buckminster Fuller. The choice of the geodesic structure over the Dymaxion House or the Wichita House to explicate Fuller's ideas and works is deliberate. The geodesic structure does not merely constitute the pinnacle of Fuller's life work but it also quintessentially exposes the symbiosis of the inventor's persona and his artifact at both the practical and the symbolic level. Further, the scale of public interest the geodesic works attracted also exceeded those found in or produced by his other artifacts.

The work deals with the sources of influence on Fuller's geodesic projects, the forging of its research agenda, the genesis of the structure, the organization of enterprises to capitalize on its business potentials, and the management of business and political alliances. It shows how, through alliances, patronage of the military, profession and particular sectors of the public, Fuller initiated and upgraded the position of the geodesic structure in particular, and the dome-form in general, into the modern palette of architectural design.

In that the thesis draws directly on the documentary materials from Fuller's archives and utilizes oral accounts of his close collaborators from the period, it is an account of the geodesic structure in the context of Fuller's life work. The research methodology adopted predisposes its presentation as an "internal history." It adopts a narrative and chronological structure that coincides with significant turning points in Fuller's career and in the fate of his enterprises. However, it also examines the reception of the geodesic invention outside of Fuller's own valiant constructions and promotional activities. It examines the views of his collaborators and critics, the rendition of the project's meanings within the architectural profession and among the public.

Chapter One provides a broad outline of Fuller's experiences prior to 1947. In particular, it examines the making and positioning of his industrialized house project, the 4D-Dymaxion House and its subsequent variants, in public and professional discourses. The primary focus is an analysis of the iconic value of the Dymaxion project via two seminal documents, "Lightful Houses" and *4D Timelock*. It reviews the strategies and effects of Fuller's self-appointed position as an outsider to advance his works; and the influence of his industrial apprenticeships, military patronage and logistic needs in shaping his subsequent research agenda. It also examines the intellectual and practical backgrounds of Fuller's life prior to the geodesic invention. The chapter locates the evidence of Conrad's speculation and affirms Fuller's early flirtation with the technocracy movement, particularly through its main exponents Howard Scott and Stuart Chase.

However, it also argues how Fuller's views on the social-political prospects of technology were fundamentally and distinctively different from those proffered by technocracy.

Chapter Two analyzes and assesses the beginnings of the geodesic structure, and how Fuller constituted the geodesic problem in an original way via his self-created science, Energetic Geometry (EG). It is compared with other prior arts generally related to space structure. The chapter draws upon the extant archival evidence, particularly sketches, drawings, reports, letters (legal and personal) and interviews with Fuller's collaborators on various geodesic projects. It also evaluates Fuller's processes in promoting and expanding his research project in the colleges; the meanings behind continued military interest in his work; his management of the publicity on the invention and the effects of the franchisees set up to capitalize on the new invention.

Chapter Three examines the organizational, management and promotional aspects of the geodesic dome business from the mid-fifties to early sixties. It traces the various alliances that Fuller forged with industries, the state and the military institutions, and argues how Fuller recognized, from a very early stage, the significance of his geodesic invention in a broad range of applications. This includes the propagandistic value of the geodesic structure in ideologically advancing the notion of American technological ingenuity as a counter-point to the threats of the Cold War. The large-span dome projects, on the other hand, also enticed the material and manufacturing industry to participate in the building arena. In addition, in the public sphere, the novelty of the dome aroused both sublime and mundane interests. It became a captivating public artifact.

Chapter Four examines more closely the causes for the growing recognition of the changing symbolic values of geodesic structure through the sixties. From a tactical tool of the military and big industries, the geodesic structure graduated into a tool for trans-national representation and for personal control. On these two extreme scales, the geodesic artifact finally achieved its status as a universal motif.

Chapter Five concludes the examination of the geodesic artifacts and their relationship to the life of their inventor. It argues that the geodesic artifacts, including those from the Dymaxion period, were intended by Fuller as links to the new social and material milieu and its concomitant new subjectivity. It is argued that that this new subjectivity, characterized by the autonomy of the Everyman, draws upon the cultural and social myths of the American frontier. The connection of these myths to Fuller's geodesic works is in the prospect of dwelling in a seamless continuity.

The author recognizes the potential problems and pitfalls in relying heavily upon the material that Fuller had accumulated, professedly in a nonchalant way. Despite recognizing that Fuller's promotional skills might have compelled him towards editing his collection, this work makes cautious allowances for the veracity of most of the material perused. While the analysis treats the material with fidelity, what it considers factual is based on analytical reconstructions of the material – reading between lines of the artifacts and writings of Fuller. The analysis also relies on continuous cross-checking and validation between evidence from various media -- sketches and drawings, letters and legal documents, preparatory notes and manuscripts, oral histories and chronicles. The thesis draws on many small facts to lend credence to the interpretive offerings. Although rigorous, the work cannot be foolproof account. Nevertheless, the thesis implicitly assumes, as it must somewhat, the integrity of its subject matter, the man Fuller. This is the first step for further critical explication of Fuller's enterprises and artifacts.

21 April 1999.

Ch.1 From 4D-Dymaxion House to DDU & DDM-Fuller House, 1927-48

Richard Buckminster Fuller (1895-1983) [Fig.1.00a] was an American visionary known for his broad range and scale of futuristic artifacts -- from a three wheel "car" (the Dymaxion Transport Unit, DTU, 1933) [Fig.1.00c], a new type of map (the Dymaxion Map, 1944) [Fig.2.14b] to a prefabricated sky-floating geodesic spherical city, one-mile in diameter called "Cloud Nine" (1968) [Fig.3.47a]. His humanistic-philosophical concerns, enmeshed in his artifacts, centered on the issue of personal and efficient control of technology. Technology's main purpose, he proposed, was to create an egalitarian and abundant world-society, albeit modeled after American social and technological sensibilities.

This chapter traces the beginnings of Fuller's interests in the industrialized house project or "repro-shelter," as he billed it. Two exemplars of this "repro-shelter" project, the Dymaxion House and the DDM-Fuller House are canonical artifacts in American modern architectural history [Fig.1.00b]. The chapter examines the course that he took to explore, to prototype and to advance his enterprises, collectively called the Dymaxion projects. It examines the pivotal projects, apprenticeships and experiences prior to 1948 primarily to highlight how they contributed towards shaping Fuller's geodesic project. The focus is on Fuller's 4D-Dymaxion House projects, his short stint in inaugurating the *SHELTER* journal; his self-created "volunteer designing association," the Structural Study Associates (SSA), and finally the culmination in his first industrial prototypes, the Dymaxion Deployment Unit (DDU) and the Dymaxion Dwelling Machine (DDM)-Fuller House or the Dymaxion Wichita House. Particular attention is given to how Fuller advanced these projects through a difficult but productive, self-appointed position as an outsider.

The issue of shelter for the single-family remained a recurring feature of his life-work. His quest was to factory-manufacture a highly practical and high-performance shelter, purged of any cultural connotations. After a series of "experimentation" Fuller finally reduced his project to the issue of a environmental-structural shell, in the form of the geodesic structure, and attempted to demonstrate the feasibility of this minimalist idea.

1.1. Invention of the 4D House (1927-28)

Fuller achieved his first public acclaim with the Dymaxion House upon its premier in the Chicago galleries of the departmental store, Marshall-Field in April 1929 [Fig.1.05a-d]. This futuristic-looking house of a hexagonal plan, suspended on a mast captivated the attention of the American public in the thirties. It remains to this day a quintessential architectural object of America's technological optimism. Despite its "universalist" impetus and basis, the Dymaxion House is paradoxically a parochial object which emerged from the cultural-social milieu of America in the deep throes of its economic Depression of the thirties.

Little is known of the circumstances or the theoretical underpinnings of this phase of the house-invention. Even contemporary accounts of the Dymaxion House tend to focus on its formal invention as a type, only to relegate it into the margin as a technological novelty. Further, between what actually happened and the legends woven around his creative activities, there lies a gulf of unsettled questions about Fuller's intentions, vis-a-vis his artifactual production. The beginnings and the value of the Dymaxion House exceeded the popular characterization and they are also significant to Fuller's geodesic structure invention in the late forties.

In 1928, a year before the Dymaxion House was premiered at the Marshall-Field, an ethically and symbolically charged version was proposed as 4D House. Public knowledge of this antecedent was kept to a selected audience, privileged enough to receive his collection of mimeographed, aphoristic essays, the "4D - An Aphoristic Essay of Research." This was subsequently contracted to *4D Timelock*. With the transformation of his 4D House to the Dymaxion House in 1929, Fuller and his Dymaxion idea-artifacts began to assume an almost legendary status. It prompted a newspaper reporter, Dorothy Baker, to offer the earliest fictional narrative of the man and his artifact. She suggested that the Dymaxion House had:

> been in conception in the mind of Buckminster Fuller since 1922, when he was thinking loosely upon the subject. In 1927 he went into the slums of northwest Chicago and spent eighteen months in systematic thought upon the subject.[1]

[1]Dorothy Baker, "Facts on the Dymaxion House and Its Originator, Buckminster Fuller, *Art Alliance-Philadelphia*, 9 December, 1932 (Copy in BFI-CR42).

1.1.1. Fuller the Man

Baker's account above initiated the subsequent popular and received account of the genesis of the Dymaxion House. To a large extent, its salient features of a selfless mission, a systematic project and the implicit moral outrage at the death of his first daughter Alexandra in 1923, were promulgated by Fuller's own presentation of his cause. The Dymaxion project was one that went beyond the mere entrepreneurial proposition of a factory-made house. To understand his predisposition to an unorthodox mission, Fuller's biographers have generally offered the exemplars formed by the pedigree of his illustrious family history.

Richard Buckminster Fuller was a descendent of five generations of distinguished Americans. This lineage of New England family received exclusive Harvard education; and his great-grand aunt Margaret Fuller was the most formidable transcendentalist intellectual of Emerson's stature.[2] His illustrious forbears were also advocates for the principle of greater freedom; whether for the colonies (Lt. Thomas Fuller), or the slaves (Timothy Fuller & Rev. Arthur Buckminster Fuller), or the student body at Harvard (Timothy Fuller Jr.), or women (Margaret Fuller). On this basis, one of Fuller's biographers, Sieden, concluded that Fuller was "the culmination of several generations of New England non-conformity."[3] Privately, Fuller also cherished his pedigree background.

The situation Fuller found himself in, in the winter of 1928, when he was thirty-two years old, nevertheless, did not commensurate with the illustrious history of his forebears. Perhaps for this reason, he felt compelled to extricate himself from the mundane setting of life. The 4D House was a product of these few "desperate" months of search for a self-mission.

1.1.2. Stockade Building System

By Fuller's own account, and those augmented and dramatized by his biographers, he held a promising and responsible position in his father-in-law's enterprise until a purported

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[2] See the Fuller family history in "Historical Notices of Thomas Fuller and Descendants, with a Genealogy of the Fuller Family" in *New England Historical and Genealogical Register* (Oct. 1859); also Appendix in *Memoirs and Works of Margaret Fuller*, Vol.I, Boston: Walker, Wise, 1863. For a critical account of Fuller's ancestors, see Karl M. Conrad's "Buckminster Fuller and the Technocratic Persuasion," U. of Texas-Austin, Ph.D. Thesis 1973 [Modern History], especially Ch.1 "Technology and the Fourty Fullers" (Henceforth as "The Technocratic Persuasion"). For a popular rendition of Fuller's ancestors, see Lloyd S. Sieden's *Buckminster Fuller's Universe, An appreciation*, N.Y.: Plenum Press, 1989, p.2ff (Henceforth as *Buckminster Fuller's Universe*); also C. Tomkins' "Profiles - In Outlaw Area," *The New Yorker*, 8 Jan. 1966, pp.52-54.

[3] L.S. Sieden, *Buckminster Fuller's Universe*, p.1.

business coup which ousted him. James Monroe Hewlett, Fuller's father-in-law, was a distinguished New York architect and President of the Architectural League who alongside his professional practice, also built up between 1914 and 1922, a line of patented concrete products called the *Stockade Building Systems*[4] [Fig.1.01a-b]. This was a fibrous, non-absorbent and lightweight block form-work with holes that enabled a structure of concrete, almost in the alignment of a "stockade," to be cast within it. Between 1922-27, as the President of Stockade and overseeing some two hundred odd building operations, Fuller was also actively responsible for improving its line of design. For his contributions to Hewlett's art in inventing a machine to cut short the fabricating processes, he jointly received with Hewlett, two new patents in June and July 1927.[5]

The Stockade business, Fuller explained, provided him his first encounter with the world of building art, or a conservative art of people "who build on the land."[6] Despite being lightweight, easily workable on site, and cheap in material cost, the *Stockade Building Systems* did not reach the market for small low-price housing. Fuller blamed it on a whole host of irrational factors: financing difficulties, building codes and various union disputes over the jurisdiction of work. Finally, it was the general newness of the technology which caused "the entangled coordination among client, architect and contractors."[7] In this sense, one could argue that the impetus of the Dymaxion House was to bypass these institutional and cultural obstacles. However, Fuller's own narrative on its genesis cast the circumstances differently.

1.1.3. A Personal Setback, Resolve or Epiphany

The details of Fuller's unceremonious departure, around August 1927, from the Stockade Building Systems Company are irrelevant for the understanding of the genesis of the Dymaxion House.[8] What is more significant is Fuller's characterization of the event. He explained that the

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[4]See "Concrete Product," Feb. 1926, pp.39-40 and "Stockade Building System" in *Architecture and Building: pp.66-67*; see also M. Hewlett's "Modernism and the Architect," *AIA Journal*, 16 June 1928, pp.340-342.

[5]U.S. Patent #1,633,702, "Stockade Building Structure"(applied in October 1926); U.S. Patent #1,634,900, "Stockade: Pneumatic Forming Process" (applied in December 1924). Hewlett's own patent was U.S. Patent #1,604,097.

[6]A. Gerber Jr., "The Educational Philosophy of R. Buckminster Fuller," Ph.D. Thesis (University of Southern California), Dec. 1985, p.43. Henceforth as "The Educational Philosophy."

[7]R.B. Fuller, "Designing a New Industry" [A Composite of a series of Talks ca. Jan.26 '46], Wichita, Kans.: Fuller Research Institute, 1945-46, p.8. Henceforth as "Designing a New Industry,"

[8]Accounts of his departure ranged from "betrayal by new management and stockholders" (See Gerber, "The Educational Philosophy," p.46), betrayal by investors of the Stockade subsidiary companies who were "Fuller's kinsfolk" (A. Hatch, *Buckminster Fuller, At Home in the Universe*, N.Y.: Crown Publisher, Inc., 1974, p.83; henceforth as *At Home in the Universe*), conflict between "making good building and making money"(R.B. Fuller & Louis M. Cochrane, "A Sense of Significance," BFI-MSS 76.12.01, p.4) to a fall-out between Monroe Hewlett over the business

"chaotic bust up of (his) control of Stockade" was due to "incompatibility (with his) traditions, (his) ideals, business and industry."[9] Thus rather than seen as personal disgrace, his proposed factory-house project was rendered as a self-mission to reform the existing state of housing -- converting it from an art of "methodical ignorance" into an industry.[10]

However, before the inauguration of this self-mission, versions of Fuller's biography and Fuller's own rendition, described how he was jolted into an epiphany from a moment of deep personal crisis and despair, during which he contemplated on "suicide." This was a moment, he explained to Louis Cochrane, when he decided to start his "life all over again" and vowed to do (his) thinking and wrote *4D Timelock*.[11]

Fuller first publicly offered a dramatized account of the epiphany in a autobiographical sketch that he wrote to Joe Byrant, a writer with *Times*, after the success of his book debut, *Nine Chains to the Moon*, in 1938.[12] Subsequent biographical renditions of Fuller drew upon this account.[13] In second person, under the section on "Family & Career," Fuller recounted the turning tide of his personal crisis which led to his legendary epiphany:

> Now came the great crisis in his life. No job, no money, infant daughter, betrayed by people he had trusted. He walked over to the lake and thought about suicide. Should he call his life a bad job and throw it away? Or should he try to figure out some way to make it all the experiences of it bitter or happy, useful? He took stock of himself, and realized that he had had a full life, and that he had acute understanding. At first, he had thought that other people were deliberately stupid, because it was chichi to be so, but later realized that they knew no better.
> Here on the lake shore, was his first real thinking about life objectively, its bigger meanings - hitherto he had been a part of it without perspective. He became aware that one can think and does only in terms of experience, and he concluded that for this reason one could hurt only in terms of experience. Thus, if one follows the tracery of experience clearly and closely enough - which would involve discarding many accepted beliefs - one would find the main road from which one had formerly digressed into the blind alley that ended in hurt. This fact would make possible the prevention of hurt not only for oneself but for others.[14]

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at Stockade (K. Simon & K. Goodman, Transcript of Interview with T. Salemme, pp.4-10). See also Fuller's *Monologue*, p33.

[9]Draft Ltr. n.d., ca.1932 RBF to W. A. Delano (Pencil Points) in BFI-CR42

[10]Robert W. Marks, *The Dymaxion World of Buckminster Fuller*, N.Y.: Reinhold Publishing Corpn., 1960, p.17. Henceforth as *The Dymaxion World*

[11]R.B. Fuller & Louis M. Cochrane, "A Sense of Significance," p.4.

[12]Ltr. 7/1/39 RBF to Joe Byrant in BFI-CR46. The letter contained six parts: Dymaxion House (13pgs.), Dymaxion Car (9pgs.), Miscellaneous Observations (5pgs.), Personal (5pgs.), Family & Career (22pgs.) and The Book (3pgs.). (Copy in BFI-HEv20)

[13]In the earliest proposed biography on Fuller, tentatively titled "Work of R.B. Fuller," Richard Hamilton (of Bemis Foundation, MIT) reconstructed Fuller's career using Fuller's letter to Joe Byrant with few alterations.

[14]Ltr. 7/1/39 RBF to Joe Byrant, p.11.

In *4D Timelock* Fuller directly alluded to this contemplation of suicide, as "throes of mental anguish" which included the consideration of "jumping into the lake."[15] Fuller subsequently reworked the drama as a suicide foil accompanied by divine instruction:

> I couldn't believe it ... I heard a voice as I had never heard, ever before saying, 'From now on you need never await temporal attestation to your thought. You think the truth.
> ... I said to myself, 'You do not belong to you, therefore you do not have the right to eliminate yourself. You belong to the universe.[16]

Whatever the actual details entailed, subsequent embellishment and reworking over layers of Fuller's epiphany by his biographers collectively attested to its significance.[17] The mysticism associated with Fuller is generally traced to this event. Clearly, in Fuller's narrative, being ousted from Stockade was a traumatic experience, a wake-up call. Needless to say, the necessity to settle into a temporary job as a sales representative for a Waukegan firm manufacturing floor tiles on a fifty-dollar-week salary was a let-down.[18] But this was far from the dire state of despair faced by many Americans in the deep throes of the recent Crash. Even if one is skeptical of the urgency of Fuller's account, his unemployment clearly threatened the gentility and prestige of his Eastern middle-class identity.[19]

As if to test the tenacity of his new found awareness after the epiphany, Fuller further recounted to Bryant how he was mugged. The physical "blow was what he needed to send him into action" and his resolve to stay in Chicago to "work out his fate there and then."[20] He sustained the momentum of his newly found strength during those three months through a disciplined routine of work and sleeping half-an-hour snatches four times a day. The work that

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[15]R.B. Fuller, *4D Timelock*, N. Mex.: Lama Foundation, 1970, p.41. Henceforth as *4D Timelock* (1970). This is to distinguish this version from the original collection of aphoristic essays *4D Timelock* (1928).

[16]Robert Synder, *Buckminster Fuller: An autobiographical Monologue/Scenario*, N.Y.: St. Martin's Press, 1980, p.35.

[17]Marks described the new resolve involving "a deep introspection and critical self-evaluation with a transcendental mission" (R.W. Marks, *The Dymaxion World*, p.18); Rosenberg described the "symbolic suicide" as merely two years of spiritual withdrawal from society (Sam Rosenberg, "The man in the White Suit," unpubl. MS. in BFI-CR64, p.7); Kenner characterized the fateful night by Lake Michigan as a "vision of destiny" (Hugh Kenner, *Bucky - A guided Tour of Buckminster Fuller*, N.Y.: William Morrow & Co., Inc.1973, p.176); Conrad was skeptical of the apocryphal event of 1927, and suggested that the conversion was carefully crafted to mimic the fate of the city of Chicago after the Great Fire - like a phoenix from ash (K.M. Conrad, "The Technocratic Persuasion," p.166); finally, Kiyoshi Kuromiya cited a 'New Age' rendition in Barbara Max Hubbard's version of the attempted suicide:

> (Fuller) actually saw a figure bathed in light that came and talked to him. He was in such despair, he was hearing voices (Notes from Author's Interview with Kiyoshi Kuromiya, Boston 6/25/95).

[18]R. Hamilton, "Notes on (RBF's) Career," p.11.

[19]See Fuller's membership transfer for the Cedarhurst Yacht Club-N.Y. (Ltr. 3/5/28 in BFI-CR34), and cancellation of his Somerset Club membership, Boston, Mass. (Ltr. 3/14/28 in BFI-CR34).

[20]Ltr. 7/1/39 RBF to Joe Byrant in BFI-CR46. p.9. For Fuller's detailed recount of his days in Chicago, see Fred Kutchin's "The Elite Feature Interview: Inquiring for Buckminster Fuller," Chicago Elite, Nov.-Dec. 1977, Vol.2, No.6.

Fuller referred to was the theorizing and strategizing of the formation of a new corporation based on his experiences with the building industry.

1.1.4. Emergence of the "4D-House" from "Lightful House"

Fuller's strategy for the new house industry is outlined and detailed in a series of notes, both handwritten and typed.[21] Labeled "Lightful Houses," this rambling 70-page document was assembled during the "holly week" of April in 1928.[22] These notes preceded a "2,000 page manuscript," which Sieden and Hatch claimed was eventually re-edited into the fifty-page *4D Timelock*.[23] In all likelihood, neither biographers are likely to have seen this document.[24] The remnants of this larger manuscript are contained in "4D File Manuscript MSS28.01.01."[25]

"Lightful Houses," consists of three parts: a 70-page manuscript which is preceded by three other documents; a one-page "Introduction," and; four pages containing two versions of "Lightful Products." The second version outlines Fuller's agenda with respect to the individual

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[21]R.B. Fuller, "Lightful Houses (Preamble for Cosmopolitan Homes Corporation)," n.d., ca. Holy week, Apr.1928, [75pgs.] in BFI-CR64.

[22]Several citations in the manuscript provided its dating: Fuller's assessment of Lincoln's public life at the time of his anniversary remembrance (12 February), his recount of the launch of Ford Model-A car at the Ford Industrial Show (February 1928, See R. Hamilton, "Notes on (RBF's) Career," p.11) and a direct mention of the "holly week" in 1928.

[23]The well-known version of *4D Timelock* published by Lama Foundation in 1970 consists of two sections. The first section consists eighteen chapters (pp.1-31), which probably formed the original *4D Timelock*; the second section, a "Chromochronofile" of nine parts (pp.38-148) was added later, after the A.I.A. meeting in St. Louis. Of the extant drawings, it is clear that not all the drawings were from the original manuscript; some were added after the Harvard Society of Contemporary Art Exhibition in May-June 1929.

[24]Hatch probably based his evidence from a letter (Ltr. 5/21/28 RBF to Henry Tomlison in *4D Timelock* (1970), p.43) in which Fuller mentioned that the presentation to "18 members of the American Institute at St. Louis" was distilled from a "two-thousand" page manuscript (A. Hatch, *At Home in the Universe*, pp.103-4).

> In 1939, Fuller recounted that the "5,000 page MSS. was "clipped" as separate items to be send: When the distribution was finished, (RBF) found that the different sheafs (sic) of items had a definite continuity, so he clipped the named off them, put them together and made them the separate chapters of his book 4D Time Lock ("Notes to Joe Byrant," 7/1/39, p.11).

[25]There are fourteen components in "4D File Manuscript MSS28.01.01," variously dated or undated. The earliest, Item#7 is from January 1928, the last probably Item#12, mentioned of "Dymaxion." "Lightful Houses " was previously a part of Item#8. All these items are located in BFI-CR64:

1. "4D File Manuscript MSS28.01.01, Folder IX" [Notes1, 2pgs], ca. 1928.
2. "4D File Manuscript MSS28.01.01, Folder IX Lightful Houses" [Notes2, 13pgs], ca. 1928.
3. "4D File Manuscript MSS28.01.01, Folder IX" [Notes3, 2pgs.], ca. 1928.
4. "4D File Manuscript MSS28.01.01, Folder IX" [Notes4, 10pgs.], 16 February 1928.
5. "4D File Manuscript MSS28.01.01, Folder IX Lightful Houses"[Notes5, 8pgs.], ca. January 1928.
6. "4D File Manuscript MSS28.01.01, Folder IX " [Notes6, 4pgs], ca. 1928.
7. "4D File Manuscript MSS28.01.01, Folder IX " [Notes7, 20pgs.], 10 January 1928.
8. "4D File Manuscript MSS28.01.01, Folder IX" [Group I notes] ca.1928.
9. "4D File Manuscript MSS28.01.01, Folder IX" [Group II notes, 21pgs] ca. 1928.
10. "4D File Manuscript MSS28.01.01, Folder IX" [Group III notes, 4pgs] ca. 1928.
11. "4D File Manuscript MSS28.01.01, Folder IX" [Group IV notes, 13pgs] ca. 1928.
12. "4D File Manuscript MSS28.01.01, Folder IX" [Group V notes, 20pgs], ca. 1929.
13. "4D File Manuscript MSS28.01.01, Folder VII," [Loose notes] ca. 1928.

consumer, his place in the home and the relationship of both to the impending "world-shelter industry." Collectively, the manuscript was a preamble and plan for his newly envisaged enterprise, the Cosmopolitan Homes Corporation. The manuscript was thus a draft for a pamphlet to be distributed to potential speculators for his proposed corporation, an investment vehicle for his new house project. However, when the document was incorporated as a collection of aphoristic essays in Fuller's self-published tract, *4D Timelock*, as Chapters 15 & 16, the name of its trademark house was changed from "Lightful" to "4D." Concurrently, the Cosmopolitan Homes Corporation (at that time qualified as a "holding, organizing, and research company") was also dropped from the final description in *4D Timelock*.

The actual period of intense writing probably occurred between November 1927 and March 1928.[26] A more reliable dating of these activities can be perused from Fuller's diary entries between January and February 1928. Writing in second person, Fuller noted:

> 25 Jan 1928: RBF (Fuller) worked on general organizational plans of Fuller Houses ... studied the philosophy of the home, home building, etc. Philosophy of new design.
>
> 28 Jan 1928: Went to see opening of automobile show...Looked at body work with thought of its application to Fuller Houses, also questions etc.... on how (it) could apply to marketing Fuller houses.
>
> 29 Jan 1928: Clearly impressed with the Auburn automobile, RBF wrote: 'Wrote data for Auburn advertising, stressing no high-powered sales. Will only sell you if you can afford & have need then we have the best (kind) which you want. Lots of psychology to this and will probably keep it for Fuller House.'
>
> 30 Jan 1928: Called on Russell Wollcott(sic) & borrowed Le Corbusier's book 'Towards the New Architecture'. Went to the Ford Industrial Exposition. Marvelous Exhibition on processes of glass, steel, etc. airplanes and tractors. RBF read Le Corbusier until very late at night. Startled at coincidence of results arrived at in comparison to Fuller Houses but misses main philosophy of house as against house.
>
> 3 Feb 1928: Made study of what 10-cents stores marketed while waiting for train. On the train wrote outline of ... Fuller Houses for (the) patent lawyer.
>
> 5 Feb 1928: RBF up early to Church at St. Chrysontan's Sermon. RBF terribly inspired by general philosophies revealing themselves so clearly & plan of life. It's (sic) source design, not waiting power. Basis of planning & thinking, etc.... wrote some notes for Fuller Houses.
>
> 20 Feb 1928: I walked up to the Drakes(?) to discuss the Fuller Houses. He (was) much taken with the whole idea and its philosophy. Glad to hear me say that God was basis of the plan.[27]

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14. "4D File Manuscript MSS28.01.01, Folder VI," [Loose notes] ca. 1928.

[26] Folder IX (Notes 7) in "4D File Manuscript MSS28.01.01," was dated November 1926, with signatures by Anne (Fuller's wife) and Fuller. It was countersigned later (2/22/28) by L.J. Stoddard & R.F. Hussey. The Nov. 1926 date, probably a later back-dating, is unreliable.

[27] R. Buckminster Fuller, Journal entries, January 25 to February 20, 1928 in BFI-CR34.

1.1.4.1. Intentions and Sources of Influence

These diary entries above are significant at several levels. First, they suggested that Fuller envisioned the new form of business as a personal creation, and hence the choice of its initial name "Fuller Houses." Probably, the decision to opt for "Cosmopolitan Homes" later was, on the surface, an act of deselfing. However, it was also likely that the distancing was a strategy to attract venture capitalists. By May 1928, however, both "Fuller Houses" and "Lightful Houses" as trademarks of his proposed corporation were abandoned in favor of "4D."

This proposal for a new type of industry immediately captivated the support of two venture capitalists from Chicago, Russell Walcott and John Douglas. An extant contract attested to their financial support. Under the terms of the contract, Fuller received from R. Walcott a sum of $500. In return, Fuller would develop the prospective patent for a "new method of housing and housing units" to a point where it would be revenue producing.[28] Walcott and Douglas further agreed to bankroll Fuller's efforts for six months "from time to time" but for an amount not exceeding $5,000. In return, they would receive stock in the said corporation or trust certificates based on the project valued at $100,000. Fuller would in turn "devote all of his time and his best endeavor to develop said invention" and agreed "not to assign, sell or otherwise dispose of said application for patent ... except to such corporation recognized by (Fuller)." On the basis of this arrangement, Fuller was able to settle, by June 1, 1928, the legal fees for filing the 4D House patent owed to his lawyers Messr. Emery Booth, Janney & Varney (Chicago).

How Walcott met up with Fuller is not entirely clear; but one could speculate that his earlier business dealings in Stockade might have played a role. More significantly, Walcott, whom Fuller characterized as "the best of residential designers in Chicago," was well-versed with sympathetic "modern" architects which included Arthur Holden, John Boyd Taylor, Harvey Corbett and Hugh Ferriss. Walcott also probably enlisted the support of John Douglas, a Chicago banker and others at a later stage.[29]

The entries also established, for the first time, that Fuller read Le Corbusier's work during his preparatory notes for " Lightful House." He noted that in November 1927, he had learned of Le Corbusier's book during his first contact with Russell Walcott.[30] So taken aback

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[28] See "Contract for 4D House" in BFI-CR35.

[29] R.B. Fuller, *4D Timelock* (1970), p.71.

[30] Ltr. 8/11/28 RBF to Rosamond Lucilla Fuller in BFI-CR46 (also in *4D Timelock* (1970), p.79).

was Fuller by the coincidence of his idea with Le Corbusier over the factory-house that he suggested that 'Towards a New Architecture" should be read in conjunction with "4D":

> My own reading of Corbusier's 'Towards a New Architecture,' at the time I was writing my own, nearly stunned me by the almost identical phraseology of his telegraphic style of notation with the notations of my own set down completely from my own intuitive searching and reasoning and unaware even to the existence of such a man as Corbusier.[31]

Despite the uncanny resemblance of Le Corbusier's "machine à habiter" project to his, Fuller would eventually articulate the details and ideological gulf that separated their projects. The source of Fuller's departure from the Corbusian mass-produced house was in what he saw as new patterns of consumption emerging in the mass-commodity market and, in particular, in the "10-cent store" and the car industry. The issue of the mass market was no longer dependent on production techniques alone; rather, it was gradually shaping and being shaped by its distribution, marketing and services. His positive reception of the mass market & culture was proffered by models he drew from popular music, literature, drama and the graphic arts. In a tone echoing the ideas of Adolf Loos, he explained that these new arts were:

> created on a reproducible basis of a vast and invisible scale, world encompassing, for the great new patrons of the arts, the public, the human family of individuals ...
> What would we think of a man walking the city streets in silk and lace neck ruffle today, or a lady in a hoop skirt? Would we concede individualistic beauty to a girl with her nose in the middle of her back?[32]

Though Fuller's ideas about industry appear quaintly European, there is no evidence that he read either German or French or that he was familiar with the cultural notions of mass object arising from the European experiences. For this reason, "Lightful House" and subsequently *4D Timelock* are seminal. They set down the uniqueness of Fuller's explication of the broad range of economic, social and technological conditions of America and how these factors shaped the iconic agenda of his artifactual production.

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[31]Ibid.

[32]R.B. Fuller, "Universal Architecture Essay No.1," *SHELTER*, May 1932, pp.60-62. Henceforth as "Universal Architecture Essay No.1."

1.1.4.2. "Lightful Houses": An Ideological, Aesthetic and Iconic Program for a Modern House

In his search for a name for his corporation and its trademark products, Fuller also considered "International Housing Corpn." to dramatize his "selfless" transnational business. Its publicity strategy, he annotated, would weave his self-history:

> Anonymousness(sic) of investor of this business, make it much more powerful, removal of jealousy factor, contain publicity linking feat and given tactical reservation feature. Have controlling stock nested in a closed corporation ...
> Popularization of truth makes it (the concept of the house) marketable. Story of precotious(sic) youth- introduction - this is no popular story but a practical application of thought (God) & the 4th. dimension time to business - by a worldly person ...[33]

Fuller primarily intended the 4D House project to be a profitable, transnational business.[34] This was evident in the untold hours he had invested in designing a trademark design befitting his 4D enterprise [Fig.1.07]. Through the presentation strategy above, Fuller found a way to diffuse the potential misreading of his return to business as a vulgar way to direct the revealed wisdom ensuing from his epiphany. Nevertheless, the notes, the name of the products and the emblematic sketches Fuller made are directly instructive of the contradiction and anxiety contained in this self-mission.

1.1.4.3. The General Tenor of "Lightful Houses"

"Lightful Houses" as a collection of preparatory notes is more direct and less contrived than its later reincarnation, *4D Timelock*. The subject matter of the latter is varied; but both, as documents intended for persuasion, are pedantic. As they informed potential speculators of aspects in the making and selling of the mass-produced houses, they also instructed on the larger, ethical project at hand. Both mixed biography, self-manifesto and advertising. Consequently, Fuller's discourse is generally, almost unreadable, full of jargons and often proselytizing. This style of presentation remained throughout Fuller's textual production; and perhaps, it accounted for his historically enigmatic position in architecture.[35]

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33 "4D File Manuscript MSS28.01.01, Folder IX" [Group IV notes] in BFI-CR64.

34 See strategic outline for the brochure for the Cosmopolitan Home Corporation especially, "How to make enterprise profitable from start" ("4D File Manuscript MSS28.01.01, Folder IX" [Group I notes]); also Fuller's proposal to extend 4D patents overseas (See Ltr. 1/24/29 RBF to D. Sweet in BFI-CR36).

35 The architectural critic, Martin Pawley added that Fuller's enigmatic position was factored by his failure to provide "a definitive book that (would) establish in a readable way what his position was, what he thought could happen, what

From May 16-18 of 1928, the American Institute of Architects (AIA) conducted its 61st Convention in St. Louis. Convinced that he had struck a "gold mine" in his idea invention, Fuller hastily re-edited the 75-page manuscript and supplemented it with several chapters which provided the theoretical underpinnings of the mission for his 4D corporation.[36] However, he failed in his attempt to solicit the support of AIA on a broad scope of his grand project. In deep frustration, he added new material to the second edition of *4D Timelock*. Chapter nineteen, "Land to Sky. The Outward Progression," especially, is summarily a caustic criticism of the profession and simultaneously an explication of Fuller's moral ethics.[37]

At a cursory level, despite its billing as his "essential monograph," *4D Timelock* was a pragmatic object to document and establish prior art and copyright to his ideas of a repro-shelter industry. Associated with this entrepreneurial project for a "standardization" in the "industrialized house," Anne Fuller suggested to her brother-in-law Wolcott Fuller, that the project was also concerned with the "waste," and "the efficiency in modern house building and the moral effect of living under (such) conditions."[38] Furthermore, the portability of the industrialized house would "erode the bond value's dependence on land and building value."

Historians and Fuller's biographers, placing *4D Timelock* in the context of Fuller's lifework, have interpreted this writing differently. Karl Conrad, in probably the first critical biography of Fuller, "Buckminster Fuller and the Technocratic Persuasion," saw it as a "sanguine" dedication to the American middle-class elite.[39] John Meller, writing more generally, fitted the work into a particular genre of confession modeled after Henry Adams' *The Education of Henry Adams*.[40] Both are reasonably accurate assessments.

Henry Adams, America's foremost literati-philosopher, for example, had called his life's experience a tailor's mannequin, which could be used as a metaphorical gauge "to show the

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he thought should happen, what could be done" (K. Simon & K. Goodman, Transcript of Interview with M. Pawley (for a PBS documentary "Thinking Out loud"), N.Y., ca. 1995, p.28).

[36]Ltr. 5/11/28 RBF to C.W. Fuller in *4D Timelock* (1970), p.43. Sufficiently convinced of the prognostications of his "'strictly confidential' strong paper," Fuller also advised his mother to relinquish their Cambridge property to finance the expansion of their island (Bear Island, Maine) property. Planning the island as "landing facilities" for air-delivered "4D-House," Fuller continued:

> In a year or so when my 4D houses are ready we will be able to put them up on the islands in one day with every facility of modern city luxury built in... on an installment plan, for a dollar down (Ltr. 7/16/28 RBF to C.W. Fuller).

[37]Additional material in Part Two (listed as "Chromochronofile") consisted of sections IV to IX.

[38]Ltr. 8/10/28 A. Fuller to W. Fuller in *4D Timelock* (1970), pp.77-78.

[39]K.M. Conrad, "The Technocratic Persuasion."

[40]James Meller (ed.), Introductory remarks on "Influences on my Work," *The Buckminster Fuller Reader*, p.51.

(student) the faults of patchwork fitted on their fathers."[41] It is also instructive to note that Adams' biography was based on a new conception of self defined not by nature or religion or specific events and achievements but by family, history, and civilization.[42] Thus, most directly, Adams' biography offered Fuller a direct cue for his eventual self-portrayal as "Guinea-pig B"(B for Bucky).[43] This self-characterization, science-writer Calvin Tomkins proposed, is both "modest (and) immodest."[44] Tactically, it was meant to diffuse the aura of mysticism that subsequently surrounded Fuller's public image in the late fifties. After all, no prophets, Ed Applewhite, Fuller's confidant argued, would call themselves guinea-pigs.[45]

"Lightful Houses" and *4D Timelock* spelt out the challenges in integrating self-mission and business. It would bridge the gulf between individual effort and the wide chasm of social organization produced by the industry. In such a grandiloquent project, Fuller indirectly reworked the cultural angst faced by Henry Adams in his search for an organic framework to direct formal actions. To evoke a sympathetic reading of and to imbue a recognition towards a particularly middle-class anxiety, Fuller suggested that rather than lamenting the dwindling of moral energies of the genteel class, he would revitalize its presence. Thus, in contrast to what Conrad described as Adams' strategy of recuperating late-19th Century America through her "archaeological and historical" past, Fuller's proposed project offered redemption in the orbits of mass consumer industry.

1.1.5. An Image of the Product

Despite its primary intent as a business prospectus, "Lightful Houses" is replete with Fuller's theological and scientistic speculations. These speculations were directed to support his ethical arguments. It is not clear exactly when Fuller dropped "Lightful" or "Fuller House" in favor of "4D," but one could speculate that it probably happened before the first patent claim of the 4D house was lodged in June 1928.[46] Though Fuller abandoned the patent application subsequently because of the rejection of several of its claims, the commercial impetus and the strategic potential in the name-change was clearly astute.

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[41]Quoted in "The Proper Study: Autobiographies in American Studies," *The American Autobiography,* (Robert F. Sayre and Albert E. Stone, eds.), Chapel Hill: The University of North Carolina Press, 1987, p.24.
[42]Ibid., p.24.
[43]R.B. Fuller, *Monologue*, p.39.
[44]K. Simon & K. Goodman, Transcript of Interview with Calvin Tomkins (for a PBS Documentary "Thinking Out loud"), ca. 1995, N.Y..
[45]Author's Notes of Robert Duchenay's Video-Interview with Ed Applewhite, ca 1993, Washington D.C.

The rhetoric for and the image evoked by "Lightful House" were apologetically Christian. "Fuller Houses" was too closely identified with invention. It was a risky promotional strategy for someone without a proven record of accomplishment. It was also inappropriate for a business based on a self-professed "deselfed" mass-industry. Anne Fuller reasoned that the trademark change was "expressive" of its aims, and steered the project "away from the personal element."[47]

"4D" the abbreviated form of "4th Dimension," on the other hand, was a witty trademark that punned Ford and Ford (Model) -T.[48]. Fuller's "4D industrial world," an industry which he claimed that Henry Ford had anticipated but failed to realize, would compress, condense and integrate extant mechanisms of household services for personal control and consumption. The 4D House, however, stood for more than a mass-produced house.

"4D" as fourth dimension was fundamentally about the effect of deploying the time element in the house industry. By inference, a 4D House stood for a house conceived for all facets of time-saving from its production, its maintenance to eventual use. It allowed Fuller to transform the implications of "light" as energy and weight into time.[49] Time saved was an objective measure of efficiency, with deep ethical resonance in the emerging corporate-industrial society. The gospel of efficiency was gradually shaped during the post-World War I years by the success of scientific management of Frederick W. Taylor and the Gilbreths.[50] Nevertheless, it is still instructive to examine what Fuller intended of the iconic label, "lightful."

Fuller's early descriptor "lightful" was significant iconologically in a two inter-related ways. "Lightful" was a double-coded semantic contrasting the significance of lightness as

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[46]See R.B. Fuller, "4D File Manuscript MSS28.01.01, Folder IX," (Notes6).

[47]Ltr. 8/10/28 A. Fuller to W. Fuller in *4D Timelock* (1970), p.77.

[48]R.B. Fuller, "4D File Manuscript MSS28.01.01, Folder IX," (Notes7).

[49]Fuller was particularly proud of this trademark, as he recounted in later years, even after the public had identified this phase of his work more with "Dymaxion":

> I titled the first mimeographed book 4D which I copyrighted. I am sure that many big TV corporations have wanted that copyright title of mine in the last decade. They have had 2D, 3D & then one Texas Company jumped to 5D, *because nobody can use 4D because it belongs to me*. You may remember that it stands for Four Dimension Design Science. It has all come out true (Ltr. 9/26/63 RBF to E.G. Freehafer in BFI-CR247; Itl., my emphasis).

[50]For an overview of the social effects of Frederick W. Taylor's "Principles of Scientific Management" (1911) and the Gilbreth's "Motion Study" see Carroll Pursell's *The Machine in America - A social History of Technology* (Baltimore: The John Hopkins University Press, 1995); Thomas Hughes' *American Genesis. A Century of Invention and Technological Enthusiasm 1870-1970* (N.Y.: Viking Penguin, 1989); William E. Akin's *Technocracy and the American Dream, The Technocrat Movement, 1900-1941* (Berkeley: University of California Press, 1977); Cecelia Tichi's *Shifting Gears. Technology, Literature, Culture in Modernist America* (Chapel Hill: The University of North Carolina Press, 1987).

opposed to weight and substance on one hand; and light as opposed to darkness, on the other hand. At one level, it articulated a leitmotif for the design of 4D House and subsequent artifacts; on another, it elaborated Fuller's "scientistic" explanation of matter to dissolve the bourgeois fixation with materiality.

Weight, Fuller argued, was the empirical quality of the "material" reality of the past. Under his iconic scheme, weight would be replaced by time, a new motif of the future. In an essay, "Universal Architecture Essay," which he wrote several years later, Fuller expanded the metaphor of weight to include the "weight of stylism and reality":

> There is no virtue in weight for itself... The progression of humanity is from stony darkness of complete and awful weight, to eternal light which has no weight.[51]

Unbeknownst to him, Fuller's iconic agenda in *4D Timelock* aptly fulfilled Sigfried Giedion's vision for the use of new materials in architecture. In 1928, writing in *Building in France. Building in Iron. Building in Reinforced Concrete*, Giedion demanded:

> As much as possible, the surmounting of weightiness. Light dimensions. Openness. Suffused with air.[52]

When Fuller coupled time with light, he treated both metaphorically as attributes of dissociated energy in contrast to matter which he considered as a form of associated energy. His philosophical-metaphysical approach to time and light echoed his theological duality of mind and body, premised on a Manichean belief in the necessity for the mind to be gradually "debodied" of its bestiality.[53]

The imperative of time, especially in time saved and the apparent efficiency of industrial time was meant to divest cultural and sumptuary distinctions which were traditionally encoded in objects as time expenditure. Thus, by "worshipped materialism," Fuller referred to objects and materials which assumed their respective status by time invested or expended as human labor in working. This "material specie" distinction, Fuller argued, was used to sustain "sensorial

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[51] R.B. Fuller, "Universal Architecture Essay No.1," p.63.

[52] Werner Oechslin, "'Material Vision: Modernism, a Formal or a Constructional Problem?" *Daidalos*, Vol.56, June 1995: 64.

[53] "Lightful Houses," p.33.

individualism."[54] Further distinctions were incrementally created when skill replaced labor, and intellect replaced skill.

With respect to how cultural distinctions were constituted in material, Fuller's example in "Lightful House" was more rhetorical than critical. Thus, stone as a category of material, though unworked by human labor assumed a natural distinction by its "trapped" natural time.[55] This was the static time that Fuller referred to, a material in a "time lock." However, he proposed that increasingly it was active time as time saved that was the new measure of worth and wealth.

Light, on the other hand, in Fuller's metaphysics of time-matter, represented a most perfect, friction-less and energized state -- it was fleet across the bounds of space and existence. Thus, "light" in "lightful" is both about a state of being lightweight, where matter is rarefied; and a state of all-around brilliance, with a reduced darkness. Besides its Manichean underpinnings and theological allusions, such a contrived construction was meant to undermine nominal notions of the permanence of the solid and to elevate an ideological-aesthetic preference for light-fullness and lightness. The American architect Philip Johnson, one of Fuller's life-long antagonists, explained that Fuller's ethical category, the "sin" of weight, was derived from his "New England (transcendental) sense." However, he offered that Fuller's "sense of lightness" and his aesthetic sensibility of "lightness as beauty" were "strange aberrations."[56]

Rather than aberrations, one could argue that up to 1927 as President of Stockade, Fuller's aesthetic and ethical sensibilities were gradually nurtured by his primarily industrial-logistic apprenticeships. These included his short stint, after Harvard, working as a "machinery installer" at Sheerbrooke Mills-Quebec (ca.1914-1915)[57], his naval service as a lieutenant (1915-1917),[58] his appointment as an assistant export manager in Armor & Company in New York City (1919-21),[59] and finally as a national account sales manager at Kelly-Springfield Truck Company

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[54]R.B. Fuller, "Universal Architecture Essay No.3," *SHELTER*, May 1932, p.41.

[55]"4D File Manuscript MSS28.01.01, Folder IX" [Group V notes], p.20; "4D File Manuscript MSS28.01.01, Folder IX" [Group IV notes]; also "Lightful Houses," p.17.

[56]K. Simon & K. Goodman, Transcript of Interview with Philip Johnson (for a PBS documentary "Thinking Out loud"), undated.

[57]See Athena Lord, *Pilot for Spaceship Earth*, Macmillan Publishing Company, Inc., N.Y., 1978, p.21; A. Hatch, *At Home in the Universe*, p.35; L. White "Bucky and the Dymaxion World," *Saturday Evening Post*, 15 October 1944, pp.22-23.

[58]L.S. Sieden, *Buckminster Fuller's Universe*, p.47; S. Rosenberg, "The Man in the White Suit" Unpubl. MS. in BFI-CR164, p.7; R.B. Fuller, "Later Development of My Work," *RIBJ*, June 1958, pp.77ff.

[59]J. McHale, "Richard Buckminster Fuller," *Architectural Design*, July 1961, p.290; R.B. Fuller, "Influences on my Work," *Architectural Design*, July 1961, p.47.

in 1922.[60] The successes of industry in general and technology in particular convinced him that the objective of industry was more than merely making physical products or the provision of services. Rather, industry was a skilled patterning of reality in the time-matter nexus, and hence his own scientistic speculations of his industrialized house in the time-matter manner.

Firstly, as an organized process for the re-composition of matter, industry reduced time invested in the working of material; secondly, and more directly, the new materials and objects in use saved time; thus, "surplus" time was made available freely. This time-matter model enabled Fuller to explain the reconstitution of time across many levels of experiences: from the microscopic constitution of matter to the middle-landscape of industrial products, to the macrocosmic world of the shop floor and resource logistics. Thus, Fuller's claim that:

> Industry makes possible one more dimension in design, the fourth dimension (time).[61]

Fuller used this time-matter foundation to equate progress in industry with the increasing lightness of its product. This lightness, manifested in time saved at all levels of production, dissemination and use, was an ethical issue in the broadest sense:

> (P)rogressive design must be time saving ... (and) is accomplished by the segregation of functions. As we segregate functions and solve them individually we get rid of superfluous matter. Therefore our design if properly conceived and solve(d) involves exceedingly light weight materials(sic). This saves in every handling from original source to ultimate disposition. (Incidentally, this deweighting process of material things goes hand in hand with the 'Debunking' process of the mind.)[62]

1.1.5.1. On the Urgency of Time – the Apocalyptic Timelock

Fuller's method of explicating time as a natural dimension is not philosophically rigorous, despite his attempt to pose questions pertaining to its ontology and nature. Nevertheless, he intuitively felt that some fundamental recognition of the nature of time was needed in order to address the condition of modernity. In the new materials of industry, he identified and illustrated the meanings of this nexus of time-matter.

Fuller's concept of the "4th dimension" in *4D Timelock* attempted to reform the mistaken identity of material as a factor in human failing and trapping. Fuller portrayed this

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[60]A. Hatch, *At Home in the Universe*, p.71.
[61]"Lightful Houses," pp.12-17.
[62]"Lightful Houses," p.3.

apocalyptically in his sketch of an hour-glass. In the final moments of reckoning, human figures are literally swept to their demise under the flow of time [Fig.1.04a-b]. For this reason, to heighten the redemptive meaning of his project, Fuller offered *4D Timelock* as revealed knowledge which emerged from "25 trillion hours" of composing time. Now the access to the philosopher's stone was a mere systematic five-hour reading of the prose. Besides the urgency of the project to human survival, *4D Timelock* also contained other connotations.

For a start, time posed as a moral asset relied on popular 19th Century homilies, particularly those of Benjamin Franklin. With Fuller, time saved as a potential resource was used to further promote the "cause of individualism" and for the cultivation of gentility, namely the "more philosophical and rhythmical contemplation of life."[63] Time read as "time arrow" assumed an active and directional nature and this, for Fuller, created a moral-ethical dimension when personal time engaged the social-collective time. This was the "time-faith" basis of all industrial products. In this time-arrow, style was tied to static time, wasteful repetition and redundancy. Thus Fuller noted:

> It is not without exaggeration that there are probably 20,000 draftsman daily in offices in the United States who are detailing the same window, for the Thousandth Time.[64]

Fuller surmised that in industrial societies, ironically despite the pervasive sense of alienation, one man's time overlapped another's. This allowed for conscious "time-saving" which otherwise would be segregated or lost in individual actions. Initially, via centralized production, and later as decentralization, activities of modern industry generally formalized and visualized time in terms of fluidity as rate, in synchronicity as coordination and in productivity as abundance. Fuller's conception of time was thus rendered homogeneous, spatialized, quantified, and discontinuous. This reading of time, in fact, was shaped by the moral reading of Henry Ford's industrial management of time. In relation to material and labor, Ford demonstrated how prudent skills in managing time removed hoarding or buying of material ahead of time. These practices as "stored human labor" were "crimes of time":

> Time waste differs from material waste in that there can be no salvage. The easier of all wastes, and the hardest to control, is the waste of time ...[65]

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[63]R. Buckminster Fuller, *4D Timelock* (1970), p.22.

[64]R. Buckminster Fuller, "4D File Manuscript MSS28.01.01, Folder IX Lightful Houses" (Notes 5), p.3.

Another of Fuller's connotations of time was characterized by fluidity, change and acceleration. This augmented his representation of man as a process. It was a proposition which he would claim to use as a means to escape nature's evolution, which had imprisoned other creations. Thus, paradoxically, the Caliban-nature of man, as one trapped between the beast and human, could only be redeemed by the externalities of his conceptual and physical tools. Fuller maintained that the mind as a continuously changing manifold, represented inner life. In *4D Timelock*, it was the pulsating self-ego as the origin, acting as one unity of duration, which recuperated the landscape of discontinuous objects and experiences. This accounted for why, despite a general focus on intellectual reflections in the space-time world of everyday life shaped increasingly by industry, he generally valued the intuition of pure duration.

1.1.5.2. On Materials and Structures -- the Place of Metal Alloys

"Lightful Houses" and *4D Timelock*, despite their incompleteness and limited circulation respectively, are seminal documents within Fuller's corpus of creative work, and are, perhaps, of nascent significance to modern American architecture. They established a tangible program for a productivist architecture and a modernist iconic agenda for materials. Fuller's metaphysical treatment of time-matter established them by charging metals with a special significance:

> The new tool metal made possible demonstration of fourth dimension which is time.
> Time x Matter = Nature - Nerve System - God
> Matter x Time x Nerve System (Wavelength) x God = Nature
> God is the only constant in this equation, all the rest has terminable measurement of relativity.[66]

These notations were laden with theological overtones; but one could readily surmise the reasons for Fuller's preference for modern metal alloys in practical terms. Metal alloys were the precision products of modern alchemy in industrial laboratories and not the hit-and-miss types of the craftsman's workshops. Thus, Fuller argued that metals as "extraction(s) from stone" were a consequence of the "selective mechanism of intellect."[67] While metals represented the progressive and active deployment of industrial and manufacturing time, stone was merely awaiting natural decay. It was as if time sat frozen in motion in stone:

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[65]Henry Ford & Samuel Crowther, *Today and Tomorrow*, London: W. Heinemann Ltd., 1926, p.110 (henceforth as *Today and Tomorrow*). Later, Fuller would claim that Ford was a bridge between the meaning of Einstein's relativity and the everyday-life of the Everyman, the "Murphys" (See *Nine Chains*, p.199).

[66]"4D File Manuscript MSS28.01.01, Folder IX" [Group IV notes].

> It is the very variation in the fourth dimension, or time of life in individual elements that finally causes the breakdown of nature's synthetic materials, such as stone by erosion.[68]

And architecture from stone technology was, thus, culturally regressive:

> Take for known the stone wall of the present method of small house construction. Without benefit of clergy, without benefit of architecture, without benefit of the 4th dimension (motion). Ignorance of localism. Arrogance of isolation. No centralization. No fountain head, no method, no Art, no God.[69]

Finally, to the architect Paul Nelson, Fuller offered the following account of marble:

> To me ... marble brings, as does all that presents itself to the senses, a picture. To me marble, incorporated in modern building design, represents diffused frozen ardor. There is the pink and white representing ardor of the Greek ice-cream parlor (not the modern Liggett's or Walgreen Drug store). To me the marble references are all of something stale and ' 'antiquated'. They bespeak of tombs.... It is amusing to watch workmen pasting on one-inch slabs of marble....In the not distant future this 'faky' veneering, excruciatingly expensive, will be the high water mark of insincerity of so called 'modern architecture,' which two words are manifestly incompatible.[70]

In Fuller's iconographic system of materials, time was already naturally-constituted in stone; thus, stone in use was not constitutionally processed but externally dressed. Stone therefore remained a form of energy that is not actuated, except in the moments of flexure under structural buckling. The energy of stone was potential. Its structural deployment mainly as an inwardly directed force towards a localized action, such as compression, implied stasis. Metals, on the other hand, refined from ores in industrial processes and rearranged microscopically, converted energy from potential into actual. The tensile capacity of metal was this new energy actuated and magnified. Thus metals, as matter rearranged, were magical transmutations purged of the static earth.

The practical significance of metals was objectified in various concepts of structuring in an unassuming but deeply emblematic drawing which Fuller made during the course of developing the 4D-House and the writing of "Lightful Houses"[71] [Fig.1.02a-b].

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[67]R.B. Fuller, "Enter Alloy: Exit Rust" in Nine Chains to the Moon, Carbondale: Southern Illinois University Press, 1963, p.184.

[68]R.B. Fuller, "Lightful Houses," p.68.

[69]R.B. Fuller, "4D File Manuscript MSS28.01.01, Folder IX" [Group V notes], p.20.

[70]Ltr. 8/17/28 RBF to Paul Nelson in *4D Timelock* (1970), p.84.

[71]Ms. Bonnie Goldstein, the archivist at BFI-Santa Barbara kindly brought this emblematic drawing to my attention.

Fuller did not use this drawing in *4D Timelock* or include it in a collection of 4D House drawings subsequently exhibited in 1929 at the Harvard Society of Contemporary Arts. Perhaps this was because of its implicitly "biographical" content. The drawing illustrated the dissolution of materiality from the center to the greater beyond via a series of concentric event points. Immediately pertinent to the meaning of "Lightful Houses" is the middle-ring composed of portable mobile objects of everyday life. This ring of floating "everyday objects," including foldable chair, bird, tennis racket, umbrella, car, suitcase, plane and sailing boat exemplifies a momentary liberation from the specificity and fixity of the earth.

The potent innocence ensuing from this drawing is also evident. Firstly, its collage of icons collectively represents the universe, as if, seen through the eyes of a child born or a man reborn. This vision is framed by luminous, inner self-healing type signifiers in the four corners: a baby (of new lease on life), a church (of spirituality and faith), a feeling (of universal human emotions), and the sun (of truth and liberation). Thus, the fatalistic and temporal pessimism of his professed dark moments seems to be replaced by a lightful, eternal optimism of his epiphany. Second, Fuller's heroic universalism is pivoted upon an anthropocentric universe, with the earth as the arena for the disclosure of experiences, albeit with America the New World as the focus. Third, the objects were largely drawn from mass-production process rather than from culture. Finally, the subject matter is about time in all manifestations including leisure, movement, spirituality, beginnings, and psychological revelation. This drawing, perhaps initially intended as a frontispiece to *4D Timelock*, was to act as a key to Fuller's "time lock" of revealed knowledge.[72]

1.1.5.3. Metals in 4D House – Sources in the Industrial Landscape

The drawing also shows the pivotal role played by metal alloys in most of the earthbound structures – radio towers, a Zeppelin mooring mast, a mast of a battleship, and a skyscraper. The tree and a pagoda were intended to be nature's "structural secret" and as revealed historical knowledge of the past respectively.

These formal structural precedents in metal directly suggested to Fuller the principle of hanging the structural case-work frame of the house from the mast. In the 4D House, the tactics adopted to reduce compression were: streamlining a singular load transfer in a primary central

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[72] I am grateful to my history elective-class at NUS (National University of Singapore, 1996/97) for expanding upon the meanings of several features in the drawings.

mast, and employing a system of structural radial tension cables and netting. The Zeppelins and Zeppelin masts provided the most tangible demonstration of the controlling factor of weight for the house.[73] Equally instructive were the lessons from suspension bridge technology:

> The principle in the suspension bridge is to have as much of compression as possible and take care of (the) greater length in tension.[74]

1.1.6. Imagining the Business and a New Industry

The iconographic system of material and the cultural distinctions of material stemmed from Fuller's metaphysics of time-matter. Their concomitant implications for the design of 4D House in terms of lightness, filled with light, mobility, and autonomy also amplified Fuller's strategy of converting the house into a commodity-product. The house as a commodity-product was underpinned as an ideological dynamism. When Fuller conceived of the 4D House as mobile and self-sufficient, he effectively mimicked the portability of modern industrial-corporate capital. Capital undermined the identification of permanence and fixity to place. When he conceived the home as a place for the re-enactment of the higher discipline of industry in efficiency and time-saving, and as an opportunity to initiate the unfamiliar materials of the industrial into the realm of the household, he was assisting in the casting of a new subject to fit the corporate-industrial world of consumption and production.[75] In both instances, Fuller was trying to naturalize obsolescence in the emerging culture of mass-consumption by melting one of the remaining cultural artifacts, the house, into the landscape of mass-consumer products. Fuller recognized in "Lightful Houses" that the house was a potentially integrative vehicle; it existed in the middle landscape of the consumptive world, straddling large, impersonal industrial infrastructures like bridges and factories and personal consumer objects like razor blades.

The preparatory notes of "Lightful Houses" are replete with references to the technological vision and the aphoristic wisdom of Henry Ford. In particular, Fuller directed the meaning of Ford's project to his own impending industry. It would not be amiss to attribute the "Lightful Houses" to the literary style to Ford's preachy, ideological and social gospel works: *My Life and Work* (1925) and *Today and Tomorrow* (1926). It was as if Fuller was answering the

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[73] R.B. Fuller, "Designing a New Industry," p.30.

[74] -, "Nesting" [Verbatim Report of July 9 Architectural League Presentation], July 9 1929, p.13.

[75] Using the motion-movement efficiency studies, Fuller also criticized the trades associated with the traditional building crafts. Thus he observed:

> (The) mechanics in the building trades average 30 steps per net useful contact... as opposed to 1/2 step in highly developed modern factory condition ("Universal Architecture Essay No.1," p.62).

questions posed by Ford for young entrepreneurs, "What am I in the business for? Whither am I going? What do I want to do?"[76]

The purpose of the "Lightful Houses" project, Fuller proposed, was not merely to augment the great consumer revolution that Ford initiated; rather, it would start another, a still greater, if not the greatest industry ever. As with the model-T as the first "people's car," Fuller suggested that his enterprise would be based on a stock-house. This would contain a "frame, utility unit, standard covering & dividing panels sold in unassembled form by distributors" intended "for use of the motor or air nomad ... for the Ford owner."[77] It would be a house produced like a car, for the increasingly mobile consumer.

The meaning of Henry Ford's success was also evoked for many ideological reasons. As an immediate heir to Henry Ford's legacy, Fuller shared his broad confidence in invention. As an activity, it was the heart of the nation's "material constitution." Invention was a biblical "second creation."[78] Fuller openly professed his desire to stand in the company of Ford whose greatest artistry was the crafting of a world-wide "constantly-mobile inventory" that was "heedless of nationalistic boundaries and banker's gold."[79] Fuller called Henry Ford the "greatest artist of the 20th Century." He was the "true industrial-principle leader" in opposition to the majority of industry under "fincap" [financial capitalism] control. Ford's industry exemplified the "principle of service." Finally, Ford saw continuity (in the moving production line) as "logically integrated with service," innovative in metallurgy and "timing system" of inventory in motion. He was producing "greater-ever-greater efficiency of service."[80]

In Ford's managerial miracles, his more benevolent policies, and his hostility to Wall Street, Fuller saw a model of personal integrity and self-discipline. Ford and his industry shattered the commonly-held view that modern technological culture was defined in Europe. Because of Ford, Fuller believed that American industry exceeded the "raw materials of

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[76]H. Ford & S. Crowther, *Today and Tomorrow*, p.43.

[77]R. Buckminster Fuller, "4D File Manuscript MSS28.01.01, Folder IX, " (Notes7), p.15.

[78]The inordinate influence of Ford Motor Company on American life, was demonstrated by the assembly line method, the wage transformation based on the five-dollar day and the social effects of the model-T. For example, Brier reported that in 1929, the automobile accounted for nearly 13% of the value of all manufactured goods -- with peripheral activities gasoline stations, road-construction, tourism and to the streamline of the Far-east rubber production, expansion of cities (Stephen Brier, et. al., *Who Built America?*, N.Y.: Pantheon Books, 1992, p.277).

[79]R. Buckminster Fuller, "Universal Architecture Essay No.1," p 64.

[80]R. Buckminster Fuller, *Nine Chains*, pp.190-211.

modernity."[81] Ford's legacy was, in his eyes, an authentic model of modern culture. Thus, he proclaimed:

> I think the modern architect is the one who has not just a Ford mentality of the industrial equation of harmony, but sees the relation between the two, not suffering from this apprehension of the material and the harmonics.[82]

Perhaps because of this "ethnocentrism," Fuller suggested that Le Corbusier "misse(d) (the) main philosophy of house as against house."[83] Fuller's tirade against European "new design pace," especially the Bauhaus, was in the same vein. He noted that it was a cultural-technological project that employed the image of American mass production. However, it was "perversely articulated in destructive elements," potentially leading the world to a mass "suicide."[84]

On the other hand, Fuller was also deeply aware that his assertion of industry's ability to create a transnational egalitarianism would be challenged as a thinly disguised form of Americanization and economic hegemony. Thus, he fortified the scale of his proposed repro-shelter enterprise around the experiences of Ford. It was not the specificity of Ford the man or American technology per se, Fuller argued, that accounted for the car's worldwide success and acceptance, but rather the generalized principles of Ford's "geo-logistics" in the integration of production and consumption. Similarly, standardization in design form and part was evidence of public consent rather than a tyranny of taste that was imposed.

Standardization presented in this way was, Fuller explained, an evolutionary process of "continually-approached perfection" achieved through the "process of applications of truth."[85] Thus Fuller claimed that the universalization of technology, though spearheaded by America, was not Americanization; rather, it represented a referendum on confidence:

> No American in conceiving and applying an economic truth to industry has any consciousness or purpose thereby of Americanizing the nations. He endeavors by such means as he may command to force the individual world to adopt his brain child which he instinctively knows if the public feels that it is good enough in design and saves them enough time for the justification of individual investment of capital for the purchase of that idea, that he

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[81]Thomas Hughes, *American Genesis (A Century of Invention and Technological Enthusiasm 1870-1970)*, N.Y.: Viking Penguin, 1989, p.9. Henceforth as *American Genesis.*

[82]R. Buckminster Fuller, "SSA-Minutes of Meeting," 12/16/31 in BFI-CR42, p.5.

[83]R. Buckminster Fuller's Journal entry for 30 January 1928 in BFI-CR34.

[84]R. Buckminster Fuller, "I Figure," *The Buckminster Fuller Reader*, James Meller (ed.), London: Jonathan Cape Ltd., 1970, p.105. Henceforth as *The Buckminster Fuller Reader.*

[85]R. Buckminster Fuller, "Lightful Houses," p.8.

personally will be rewarded therefore by the world, and he also knows waste not want not, and practices within this truth according to his self control and abstract independence. That is all there is to it. If we are Americanizing the nations by there(sic) adoption of our safety razors, autos etc., it is because they make life better for those who buy them. There is no power under heaven or earth that can (make) the individual buy something unless he wants to.[86]

Thus there was no consciousness of nationality in the inanimate objects of industry, be these razor blades or a Ford car.

1.1.6.1. Extending Ford's Industrial Legacy

The radical measure of the industrial efficiency that Ford had put in place was, Fuller identified, "performance-per-pound." For this reason, the 4D House represented a minimal model of Fuller's repro-shelter, an equivalent of Ford's model-T. Fuller was cognizant that the industrial capacity had improved considerably, and, with this change, greater expectations of its performance. Even Ford, by the early thirties, had realized through the acquisition of Lincoln Motor Car Company that "services" had to be graduated, given the critical significance of distribution and marketing.[87] Fuller gave a marketing prognostication of this industrial condition when he compared two scenarios of an imaginary shelter industry -- one prompted by Ford's assemblage technique of the twenties versus the situation in the thirties. In the first, he noted that:

it would have been consistent with the Ford marketing that carried no self-starter, or other accessory, at that time, to have marketed partial houses, with minimum equipment - just 'shells'

In opposition to the first scenario, a second consisted of greater expectations of change and improvement. Like eggs and milk, the "labyrinths" of consumer goods encouraged instantaneous consumption, and hence the necessity of planned obsolescence. Hence:

The mechanical composition must be identified by its date of issue and ability-indicating model number. The scientific progression is so rapid in the industrial mechanical composition field ... that it is taken for granted that the mechanical unit is out-of-date as soon as delivered and must be considered not for its resale value, but for its specific satisfaction, for a specific time.[88]

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[86]R. Buckminster Fuller, "Lightful Houses," p.50, cf. Ch. 19 "Land to Sky. The Outward Progression" in *4D Timelock* (1970), p.32.

[87]Nevins suggested new demands had to be created to fulfill and encourage the perception of cultural distinctions:
There must be grade of service, just as there are grades of human beings, one man's effort will bring him a return sufficient to buy one kind of article, while another man's effort will bring him a return sufficient to buy something higher in price [Allan Nevins and Frank Ernest Hill, *Ford (Expansion and Challenge 1915-1933)*, p.81].

[88]R. Buckminster Fuller, "Universal Architecture Essay No.3," p.38.

However, Fuller's general disdain for style and shaping as a commodity-form compelled him to demand that even at this second stage of development, a "public standard or ideal" to be developed. Similarly, he was ambivalent about the new engines that propelled consumption, namely, the media of advertising and the formation of opinion, which he called a retrogressive "propaganda for vanity and ownership."[89] In this respect, Fuller had characterized Ford's Model-A as an exemplary model for emulation, a resilient form of "principle of scientific service-by-the-people-to the-people."[90] Curiously, the choice of this closed model of production and consumption, which Fuller felt was the only way to ensure the integrity of 4D repro-shelter, betrayed his entrenched Puritanical values and his asceticism.

1.1.6.2. The Actual Design. A Strategy for the House

While the house as an autonomous and a mobile container acted as a purveyor of the "corporate life," the home, its "corporate soul," as the site of renewed consumption, would align that life with the productive capacity of industry. In these capacities as soul and life, the 4D House would become an apotheosis of middle-class values which eased the perceived juncture between home and industry.[91] The 4D House would form a seamless continuity between the private realm of consumption, previously insulated from the public realm of economic production. Thus, the mention of the 10-cent stores and the automobile exhibitions in Fuller's diary entries in "Lightful Houses" were not casual statements.[92] They were provided as tangible evidences of a new phase of the industrial transformation. With the techniques of moving assembly-lines, machine tools and logistics control close to perfection, the abundance of consumer products was no longer a desire. It had become a reality. Fuller's repro-shelter envisioned in "Lightful Houses" would consolidate the places of these products in the home. As economic opportunity and social mobility became entwined more intricately with physical mobility in the repro-shelter, Fuller was able to recharge the frontier mythology in the form of a

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[89] I have chosen "ambivalent" over skeptical because the preparatory notes indicated that Fuller was considering engaging the support of Walter Thompson, an advertising giant to support the project. Fuller noted:

> Phsycology(sic) of Will Thompson getting combo of truism + Rhythm = Slogans or songs ["4D File Manuscript MSS28.01.01, Folder VII" (ca. 1928, Loose notes) in BFI-CR28].

It is possible that Fuller was persuaded by the increased sophistication in advanced advertising that was shifting from "more or less educated guessing" to an ostensibly experimental basis (See Leonard W. Smith, "Is there a 'New Psychology of Advertising?" in *Postage & Mailbag*, August-September 1932, pp.377).

[90] R. Buckminster Fuller, *Nine Chains*, p.200.

[91] Fuller thought that the social reproduction of the family would be undertaken through the electronic media:

> Education and the proper upbringing of the young in modern truthful healthful environment will quickly efface crime and the mental deformed ...
>
> (S)olve the problem of the home, the housing of childhood the prime reason for the home, and we will remove the majority of the traces of the dark ages of selfish unenlightenment ("Lightful Houses," p.32).

[92] R. Buckminster Fuller, Journal entries, 28January and 3 February 1928 in BFI-CR34.

consumer's paradise. With the new industrial capacity, it was easy to see why Fuller did not take long in abandoning the ascetic marketing concept of Ford.

The "labyrinth" of consumer goods, Fuller observed, had created greater expectations of change and improvement. These goods were to be consumed instantaneously like eggs and milk; and hence, the necessity of planned obsolescence:

> The mechanical composition must be identified by its date of issue and ability-indicating model number. The scientific progression is so rapid in the industrial mechanical composition field ... that it is taken for granted that the mechanical unit is out-of-date as soon as delivered and must be considered not for its resale value, but for its specific satisfaction, for a specific time.[93]

The "shell" 4D House and its variations were evidence that Fuller saw choices as increasingly important in garnering public support. Further, he began to view the house as a "service" rather than as a possession. This changeover transformed the house into a new form of "commodity," making it increasingly receptive to greater consumption. In the earliest of Fuller's proposal there was to be four classes (Class A-D) of houses. These were to be built from "unit bays" of steel and concrete construction, "in the most modern and least costly manner completed with standardized 'utility units' (bathrooms, kitchens, laundries, etc.)." The Dymaxion House, subsequently billed as the "minimal model," was ironically the most "completely finished (model) inside and outside" among the four classes.[94]

Besides mass-consumer products, the 4D House would create great demand for the end-line products of the industrial processes. These gradually influenced the expression of the house where craft methods and material previously pervaded. The structural mast of the 4D would domesticate the steel tension cables of suspension bridges [Fig.1.03a (1-4)]. The windows would be of the same casein plastic used in fountain pens. The walls and the foundations of the house would build on the success of the sound and heat insulated wall of the Pullman Club Car on roller bearings. The ancillary structures of the house would exploit the alloy-metal struts of planes or the pneumatics of car tires. No matter how unfamiliar these objects of industry might have been, and whatever the previous resistance towards their presence in the house form was, Fuller's 4D House offered a radical assurance. His project proposed that the gulf between the interior landscape of the home and exterior landscape of industry would be erased, as the container and the contained enmeshed. Disparate and ad hoc parts of industry, individually rational, were

93 "Universal Architecture Essay No.3," *SHELTER*, May 1932, p.38.

94 "4D File Manuscript MSS28.01.01, Folder IX Lightful Houses, "[Notes2], p.5.

orchestrated, through design, into a seamless continuity. In the 4D House, existing boundaries between furnishings and the interior, between the support and the supported, between lighting and its container, spaces and the space-definers would be masterfully dissolved.

The 4D House in Fuller's scenario would be the site for consumption of a broad cornucopia of commodities from mass-consumer products to the raw, unfinished materials of industry. For example, in the 4D House, the library represented the widest form of consumption in self-education. As a place for the reproduction of knowledge, the "Go-Ahead-with-Life room" contained cornucopia of visually-oriented elements: built-in radio-television, maps, globes, revolving book shelves, drawing boards, typewriters, etc.- gadgetries of the corporate-industrial world. Standards on consumption would be set by mass consensus and the demand it engendered would encourage flowing supplies. This would make material hoarding and its associated fetish of permanence, obsolete.[95]

1.2. Promotion of the Dymaxion House (1928-33)

By early part of May 1928, the 4D House patent claim was filed, and the draft of his corporation prospectus was close to completion. The next obvious task was to spread the propaganda on the subject:

> (I)t is a peculiar advantage of patent law that during the two year claim period that while no publication is made of the patent, any ideas evident in industry pertinent to the original claims allowed may be made to accrue to the patent before final disclosure. This is extremely powerful and gives absolute protection to the originators of the ideas, and *makes evident the great advantage of spreading propaganda on the subject during this two year period*. It will ever be the purpose of the organization to keep as rigid a control as possible of these ideas and the materials involved. Though we shall go through phases of assembly of parts and manufacture thereof by industrial firms allied only through contract, there will come a time when royalties, etc. involved within the contracts will make preferable to the allied industrial firms, acquisition thereof, by Lightful Corporation. This development is well portrayed in the development of the two greatest companies within the automobile industry, to wit: Ford and General Motors....This is essential to efficiency (Itl., my emphasis).[96]

With this ambition of promotion in mind, and probably instigated and supported by Russell Walcott, Fuller decided to conduct a pamphleteering campaign of 4D House idea at the 61st AIA National Convention in St. Louis, Missouri. For a city which, until a few months

[95]"Lightful Houses," p.54.
[96]R.B. Fuller, "Lightful Houses," p.24.

earlier, had been ravaged by a severe tornado, the publicity value in advancing a new disaster-proof house was opportune.

1.2.1. AIA Meeting in St. Louis – Non-event or Publicity

In preparing for the event, Fuller was careful to qualify that his attendance at this meeting was on the "formal request (of) Chicago delegates, entirely unbeknownst to Mr. Hewlett." Further Fuller claimed that expense to St. Louis was paid by the Architect's Club-Chicago.[97] The qualification was significant at several levels. Hewlett was recently elected the first vice-president of the AIA. Lest Fuller's attendance be read as professional nepotism, Fuller's other intent, was to demonstrate his self-initiative, and to eventually distance himself from the conservative faction of the architectural profession his father-in-law represented.[98]

By Fuller's account, he made a presentation to eighteen AIA-members "who were picked out as being broad and unselfish thinkers." The reception of his mass-produced shelter proposal was greeted "with more than satisfactory results" and the expository content of *4D Timelock* was cited for its "scholarly ability."[99] Among his audience, Arthur Holden, one of the directors of the New York City Housing Corporation and member of the New York State Housing Commission, was Fuller's "most receptive" supporter. However, outside this select group, the reception to Fuller's presentation was not clear. By Fuller's account, it was far from encouraging.

In his notes kept during this period, Fuller expressed frustration at "the impenetrability of the delegates," and a convention which he viewed "charming" but of "standard ineffectiveness."[100] Fuller was disillusioned by press accounts, which he claimed, superficially glossed over the issue of standardization.[101] The press probably did not see or refer to his pamphlet; but he read this as evidence of complicity of the architectural journals and the profession:

> The very periodicals which serve and might enlighten the architect are so dependent for their apparent survival on their present feudalistic adroitness as to have their (role) effectively reduced ...[102]

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[97]R. Hamilton, "Notes on (RBF's) Career,"p.12.

[98]J.M. Hewlett was active in the AIA national convention; at its 60th Convention, he chaired a session to promote interest in inter-professional ties with landscape architects, painters, sculptors and the craftsman.

[99]Ltr. 5/21/28 RBF to H.W. Thomlinson (Joliet-Ill.) in *4D Timelock* (1970), p.43. Elsewhere, Fuller recorded that he "made no speech; he talked to (the Convention) architects individually and gave them his books" (See R. Hamilton, HE-MSS "Notes on (RBF's) Career," p.12).

[100]R.B. Fuller, "Notes for a 'Prayer'," undated (ca. May 1928), in BFI-CR33.

[101]Ltr. 5/21/28 RBF to S.W. Stratton (President, MIT) in BFI-HEv7.

[102]R.B. Fuller, "Notes for a 'prayer'" undated (ca. May1928), in BFI-CR33.

While Fuller's records of the reactions to his work were probably exaggerated, his general portrayal of the Convention's lack of interest on the issue of standardization in architecture was accurate. Openly, the Convention theme, "The Mobilization of the Forces that Make for Better Architecture" carried many concerns impinging on architectural practice, of which the effects of business and industry were particularly acute. In the convention report the following year, the section on "Standardization of Architectural Design -- A Criticism" characterized the issue as "nobody's child, yet everybody's":

> Architectural design is the flavor, the spirit and the inspiration of our work. Shall we allow it to become ordinary hum-drum and nondescript? It is quite possible that certain functions of the Architects may well become standardized, but what of the art of design? Can one seriously consider the standardization of all the drama, of literature, of music or of the arts kindred to our own, such as painting and sculpture? Are the qualities of inspiration and of originality to be superseded by subservience to custom and rule? ...
> Local characteristics are fast disappearing in this era of common thought and mechanical advancement. Communities are coming to look more and more like *peas of one pod* and a certain commercialism is making itself more and more evident in the type of architecture universally employed throughout the country [103] (Id., my emphasis).

Generally, AIA perceived that the utilitarian and functional aspects of standardized and mass-produced housing were detrimental to the development of architecture as art. As a result, hostility towards this issue was evident in one of the presentations at the Convention:

> To limit architectural expression to a naked answer to a given problem, with exaggerated emphasis on the utilitarian or functional aspects, is by no means a guarantor of sincerity or truth, and is more often than not an indication of a poverty of imagination.[104]

Despite his obvious intentions to challenge professional orthodoxy, Fuller strangely took the brunt of these criticisms as personal affront to his ideas. Contemporary biographical accounts of the AIA meeting reiterated Fuller's account that, after the convention, he entrusted his 4D House patent offer to the Institute.[105] With AIA as a permanent custodian of his idea, Fuller explained, the idea would never be privately exploited.[106] Fuller cast the offer in these words:

> I hereby offer to the Institute, prior to its becoming in any way commercialized, an eleven months (sic) option to acquire controlling interest of the 4-D patents, which they may even divert nominally to a separate body to be known by another suitable name; if that should seem desirable, provided that such body be completely controlled by AIA; also provided they may

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[103]AIA, "Report of the Board of Director to the 62nd Convention of AIA," 1929, pp.7-8.

[104]Excerpt of a speech by Milton B. Medary in AIA Journal, 16 June 1928, p.238, quoted in K.M. Conrad's "The Technocratic Persuasion," p.182.

[105]See S. Rosen, *Wizard of the Dome - R. Buckminster Fuller*, Boston: Little, Brown & Co. 1969, p.64; L.S. Sieden, *Buckminster Fuller's Universe*, p.130; M. Pawley, *Buckminster Fuller*, London: Trefoil Publications, 1990, p.12.

[106]R. Hamilton, HE-MSS "Notes on (RBF's) Career," p.13.

> qualify upon a certain schedule of action deemed necessary and suitable to the proper safeguarding of the patents. Patent license might then be meted out by the Institute on a competitive basis of the highest order and royalty producing, this providing an opportunity to its membership to participate both creatively and possessively(sic) in the activities of the new industry which might otherwise go to quite foreign hands.[107]

Fuller's offer, however altruistic, was not practical and unlikely, given that Fuller had already signed on two prospective speculators.[108] Fuller professed that although approving his plan, Walcott, one of the speculators, was "dubious" about his offer.[109] Further, Hewlett, being more pragmatic, suggested that the impending 4D House patent needed more detailed work. He was generally skeptical of Fuller's plans to plunge into production. A greatly improved solution, he advised, would only come from a "long period of experimentation and promotion."[110] Further, AIA, as an organization of small practices, had neither the time nor the resources to accommodate a request of such a scale.[111]

It was also likely as Conrad suggested, that because the turn out was poor, the patent was offered as "enticement" to perhaps sustain Fuller's advocacy in getting AIA to redress its stand on the ideal single-family dwelling.[112] Such an arrangement would also allow him to maintain and legitimize his crusade for the radically new industry, and yet to remain as an outsider.

Fuller's presentation at the Convention thus was an attempt to gauge professional and public reactions to his radical project. One could suggest that the negativism be in itself, a type of publicity, and a necessary impetus to spur Fuller to advance his cause outside the establishment. For this reason, Holden encouraged Fuller to send his criticism of the Convention to Parker Hooper at *Architectural Forum*, who he proposed, would have "the nerve" to publish the writing.[113] More significantly, despite the failed public relations effort in directing national attention towards his 4D House, Fuller nevertheless established it as a prior-art for his envisaged repro-shelter industry.

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107 Ltr. 6/8/28 RBF to J.M. Hewlett in *4D Timelock* (1970), p.53.

108 See also bill dated 5/3/28 from Emery Booth Janney & Varney for services in conference and preparation of the application of 4D patent (File #1793) in BFI-CR33.

109 Ltr. 6/15/28 RBF to J.T. Boyd, p.70.

110 Ltr. 6/4/28 J.M. Hewlett to RBF; Ltr. 7/9/28 J.M. Hewlett to RBF in *4D Timelock* (1970), p.50, 72 respectively.

111 Ltr. 7/17/28 J.M. Hewlett to RBF in *4D Timelock* (1970), p.74.

112 K.M. Conrad, "The Technocratic Persuasion," p.226.

113 Ltr. 5/23/28 A. Holden to RBF and Ltr. 9/29/28 A. Holden to R. Walcott in *4D Timelock* (1970), p.48, 49 respectively.

Incensed by the nonchalance of the press and the profession, Fuller resorted to, on May 28, an expanded strategy of pamphleteering of his mimeographed essay.[114] The segment of sympathetic "influential" public he identified was, he believed, unadulterated by the narrow professional view. Their unbiased views would ameliorate the damage caused by professional complacency. In determining the recipients of the first forty copies of his essay, Fuller revealed how he valued the symbolic significance of its subject matter.

The first forty recipients of the two hundred copies of *"4D - An Aphoristic Essay of Research"* included six family members and friends, nineteen writers, three members of business and industry, six academics and seven architects. In addition to this first list, a second (undated) in preparation included Lewis Mumford and several prominent architects: Paul Nelson, Eliel Saarinen, Le Corbusier, Ralph Walker and Raymond Hood. Walker and Hood represented two of the "three Napoleons" modernists practice of "new architecture" in New York.[115] Their transitional roles shaped by academic-traditional practice and enthusiasm for architecture as business explained why they were attractive to Fuller and vice-versa. Similarly, Paul Nelson, who Fuller described as " a friend (and) antithesis of the prevalent Beaux-Art modes," was previously associated with A. Perret and Le Corbusier, two French exponents of modern architecture.[116] Fuller would eventually enlist Nelson's support to spearhead his ideas and projected business-venture overseas.[117] He triumphantly envisioned:

> The fero-concrete(sic) architecture (of L. Corbusier and A.Perret) may be likened unto the plastic cocoon of the archaic worm from which will emerge the 4D butterfly.[118]

The significance of the second list of names lies in Fuller's identification of his project with the more radical exponents of modernist architecture. However, the first list is more illustrative of the ideological intention of the 4D House project. It highlighted the social-cultural milieu in which it was forged

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114 See receipt, dated 21 May 1928 in BFI-CR33, from Chicago Advertising Co. for "stencils & letterheads of mimeographing service for "4D- An Aphoristic Essay of Research." R. Hamilton also noted that the rest of the 4D pamphlets were mailed from Chicago (R. Hamilton, "Notes on (RBF's) Career," BFI-HEv20, p.13).

115 See Pai Hyungmin, *From the Portfolio to the Diagram: Architectural Discourse and Transformation of the Discipline of Architecture in America, 1918-1943*, Ph.D. Dissertation (Architecture, Art & Environmental Studies) MIT 1993, p.98. Also refer to Ralph Walker's "A New Architecture," *Architectural Forum*, Jan. 1928.

116 Ltr. 8/11/28 RBF to Rosamond Lucilla Fuller in *4D Timelock* (1970), p.78.

117 See Ltr. 8/17/28 RBF to Paul Nelson and Ltr. 8/10/28 RBF to Paul Nelson in *4D Timelock* (1970), p.83-84 and p.85 respectively.

118 Ltr. 8/11/28RBF to Rosamond Lucilla Fuller in BFI-CR46.

1.2.1.1. Audience of Fuller's *4D Timelock*

Two hundred copies of *4D Timelock* were sent out to establish Fuller's copyright of his repro-shelter idea. But, as a middle-class discourse to an "elite" audience, Fuller's moral authority rested on his claim that the project was primarily undertaken "at heavy cost of abstract experience and material forfeiture," and hence its "selfless" nature.[119] In addition, the final beneficiary of his proposal was the "whole of humanity" in the future. This was, one is to read, in opposition to the pervasive mood of bourgeois individualism, variously characterized elsewhere as unthinking, indulgent and selfish.[120]

Fuller's audience, carefully picked, belonged to what he personally characterized as the "(second) generation of beneficiaries of the new economics of individualism."[121] This breakdown shows that the selected group was strategically remote from the profession of architecture, and in some instance represented dissent to the prevalent practice.[122] Besides being unadulterated by professional interests, they were people with "vast moral resources."[123] Fuller also believed that the writers, in this selected group, were closer to the pulse of America. It consisted of "well-known publicists," supposedly voices of reason, which he thought were "attuned" to similar propensities. He had hoped that upon his persuasion and on his behalf, they would influence "the industrialists" to bankroll the project for the new home.[124] However, believing that there was economic prospect in his new business, Fuller ruled out anyone with potential speculative interests. Besides, he already signed up two prospective speculators.

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119 R. Buckminster Fuller, *4D Timelock* (1970), p.x.

120 See William E. Leuchtenburd, *The Perils of Prosperity, 1914-1932*, Chicago: The University of Chicago Press, 1967 [1958], p.201ff.

121 R.B. Fuller, "Land to Sky. The Outward Progression" in *4D Timelock* (1970), p.32.

122 R. Buckminster Fuller, *4D Timelock* (1970), pp.44ff.

123 Ltr. 6/8/28 RBF to J.M. Hewlett in *4D Timelock* (1970), p.51.

124 Among the recipients were architects (Eliel Saarinen, Le Corbusier, Raymond Hood), college presidents, public figures (Henry Ford, Bertrand Russell, Chris Morley) architectural magazines (*Pencil Points* and *Architectural Forum*).

Thirty eight of these recipients were accorded a follow-up second edition (dated after 5/21/28) Of this group there were nineteen writers, seven architects, six academics, six fiends and family members, and two business men:

Family & Friends (6) -- Mother, Arthur Hewlett, S.G. Hoffman, Earl Reed, Wolcott Fuller, Lincoln Pierce

Writers (19) -- G. Bradford (biographer of Margaret Fuller), John Galsworthy (author, *Castle of Spain*), St. John G. Ervin, F. Parson, J. McCutcheon (Chicago Tribune, *Master of the World*), Roger W. Babson (*There is Magic in the Air*), Harper Leech (Chicago Tribune), Thorton Wilder (*Bridge of San Luis Ley*), Claude Bragdon, Fay Leon, R. Washburn Child (U.S. Ambassador to Italy), Albert Wood (*Sat. Eve. Post*), Avery Park (*New Background for a New Age*), Fred Etchell (Intro. to Le Corbusier's *Towards. A New Architecture*), Garet Garret (*American Book of Wonder*), Dr. Isaac Abt (a pediatrician), Chris Morley, P. Frankl (*New Dimension*), J. Harvey (Harper & Bros.)

Business (3) -- Bruce Barton (advocate), Henry Ford, R.W. Babson

Academics (6) -- B. Russell, Lawrence Lowell (Harvard Univ.), Max Mason (Univ. of Chicago), S. W. Stratton (MIT), H. Bushbrown (GIT), E. Victor (Yale)

Architects (7) -- Thomas Kimball (Fmr. President, AIA), A. Holden, K. K. Stowell (A. Forum), A.P. Herman (Univ. of Wash.-Seattle), Ralph Walker (*New Architecture*), R. Bach (Metropolitan Museum), L.H. Provence (Dept. of Architecture, Univ. of Ill.-Urbana)

This pattern of using surrogate influences and agents would become a perpetual feature in Fuller's later undertakings. As a shield, rather than as a veil, it was a solicitous strategy; and yet it allowed for distancing and ascertaining the objectivity of his actions. As if to create a difference, Fuller's strategy was to "individualize" a commodity through respected individual testimonials, without the "personal faith" of salesmanship. For example, to allay suspicions that the 4D House was a scam-business, Fuller felt compelled to reassure even his mother that "this whole affair is not a personal "scheme." Rather, it merely the "observance of truths which people overlooked in their great rush for survival and selfish existence."[125] In this respect, and in terms of the scope of market he envisaged, Fuller's general misgiving about advertising was clearly retrogressive.

Rather than undo the pattern of consumption, Fuller was preparing his specially selected audience to recognize the protean possibilities that existed in a new "Eden, " the sphere of consumption. Fuller felt that growing "egalitarian" public taste rather than the "elitist" culture was becoming the gauge for reforming industry. The magnitude of this effect on the market for popular culture, he observed in the paperback industry for example, was staggering.[126] Thus, the new spaces of consumption and the forces of "decentralization" and "standardization of production," shaped by mass production and transportation were destined to impact house design:

> In hospitals, moving picture theatres, the modern drug store restaurant, ocean liners, aeroplanes, etc., where the need for expeditious and healthy handling of masses of people, catering to their needs, takes place, we find great improvements in method and design, which can only be applied to the house when complete redesigning of the building takes place.[127]

Fuller's ambition to edify the new Eden contained no social protest against class inequalities. He merely chided his genteel class for its habitual fixity with the good things in life, and pleaded for the move towards a pattern of consumption that was more responsive to the dictates of industry. As Fuller gained a greater confidence in the redemptive potentials of technology, the apocalyptic tone in his earlier message was gradually tempered by an urban utopian message. This transformed his ideas closer to the beliefs of Edward Bellamy's domesticated socialism in *Looking Backward* (1887) and Herbert Croly's industrial optimism in *The Promise of American Life* (1909).[128] Thus, on one hand, reaping of the promised benefits of

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[125]Ltr. 7/16/28 RBF to C.W. Fuller in *4D Timelock* (1970), p.73.

[126]In particular, Fuller referred to Thorton Wilder's *The Bridge of San Luis Rey*, one of the recipients of his *4D Timelock* (1928).

[127]R.B. Fuller, "Lightful Houses," p.6.

[128]For a discussion of Edward Bellamy's *Looking Backward* as a type of "Yankee communism" or "Associationism," see Daniel Aaron's *Men of Good Hope, A Story of American Progressives*, N.Y.: Oxford University Press, 1961, p.102;

material abundance could be advanced in a palatable form without the objectionable and disputable features of bloody revolutions. On the other hand, individualism could be reconstituted through discipline without adverse compromise to the American progressive tradition.

In opting for this route, Fuller assumed the classic role of the American reformer who stood with no oppressed classes, since there were no classes with which to stand. That "a bloodless revolution" could be obtained through the implementation of his 4D project was most evident in this striking statement by Fuller to a Chicago banker, George Buffington:

> The 4D book quite evidently has not been designed to flatter any banker, society tin-ear, or other material tyrant, into inscribing a 'foreword' which might insure a fadish(sic) sale; nor was it written to secure a free red ticket to Moscow, to join the mob exploiters 'conference' of that vast and long suffering people; nor to receive any minor endorsement of radicalism, but rather, *to be the epic of the great 'middle class', which is Humanity*[129]

Such confidence in the onus of the American middle-class was expressed despite Fuller's earlier accusation that it was fixated by emblems of power, prestige and property. He characterized these values as continual associations to a metaphorical feudal past. However, the 4D House project would redeem and revivify the middle-class moral system by repairing the perceived disjuncture between unrealized potentials of industry and scarcity of good life. The apocalyptic tone of this message was obvious in his caution to William Delano, a harsh and unreceptive critic of his 4D proposition.[130] His project was, he proposed to Delano, was a form of deterrence. It was a "salvation from suffering and bloodshed of a class warfare":

> Your experience has been unquestioningly as trying but of empirical locus, unattended by proletarian tragedy...
> I feel that in this critical stage of social transition *the potentialities of all the group of society to which we are both born are negated by their 'traditional bondage'* from which I was freed

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James O. Robertson's *American Myth, American Reality*, N.Y.: Hill & Wang, 1980, p.171; Howard P. Segal's Technological *Utopianism in American Culture*, Chicago: The University of Chicago Press, 1985, p.6 and James Gilbert's *Designing the Industrial State, The Intellectual Pursuit of Collectivism in America*, Chicago: Quadrangle Books, 1972, p.22-27. For the broad effort of Croly to redeem individualism and American history in industry, see Cecelia Tichi's *Shifting Gears*, p.79; Henry E. May's *The End of Innocence*, Chicago: Quadrangle Books, 1964, p.313; William E. Akin's *Technocracy and the American Dream*, p.4).

129 Ltr. 8/31/28 RBF to G. Buffington in *4D Timelock* (1970), p.148. It is interesting to note that S. Baer quoted this paragraph in total, as a foreword in the 1970 Lama Foundation reprint of *4D Timelock* (1970).

130 W. Delano was one among a delegation of eastern architects who staged a protest walk-out during Fuller's presentation of the Dymaxion House at the AIA Annual Convention, Washington D.C. (6/1-6/7 1930). Fuller had characterized this "ungraceful" act as the "bone of contention (by the) 'Easterners'" since he was the guest of the of Chicago Chapter of AIA (See entry in *Dymaxion Index 1927-47*, p.2). Delano also spoofed the Dymaxion in "My Daxian," *Pencil Point*, November 1932, p.735, as a home "halfway between a gas tank and a greenhouse on the wing" that turned out to be disastrously warm and incinerated the dweller."

only by excruciating experiences, through which I would have none of them pass, despite the richness of spiritual counterbalances[131] (Id., my emphasis).

Thus, a quarter century after Henry Adams, Fuller nonchalantly accepted the idea of infinity and force, which had previously thrilled Adams, for a whole new social mission. Not only were they incontrovertible; machines as industry were not the "occult mechanism" with which Adams had equated with charisma. Where Adams' general ambivalence colored his view of the emerging industrial landscape as one populated with Faustian objects, Fuller saw a redemptive technology of abundance destined to enfranchise more Americans. In this sense, Fuller's *4D Timelock* departs from Adams' apocalyptic characterization of power unleashed by the machine. While the Gallery of Machines ominously proclaimed the incompatibility of nature and machine to Adams, Fuller saw in the Ford Industrial Exposition, the marvelous processes orchestrated processes of industries.[132] Thus Fuller shared a belief with the "cult of engineers"; a belief in practical tangibility, which historian Cecilia Tichi described as a demonstration of "democratic instinct" of American inventors.[133] Fuller examined American political history as a mechanism, and tended to evaluate it in terms of efficiency.

4D Timelock reveals Fuller's underlying confidence in his reading public to recognize the broad traces of its ideological intent and agenda. For example, Fuller assumed his public would accept, self-evidently, his nominal leitmotifs as "our 4D laws." Likewise, the conflation of its purpose as an advertisement of a new ideal of Christian faith was instinctive. Despite Fuller's attempt to depersonalize his project and to cast the business beyond the mere interests of profits, he was, Conrad accurately termed, an "evangelistic businessman." His ambition, however, was neither parochial nor was it a type of Christian apologetics to tame "the unruly jungles of the natural competitive struggle."[134] Rather, Fuller's project secularized Christian beliefs and naturalized its ethical imperatives to fit the new mass consumer in a new world of individualism and industry. The "industrial principle" was, Fuller proffered, "the simplest exposition of the real meaning of the Christian era of human progress."[135] He clarified the meaning of this view, thus:

> Don't think we are attempting any form of cult or evangelism. The rewards of virtues are ahead not behind. THINK. This is all translatable into business. Truth is the commerce of

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[131] Ltr Can. 1932 RBF to W.A. Delano in BFI-CR42.

[132] See Henry Adams' description of the Gallery of Machines in "The Dynamo and the Virgin," *The Education of Henry Adams*, Boston: Houghton Mifflin Company, 1973, p.382.

[133] Cecelia Tichi, *Shifting Gears*, p.138.

[134] K.M. Conrad, "The Technocratic Persuasion," pp.218-220.

[135] R. Buckminster Fuller, "Universal Architecture Essay No.1," p.61.

> Christianity and faith and the industrialized sorting of worlds' goods in even distribution to the individuals. The more time saved, the smaller the world, the happier the individual.[136]

1.2.2. The Middle-class Inclinations for a Single-Family House

"Lightful Houses" was premised on Fuller's choice of the single-family house as a vehicle for social transformation. This is despite countless number of variations and proposals for ten-deck multi-family towers to populate his "One-World Town." These towers were meant to demonstrate the productive capacity of lightweight technology rather than a design preference.

While accounts of his epiphany alluded to the deeply-felt choice of a single-family house, one could propose that it was also a culturally-determined promotional strategy. Fuller was influenced by public and professional discourses that had elevated the single-family house as a moral bastion and as a way to escape the ills of the city. However, on a personal level, his residual Victorian morality gave rise to his disdain for the multi-family tenement, he was equally critical of the massive evacuation into the suburbs.

1.2.2.1. The Single-Family House Reformed – A House of "Corporate" Morals

Fuller offered his project, the industrialized house, as an alternative to transform the gentility of the late-nineteenth century American "moral" household. This was contained in the most significant encryption of the tract:

> Our singleness of purpose is housing. The home is a corporate soul and a corporate life in a house.[137]

Fuller implied in the observation that the house was an ideal vehicle for the production and perpetuation of values associated with the corporate-industrial society, and vice versa. The remark was underpinned by his positive views about the corporate-industrial entity. One could suggest that, at this stage, in 1928, he shared the faith of the Progressive Era, namely in the corporation as a viable option to reform society. However, Fuller distinguished between corporations that thrived on financial speculations and those which were "productive," that is, demonstrated in goods and services. Also in relation to the from of his business, Fuller argued that the corporation, fueled by the vital life-line of the stock market process, allowed for the

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136 "Lightful Houses"-- preamble for Cosmopolitan Homes Corporation, p.69.
137 R.B. Fuller, "Lightful Houses," p.22.

demonstration of "popular" approval. Thus, under the corporation, the "worlds of capital" would pass from "feudalistic, unthinking, selfish hands to the hands of the unselfish, thinking workers."[138] For Fuller, such incipient transformations had a purifying effect of removing staticism associated with the house and home, or the life of its occupants within. On another level, the house as a product of corporate-industrial activity would disentangle the intertwined traditional land-shelter economic couplet.

Contemporary misgivings of the excesses of corporation aside, Fuller's optimism for the corporation to affect the house was not so far fetched. The new collectivism implied in corporation had clear social advantages. As a form of good intelligent industry and management, the corporation enabled material abundance. Its "political" effect appeared to replace the rugged and laissez-faire capitalism of the Gilded Age. It stood at the threshold of resolving class conflicts and antagonisms by erasing differences among owners, managers and workers. The identity of the worker as an incorporated individual was defined as much by his productive role as by his consumptive one. For this reason, Fuller argued that it was in the worker's own survival interests to ensure an integrity in what he consumed and what he produced. In this way, the corporation, despite its appearance of anonymity, was an apotheosis of the individuals that it had displaced. Under such a collectivist sensibility, Fuller believed that the corporation as a new social order with industry as its primary productive activity, would enfranchise "Everyman" as a stockholder Thus he claimed:

THE LABORING MAN OF TODAY IS THE CAPITALIST OF TOMORROW[139]

The house produced by industry, by extension, would be an egalitarian object, free of conflicts and class antagonisms. In casting the identity of the worker in his consumptive rather than productive role, Fuller basically relegated the working class to a mere beneficiary and not an agent of changes. The transformative power lay in industry in general, and in his industrialized house, in particular. With the production processes streamlined and a home populated by mechanical appliances, inanimate forces would replace the bestial labor, the source of age-old exploitations. The savings accrued in manpower and material, Fuller surmised, when "unselflessly" reapportioned to all workers would deter destructive revolutions. This was the redeeming moment of the evolutionary force of technology, under the auspices of his imagined world housing corporation.

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138 R.B. Fuller, "Lightful Houses," p.26.
139 R. Buckminster Fuller, "Lightful Houses," p.54.

For Fuller, a viable commonwealth could only be secured on the ground of the autonomous existence of its constituents. This was his tacit belief when he lamented how "commercialism" had devastated the "dominantly communistic" New England common.[140] Though sympathetic towards its pastoral communalism, Fuller's eyes were focused more on a model of future community which he saw as industrially communistic, if not syndicalist. It is probably more accurate to identify Fuller's imagined community as closer to the collective agenda of the later New Deal liberals who subsequently inherited the Progressives' political mantle. In particular, Fuller was receptive to and supportive of the fundamental moral, social and political reorientation of the protective legislations that the Progressives had created to curb the excesses of rampant acquisition and conspicuous consumption of the Gilded Age. At this point, however, Fuller openly supported increased governmental interventions of the nation's economic and social life. This political positioning allowed for orderly markets, which curbed competition without the destructive interests of establishment politics, conservatives and radicals. Fuller's ideological rhetoric, one could say echoed that of Henry Ford:

> The world can have what it wants of goods if the spirit of service - the wage motive - prevails ... The days of dead conservatism or wild radicalism has passed.[141]

Paradoxically, the subject of Fuller's self-mission was to reform the excesses of the "rugged individualist," which he exemplified in the "virile Mid-west industrialists." Similarly, the adverse competition increasingly embraced by the so-called moral household of his genteel class had to be undone. His self-crusade was a new moral enterprise to dismantle that household form from within and without. The process, he believed would strip away the formal distinctions of wealth and privilege. The 4D House, emptied of the past, would be inhabited by a new set of values drawn from what Fuller surmised, the egalitarian values of the emerging corporate-industrial society. Fuller's repro-shelter project departed from Le Corbusier's mass-produced house in *Towards the New Architecture*, by avoiding a purely formal proposition, and by locating of praxis directly in the activities of corporate-industry. This was the direct link between public demands of houses and the productive capacities of industry without, he believed, the intermediaries of architects and the financiers.

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[140]R. Buckminster Fuller, "Universal Architecture Essay No.3," p.41.
[141]Henry Ford & Samuel Crowther, *Today and Tomorrow*, p.272.

1.2.2.2. Consumption Fulfills Life and Soul

For Fuller, the prospect of the industrialized house as a carrier of this transnational ambition was real and desirable. Its force was industry, and the new media of mass communication, its conduit:

> Industry will go forward by leaps and bounds, national and political boundaries will disappear (sic) [and] a universal language will develop by means of the television, movey (sic), combining both, written and spoken word, demonstrated by the universal language of the movey (sic).[142]

Fuller's idealistic egalitarianism is represented in the form of democratic and enfranchised consumption. For instance, during the writing of "Lightful Houses," Fuller attended movie houses in Chicago almost incessantly. Thus, he was keenly aware of how that mass culture industry had assisted in assimilating the new immigrants of the ethnic enclaves in the urban areas, albeit via an immersion in white middle-class values. At this point, even the process of assimilation by the agency of advertising was viewed by Fuller as a constructive, industrialized medium. It was not duress but an informed practice of freedom in choice and consumption. Thus Fuller proposed that in America, the land of voluntary diaspora, the diverse racial enclaves finally reckoned their common ground via the objects they consumed and by their experience of the landscapes of industry, purged of cultural connotations.

However, there were new threats emerging in the consumptive society where "service" was touted ad nauseam via the excesses of salesmanship and promotion, and where consumer goods were artificially rendered obsolete by each new model. Fuller had no answers to these threats; rather, he wrote against style as effects of social distinctions, and attempted through his ascetic design, to purify the consumer market of such vagaries.

Nevertheless, his key to social assimilation was in enjoining the public to reduce the house to the level of a commodity. Eventually as a commodity, Fuller proposed that the house would be designed on a ten-year obsolescence cycle.[143] In "Lightful Houses," the house as a commodity was shaped by the imperatives of mobility and continuous, democratic consumption. By treating the 4D house as a commodity, Fuller had aimed to dismantle the house as an object of cultural resistance. Further, Fuller had intended the house to dissolve into the world of mass-consumptive objects. Hence, his preference for the functional label of "shelter" over the cultural

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[142] R. Buckminster Fuller, "Lightful Houses," p.28.
[143] See "Universal Architecture Essay No.1," p.64.

connotation of "architecture", and self-characterization of all his subsequent production as artifacts.

The choice of the house as a "service" over the house as a possession articulated his broad strategy for the meaning and design of the 4D House. It directly reinforced notions and practices of mass-consumption, then current. Leuchtenburd, a historian of the Gilded Age, proposed that an economy based on service over production meant a people-focus emphasis rather than a material-environment orientation. Thus:

> The nineteenth-century man, with a set of personal characteristics adapted to an economy of scarcity, began to give way to the twentieth-century man with the idiosyncrasies of an economy of abundance.[144]

As a form of enfranchisement, this was the road to "the universe of free individualism of the intellect or soul." It was an affront to the staticism of the genteel class which distinguished and demarcated its social position by conspicuous consumption and material hoarding. Fuller thus showed no anguish for the eventual loss of high culture. In the new consumption, time, timing and access were vital considerations, thus the significance of 4D as a trademark:

> Having understood the 4th dimension attributing a new meaning to the world, we will call things *temporal instead of material*.
> When we have harmonized all beastial(sic) material & all those portions of natures temper through Faith, mind you (and the home is almost the last thing) then will we have balance or the milenum(sic)[145] (Id., my emphasis).

1.2.2.3. Mobility and Detachment from the Utility Grid

The fixity to the land, Fuller argued, had singularly accounted for and legitimized the broad social and economic inequalities in America. Thus, whether as tract houses or planned communities, contemporary reforms in housing were literally shackled by their fixity to the land, to the utility grid, and ultimately to institutional structures. Calling tenements "sardine-box communism," Fuller sketched how control over the "group arterial system" thwarted natural human growth:

> In such sardine-box, central service shelter and arterial system, for instance water, can be controlled by a material-bully, so mechanically empowered that he may arbitrate in relation to social intercourse and growth.

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144 William Leuchtenburd, *The Perils of Prosperity, 1914-1932,* Chicago: The University of Chicago Press, 1967, p.198.

145 R. Buckminster Fuller, "4D File Manuscript MSS28.01.01, Folder VII."

> Picture humans linked together by group stomachs and nervous systems as Siamese Millionuplets(sic) attempting to develop self or community in relation to the dictates of their intelligence and faith.[146]

This encumbrance of the "proletarian," Fuller continued, could only be "cured" by uprooting, mobility, and expansions of the suburbs and sprawls to their limits.[147] With an all-around increase in physical mobility and availability of high-strength lightweight materials, Fuller's "Lightful Houses" and "Lightful Products" would be vendored as a form of service. Not only would the project decentralize the tumultuous cities, but also it would totally undermine the naturalized permanence and cultural status of the house. Revivifying a Jeffersonian pastoral ideal, Fuller claimed that:

> a home, like a person, must be as completely as possible; independent and self-supporting, have its own character, dignity and beauty or harmony[148]

At a cursory level, Fuller's proposed evacuation from the city appeared to feed into mainstream and professional discourses on housing reform, which similarly entwined the issue of population evacuation from the urban areas with those of health, morality and density. However, his romantic primitivism was more far-reaching, being one based on the myth and ethos of the American frontier, and characterized by mobility and self-sufficiency.

"Lightful Houses" tried to establish the form of radical self-sufficiency through the new technologies. It was more than a symbolic gesture when Fuller proposed to divorce the house from the public utility grid. Increasingly, he felt the need to unravel the entrenchment of community, which gained its socio-political legitimacy in the invisible public amenities and utilities. This "umbilical cord" was, he argued, an insidious form; being invisible, these public support systems were naturalized into taxes, rates and mortgage structures. These inanimate objects in turn legitimized social controls and perpetuated gross inefficiencies in resources. The act of severing the house from this public "cord" was a sure guard against the complacency of institutions and a realignment of abundance for all.

1.2.3. Change of Tide – Events Leading to The Marshall-Field Exhibition

Up till the legendary exhibition of 4D House and its billing as Dymaxion House at Marshall-Field in April 1929, Fuller's promotion of 4D House was confined to pamphleteering,

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[146] R. Buckminster Fuller, "Universal Architecture Essay No.2," p.77.
[147] Ibid.

letter-writing and work on packaging the design ramifications of his 4D ideas.[149] Fuller also recorded that he spent the summer and winter on making models and keeping up his "Yogic" exercises of breathing and stretching[150]; the latter discipline, no doubt encouraged by Jean Toomer.

Walcott was probably instrumental in introducing Fuller to Toomer. Jean Toomer, an African American poet (b.1896-1967) was among the most influential and totally committed exponent of G. Ivanovitch Gurdjieff's psychological and yogic methods in America.[151] In the thirties, Toomer scurried between New York and Chicago conducting very successful lectures in homes of individuals. It is evident that Toomer knew of and was sympathetic to Fuller's project as early as June 1928. He even attempted to arrange for another Gurdjieff's disciple, Hugh Ferris, who he characterized as "a well rated architectural designer," to meet Fuller.[152]

Toomer probably also had a role in influencing this early phase of Fuller's self-presentation; and Fuller's emotional state might have been receptive to Gurdjieff's philosophical and psychological propositions. However, this influence was probably also limited. It was evident in the writings of *4D Timelock* and "Lightful Housing" that Fuller reworked his philosophical and psychological anxieties from a Christian perspective, relegating all beginnings to the evil source of the original biblical sin. His body-soul and mind-body dichotomies, though echoing the discipline of Gurdjieff's system of self-observation of one's body from a distance and the non-identification with the body, was finally about eventual self-empowerment to act rather than for contemplation. In this sense, Fuller's "deselfing" process and the ascetic system of abstinence and bodily control, as such, were respectively self-invented psychological theory and system of redemption.

Toomer, in the mean time, was instrumental in gathering an audience at Le Petit Gourmet Restaurant, Chicago in September 1928 for Fuller's first private showing of his work. It was billed as a "hexagonal" 4D House.[153] By December 1928, ensuing from the lecture, the first newspaper article by C.J. Bouliet, an art news editor of *Chicago Evening Post,* vividly described

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148"Lightful Houses," p.18.

149"Chromochronofile," a record of correspondence and clarification of his 4D ideas was eventually added to the subsequent version of *4D Timelock (1928)* during this period.

150R. Hamilton, HE-MSS "Notes on (RBF's) Career," p.13.

151For discussions of Toomer and Gurdjieff's psychological approaches, see Rudolph P. Byrd, *Jean Toomer's Years with Gurdjieff: Portrait of an Artist, 1923-1936*; George Baker & Walter Driscoll, "Gurdjieff in America: An Overview," in *America's Alternative Religions*, SUNY Press, Albany, 1992.

152Ltr. 6/15/28 RBF to J. Toomer; Ltr. 6/17/28 J. Toomer to RBF in *4D Timelock* (1970), p.75.

the 4D House as a "tree-like style of dwelling."[154] From this point, the process in the making of Dymaxion House is almost legendary.

Fuller explained that Marshall-Field's impetus to host a two-week exhibition of Dymaxion House and a series of lectures was formed by their own sales promotional interests. Marshall-Field had recently acquired a stock of modern-style European furniture, and was looking for an appropriate setting to promote this new merchandise. In March, the departmental store came across Bouliet's feature article on the 4D House, and immediately saw its value in enhancing their products. Marshall Field's strategy, Fuller explained with shrewdness, was to "walk forward backwards," thus:

> This (4D) house is so extreme that it will make (Marshall-Field's) modernistic furniture seem mild and old-fashioned and therefore saleable.[155]

Waldo Warren, a "namesmith" who was the advertising specialist at Marshall Field, subsequently contracted the word "Dymaxion" from "dynamic," "maximum" and "ions" to dramatize the broad scientific appeal of the 4D House.[156] Fuller offered the genesis of the name in this way:

> The word 'Dymaxion' was composed by Marshall Fields' Advertising Counsel on mathematical rhythm basis, as indicative of the principle of design which embraces dynamics, maximum space; multi-dimension, etc.. The word is intended not as a trade-name but as a general term, such as 'radio', to be applied to any design from the inside out, which compasses the time dimension. This sounds rather involved but in effect, is relatively simple.[157]

While the name Dymaxion was probably more effective for public recognition than 4D, Fuller expressed ambivalence about its use. 4D was intimately meaningful to Fuller as a set of principles based on "design from the inside out, which compasses the time dimension." Further, despite its effectiveness as trademark, Dymaxion was perhaps too closely connected with the commercial hard-sell of futuristic style. Yet because of the appeal of the name and his concomitant promotional activities, he quickly accepted it as "generic (term) for new scientific architecture," and reduced it to a descriptor for his personal style.[158]

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[153] See Entry in "Public Presentation of Fuller and Dymaxion Items," in *Dymaxion Index (1927-47)*, p.1

[154] See C. J. Bouliet & R.B. Fuller, "Tree-like Style of Dwelling Planned," *Chicago Evening Post*, 18 December 1928.

[155] HE-MSS "Notes on (RBF's) Career," p.13.

[156] R.W. Marks, *The Dymaxion World*, p.24; A. Hatch, *At Home in the Universe*, p.105.

[157] Ltr. 6/3/29 RBF to A. Sweet in BFI-CR36.

[158] R.B. Fuller, "Universal Architecture Essay No.1," p.59.

There was more than newness, in the house design before the name change to Dymaxion. Over six months, between May 1928 and September 1928, a significant formal transformation in the presentation of the 4D House also occurred in its plan form. Rather than a rectilinear plan of the patent, 4D House assumed its more imageable and trademark hexagonal plan. Fuller also reported that from the Christmas 1928 to February 1929, he completed two model houses.[159] The apparent revision to the 4D House plan warrants a closer examination and explanation.

1.2.4. The 4D-House Patent and the Dymaxion House Design

The published version of Fuller's 4D House patent of 1928, based on a 30'x24' rectilinear plan differs substantially from the hexagonal model version that he displayed in Marshall-Field in April 1929. Because of the substantial formal revisions and technical transformations in the design, doubts were cast over the extent of Fuller's role in making these design changes.[160] What has added to the confusion of attribution in the design is that many of the extant renderings of 4D towers in *4D Timelock* were not executed by Fuller. In all likelihood, Fuller directly heeded Arthur Holden's advise to get 4D published with illustrations by a number of well-known architects.[161] In the development of these 4D-Towers, Fuller was supported by a number of architectural students - Leland Atwood (Univ. Michigan), Robert Paul Schweikler (Yale), Clair Hinkley (Armor), Tad E. Samuelson (Armor).[162]

James Ward, who curated the most extensive collection of Fuller's drawings, in *The Artifacts of R. Buckminster Fuller* (1984), suggested that "the public considered the 4D design impossibly futuristic. Consequently, Fuller presented his house as a more conventional rectangular volume with Georgian fenestration in his application for a patent."[163] The explanation of Ward is not only chronologically incorrect, but it also post-rationalized the reason for the conservative appearance of the patent version.

Fuller offered a more astute consideration for why, the patent appeared conservative. The patent, he argued, was a demonstration of a radical principle of construction and not a radical appearance of construction. Thus, to sidestep the misreading of this serious proposition as a

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[159] Ltr. 2/4/29 RBF to Mrs. Caroline Wolcott Fuller in BFI-CR36.

[160] M. Pawley, *Buckminster Fuller*.

[161] Ltr. 8/13/28 A. Holden to RBF in *4D Timelock* (1970), p.81.

[162] Ltr. 8/10/28 RBF to Paul Nelson in *4D Timelock* (1970), p.85.

[163] James Ward (compiler), *The Artifacts of R. Buckminster Fuller, Vol. One: The Dymaxion Experiment, 1926-43*, N.Y.: Garland Publishing Inc., 1985, p.53. Henceforth as *The Artifacts*.

novelty, he acted upon the advice of his patent lawyers to make his patent claims "much more convincing" in a "rectilinear structure of conventional appearance."[164] Despite the rejections of his patent claims, he felt that lodging the patent already established prior art to ward off potential competitors.[165] The hexagonal scheme, by this account, merely elaborated the principles of the various claims; he called this latter scheme a "clean-up model" of the first.[166]

In July 1928, Fuller explained to his father-in-law the formal changes in his work and the hesitancy to make these changes public:

> The drawings don't look at all like the harmonious 4 D House, and the cubical termination of the design is only so shown to indicate its possibility from a *central rounding plan*....
> The fact that a top cantilever truss is shown is not confining, but indicates that the floors and walls might be suspended from such, as well as directly from the mast and caisson. I am loath to show these as it was my intention to keep them from the view of any designers lest they be grotesquely prejudicial[167] (Id., my emphasis).

Fuller further suggested that the 4D House was a minimal version of the 4D Tower [Fig.1.06a]. It is also clear from the sketches in *4D Timelock* that the primary application of the 4D principles were in tower blocks rather than in the single-family, free-standing house. Four extant sketches prepared for the Chicago Home Owners Exhibition at the Chicago-Coliseum in May 1929 illustrated this intention.[168] Fuller did not execute these drawings; they were renditions of his 4D tower concept by a skilled draftsman, clearly one trained in the conventions of presentation sketches and familiar with the plan composition based on Beaux-Art axiality. The structural efficiency of the multi-story 4D Tower was to contrast with the conventionally-crafted house [Fig.1.06b].

Fuller's own experimentations with the trademarks for his 4D enterprise clearly disclosed that the hexagonal motif of the 4D towers was present all along [Fig.1.07]. The nomenclature

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164 R. Buckminster Fuller, *Inventions. The Patented Works of R. Buckminster Fuller*, N.Y.: St. Martin's Press, 1983, p.11.

165 The prior arts that Fuller perused to establish his own claims included:

1. 5/14/1912: #1,026,406 Charles W. Nichols "Arrangement for Inclosing Vacuum Conduit Systems"
2. 4/24/1928: #1,667,484 Paul Liese (Berlin Tempelhof) "Translucent Wall, Ceiling, Floor Structure"
3. 9/5/1893: #504,544 William van der Heyden (Yokohama, Japan) "Sanitary House"
4. 6/23/1925: #1,543,134 Libanus M. Todd "Shelter"
5. 9/11/1928: #1,683,600 A. Black (Garden City) "Building Construction"
6. 3/10/1925: #1,529,516 Alexander T. Thorne (Tulsa, Okla.) "Cantilever Building Construction
7. 1/4/1881: #236,141 William F. Beecher (Brooklyn, N.Y.) "Heating & Ventilating"
8. 10/28/1890: #439,376 Dudley Blanchard (Brooklyn, N.Y.) "Tornado-proof Building"
9. 10/16/1923: #1,470,935: A.C. Rush, "Observation, Amusement & Utility Tower"

166 R.W. Marks, *The Dymaxion World*, p.80.

167 Ltr. 6/8/28 RBF to J.M. Hewlett in *4D Timelock* (1970), p.52.

that Fuller developed for the towers were based on the depth ("time units") from the structural-mechanical core to the exterior window edges, and the number of floors [Fig.1.08a]. Thus a "5T-4P" tower model, one which Fuller claimed as "analogous to Ford auto," was five modules deep (five-meter radius), with four floors; a "8T-12P" tower had a radius of eight meters and twelve floors [Fig.1.08b]. By varying the "time unit" over each floor, different profiles of towers were produced. Thus, 4D was a proposition for a building system that was expandable, variable and portable by air [Fig.1.08c-d]. However, the mass-market for such fantastic towers was a long shot. Given that Fuller positively valued the conservative nature of the single-family house, the minimal 4D House was his preferred object; and indeed, the 4D Corporation was set up initially for this market.

One could speculate that the first rectangular plan shown to AIA was still amenable to the standing practice and craft of the profession, although the material range and aspects of the structuring were radically new. He envisaged independent bathroom, bedroom, kitchen and components. The non-structural wall panels made of panes, as a translucent skin, were to be structured and stiffened by pneumatic tubings. The floor system consisted of tension wires in a single spiral was to be covered over by stretched canvas or heavy tarpaulin and square three-foot module of pneumatic mat. Eventually, this was replaced by a single pneumatic duralumin "bladders" topped with bakelite rather than rubber.

The St. Louis meeting probably further spurred his belief that only a radically-revamped house design destined for a total industrial process would leave out the architect altogether. The name shift from "Lightful" house and products of the "Cosmopolitan Homes Corporation" to 4D was concerned with a total product, an emblematic standard for living in the industrial age. Thus, the hexagonal model was a carefully-considered choice, not a fallback model [Fig.1.09a & b].

The hexagonal geometry has an economy which promises immediate technical simplification. While there are more sides, the hexagon is constituted form a single, equal, repetitive linear element, compared to a minimum of two elements in the rectangular plan. Likewise, the sixty-degree angle unifies all interior and exterior joints, while the intermediate square or pentagonal geometries create either more complicated joint-angles or more linear components. The constituent equilateral triangles of the hexagon promises immediate unification of parts, and standardization of components. As a planar object, the triangle was a minimal system of structuring that possesses shape integrity. Thus, in the patent proposal, eighteen

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168 *The Artifacts* (Vol.I), pp.29-32.

radiating load-carrying beams of five different lengths gave way to equal-length radial tension cables and rim beams.

Functionally, in the hexagonal minimal 4D House, all the rooms are consolidated in one suspended floor, with the ground freed for an "amphibian airplane-automobile" hangar. There are two versions of the hexagonal scheme, distinguished by the disposition of the central core. The first specified a "worm-gear elevator" while maintaining two stairs on the *piano nobile* leading to the play deck. The second consolidated a central stair core. In both instances, the spatial accommodation of the mechanical core of power source and service units, specified in the original patent, became highly problematic. In fact, this feature was graphically omitted in extant drawings of the revised Dymaxion. The elevator core, a left-over feature of the tower proposal, became economically unfeasible as Fuller sought for a minimal model. Likewise, the metaphorical autonomous womb of mechanical support was dropped off as Fuller sought a "practical" model ready for immediate demonstration.

While the core mechanical support appears plausible, the core of illuminance creating an outward glow of harmonic grace remains viable. Fuller proposed lighting from a source with "conical reflecting surface" directed and augmented horizontally by a battery of reflectors above the translucent ceiling. The reflected and diffused light to the spaces below was to be controlled via shutters & color prisms. This new hearth emanating an equidirectional, equipotential glow of industrial light displaces the symbolic Victorian progenitor. These accommodations illustrated the impracticality of the 4D House despite Fuller's explicit proposition it was a "last word in scientific marvels," and practical as the "best for all plan." [169]

Fuller nevertheless retained the radical conceptualization of the household as integrative landscape for a potpourri of mechanics. Work units remained functionally independent, but they were dovetailed in a rational matrix; equipment and furnishings rather than the figurative spaces defined uses; and the identity of the body-house dissolved into a gigantic self-cleaning, self-lighting and self-ventilating appliance. All parts merged into a seamless, frictionless unity where, Fuller described, "cooking grills are like a piano," and shelves in the dish closet "come around to you instead of your going around to them." While the house environment was hermetically sealed, the erasure of the inside and outside was augmented by an interior filled with communication instruments, like telephones, televisions and radios for the sending and receiving

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169_ "Fuller tells of his amazing 4D Five Room House," *The City Club Bulletin* (Chicago), 27 May 1929, No.21 Vol.XXII, p.120.

of messages. These instruments created an ambivalence: a house that was totally separated from the surrounding, as if to escape from locality, yet returned to and became embedded in a universal space defined by objects of industry. This implicit desire to erase boundaries between things was contained in his "radionic" metaphor of inside-out.[170] His references to Louis Sullivan and Frank Lloyd Wright were apparent:

> One cannot design from outside in. There can be no character unless we design from the inside out. The surface must express the interior functionalism and life.[171]

1.2.5. Return to New York

> (The) magazines and news articles are daily stealing the thunder of novelty from us ... (The) end would seem to justify the means of our 4D housing[172]

The positive media and public reception, after the Marshall Field Exhibition, of 4D House as Dymaxion House was pivotal in the history of the Fuller's advocacy of his repro-shelter project. Rather than "peas in pods," Fuller was confident to offer a more positive imagery of his house as "a bunch of roses."[173] The event also galvanized his view of the positive aspect of Dymaxion houses as a standard industrial product or as "machines for the propagation of life."[174]

Between April 1929 and December 1932 when Fuller finally shelved the Dymaxion project, he took to the road actively searching for patrons and investment support on terms he dictated. Of the myriad promotional activities, perhaps his presentations to the Chicago Home Owners Exhibition and Architecture League of New York in the Spring-Summer of 1929 were the most significant for the subsequent tenor and conduct of the Dymaxion House project.[175]

At the Chicago event in May 1929, Fuller met up with the "big men" in the Architectural Committee of the Chicago World's Fair of 1933. At the meeting, Fuller claimed that Harvey Corbett, the Chairman of the Committee and a prominent New York architect, said that he would see to it the Dymaxion House was built for the Fair.[176] The theme of the exposition was to be the progress of civilization during the century of Chicago's corporate existence. "A Century of

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170 See extended discussion of this metaphor in "Universal Architecture Essay No.1," p.68.

171 R.B. Fuller, "Lightful Houses,"p.14.

172 Ltr. 6/15/28 RBF to A. Holden in *4D Timelock* (1970), p.70.

173 Ltr. 5/24/29 RBF to A. Fuller in BFI-CR73.

174 __, "Nesting" [Verbatim Report of July 9 Architectural League Presentation], p.9.

175 Entries for the "Public Presentations of Fuller and Dymaxion Items," *Dymaxion Index* (1927-47).

Progress" corporation was constituted in January of 1928 with a charter to administer the Fair. General Rufus C. Dawes, a Civil War veteran, was selected president of the Board of Trustees.

The second event following on the heel of the first, was Fuller's one-man show at the Architectural League-New York in the Summer of 1929. With a sympathetic audience, during which he was publicly introduced by Corbett no less, Fuller fired up several American modernist architects to receive their support of his project. At the same time, the commercial value of the publicity that Fuller gained in his promotional-lecture circuit on the Dymaxion House was not lost to the publishing world. To appropriately complement the radical nature of the Dymaxion House, Schribner & Sons Publisher seriously considered making the Architectural League event an opportunity for a new type of book:

> Just as Dymaxion House, designed for industrial fabrication is unlike anything that has gone before, so may this book describing it, properly follow a new road in book publication.[177]

Though the book project did not materialize, the exposure and the network that Fuller managed to establish were significant.[178] Immediately the prospect of a prototyping opportunity for the Dymaxion House seemed at hand.

1.2.5.1. Enlisting Support from the American Avant-garde Practices

Besides the expressed interests of Corbett, Fuller recounted that Raymond Hood, Ely Kahn, W. Harrison & R. Walker were also sufficiently persuaded by his Dymaxion ideas at the Architectural League presentation that they gave him immediate support. By Christmas in 1930, Fuller recounted that these architects, gave him a $1,000 to illustrate "how seriously they took (his) research findings" since "architecture needed a true research department and (he) seemed to be carrying on the only such activity."[179] While Fuller was clearly aggrandizing the significance of his work with such a claim, it was probably true that the Dymaxion project was broadly seductive to these architects.

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176 Ltr. 5/24/29 RBF to A. Fuller in BFI-CR73.

177 Ltr. 6/2/29 C. Schribner Publisher to J.C. Bierwith in BFI-CR36.

178 The event is contained in a 57-page document titled "Nesting" [Verbatim Report of July 9 Architectural League Presentation], July 9, 1929 in BFI-CR36. Also filed as "Address to the Architectural League, N.Y.C. Spring 1928(sic)" BFI-MSS 1928 in BFI-HEv14.

179 Ltr 12/10/76 RBF to T.H. Gibbins (Santa Rosa-Calif.).

Harvey Corbett's supportive role in promoting Fuller's Dymaxion House also reflected his own public view on mass production in housing.[180] Corbett shared Fuller's view that the building industry, despite its size, was the "most inefficiently managed, the most uneconomic."[181] Corbett was convinced, as many critics of the building industry were, that it was "underproducing." The repro-shelter was a potential savior of the economic depression. In his prognosis, the scale of such an undertaking in 1929 should be three hundred thousand homes at $5000 a piece.

To Corbett, Fuller's role as an outsider represented an ideal type to address the pressing inefficiencies in house design. The perception of Fuller as lacking in preconceived notions about housing was largely because he stood outside existing professional discourse. Corbett's introduction at the Architectural League presentation testified to that impression:

> *Mr. Fuller, fortunately is not an architect. Still more fortunately, he is not an engineer.* He isn't any of these objectionable things we all know about ... You know if an engineer tries to design a house, he immediately thinks that he ought to put some architecture in it, which he doesn't know much about; and if an architect tries to design a house, why he knows he has to put some engineering in it - and he doesn't know much about that. Between the two, they always mess it up.
> *He(Fuller) approached it so abstractly, so free from any previous conception of what a house ought to be*[182] (Id., my emphasis).

Corbett was also responding to the government initiative, spearheaded by Charles Reis, Chairman of President Hoover's Conference on House Building and Home Ownership, Washington D.C. Ries had appealed to the architects and industry to produce twelve demonstrative types of house to be certified upon the approval of the government as "Department of Commerce Model Homes."[183] However, the scale of the work, he surmised, could only be undertaken by great individual corporations rather than by the building industry. Only the former had experiences with standard products, continuous production through winter and lower overall costs in terms of wages. Furthermore, the model home:

> must be fireproof, stormproof and floodproof; full of sunlight; with every modern device; erected by union labor; sold by present material mean; and able to pass all building laws. It

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[180]Corbett had established his reputation primarily through his concerted studies on the formal implications of the new zoning laws. By being opportunistically creative, he was able to forge the restrictions of zoning into spectacular images of a new architecture and vision of the future. (See Corbett, "Zoning and the Envelope of the Building," *Pencil Points*, 4 April 1923; also "The Coming City of Setback Skyscrapers," *New York Times*, 29 April 1923 -- sources cited in Carol Willis's "Zoning and Zeitgeist: The Skyscraper City in the 1920s, " *JSAH* 45, March 1986, p.55; also Pai Hyungmin, "From the Portfolio to the Diagram: Architectural Discourse and Transformation of the Discipline of Architecture in America, 1918-1943," Ph.D. dissertation, MIT 1993.)

[181]-, "Nesting" [Verbatim Report of July 9 Architectural League Presentation], p.1.

[182]Ibid.

[183]See W. Harrison and H. Corbett's public advocacy of the minimal house in "$3,000 House Built in Week (Architect points out the Need for Such Housing and Urges Research)," *New York Times*, ca.1930-31 (Copy in BFI-CR38).

> must be capable of being erected in a week or less; be light, mechanically simple and perfectly planned to relieve the housewife of all drudgery.[184]

Fuller's Dymaxion House, despite its unproven record of accomplishment, appeared well-poised as a prime candidate to test most of the performance criteria that Corbett set forth. Furthermore, Corbett's agenda for housing also included reforming the emerging "artificial life" in the city. He saw Fuller's Dymaxion House as a minimal machine in the garden that would fulfill this purpose.[185] The Dymaxion House, besides being a solution for housing in the country, would also return the unemployed city immigrants to their origins, thus averting an impending social problem. More immediately, Fuller's Dymaxion House project represented a potential aesthetic update of the Chicago World's Fair.

1.2.5.2. An Eye to the 1933 Chicago World's Fair

Corbett's interest in Fuller's Dymaxion project and Fuller's enthusiasm in his support were mutually reinforcing. Their interests were beyond mere gestures. Corbett, the Chairman of the Architectural Committee of the 1933 Chicago World's Fair, Fuller felt, was well positioned to help him realize the Dymaxion House and extend it beyond its present limited audience. Corbett, on the other hand, saw a radical newness and novelty in the Dymaxion House. His own comments several years later, at the symposium, "International Style," Exhibition of Modern Architecture, Museum of Modern Art (1932) attested to this perception. Corbett confessed that after viewing the MoMA Exhibition, he realized how the "modern" World's Fair at Chicago was "very old-fashioned." Defining modern as "turning... back to fundamentals (and) enclosing of space on a rational basis," it was not difficult to see how Fuller's Dymaxion House might have fitted his billing for the Chicago Fair.[186]

Planned since 1927 by private industries & spirited citizens, the Chicago World's Fair was eventually opened in May 1933 -1934. Sited on a 427-acre lot at Lake Michigan, the Fair was a celebration of Chicago's centennial to depict a "'century of progress' in science and technology and its effects on industry and on everyday life."[187] "The Century of Progress" at Chicago was to witness, for the first time, the full capacity of mass media of the post-industrial

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[184]Ibid.

[185]Fuller also characterized the Dymaxion as a "minimum rural dwelling" in "Universal Architecture Essay No.1,"p.65.

[186]See Harvey Corbett's remarks on the MoMA Exhibition in *SHELTER* April 1932, p.9.

[187]H. Ward Jandl et.al., *Yesterday's Houses of Tomorrow, Innovative American Homes 1850-1950*, Washington D.C.: The Preservation Press, 1991, p.127. Henceforth as *Yesterday's Houses of Tomorrow*

age. Mass media in such as professional magazines, advertising and the departmental store, movies, material, utilities and household technology industries created new consumptive desires.[188] In the throes of the Depression-beaten thirties, the optimism of the Fair was a welcome escape.

Corbett was eventually able to exceed Reis' plea for twelve prototypes of modern houses at the Fair by drawing support from private corporations and trade associations.[189] In the interim, perhaps speculating that Fuller's Dymaxion House might, by a long shot, be one of the twelve prototypes, Corbett and his partner Wallace provided Fuller a variety of professional support. Corbett himself directly promoted Fuller on the college lecture circuit.[190] Along with Ely Kahn and Edward Forbes, Corbett supported Fuller's application for Guggenheim Memorial Foundation scholarship in architecture.[191] Corbett's office (Corbett, Harrison and MacMurray) provided the physical setting for the preparation of architectural drawings of the Dymaxion House with a view to producing a full-scale prototype model for the Fair.[192]

While Corbett expressed interest in and lend support to the Dymaxion House, he made no other firm commitment that it would be finally prototyped for the Fair. Fuller's activities, however, indicated that he personally assumed the venue of the Chicago World's Fair was a serious proposition for featuring the Dymaxion House. More than confident that the model house would pay for itself, Fuller's primary aim then was to secure the opportunity to present the Dymaxion House to the public.[193] Its positive public reception would catalyze the process towards the repro-shelter he envisaged. Potential sponsors for the House were lobbied probably under Fuller's instigation or directly by him. For example, one anonymous letter advocated that the Dymaxion House would best fit the American Union of Decorative Artists & Craftsmen Inc.

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[188] Ibid., p.10.

[189] These included H. Corbetts' own *The House of Today*, executed in collaboration with Harrison & McMurray; *The General Houses* by Howard T. Fisher; *The Design for Living House* by John B. Moore; *The Armco-Ferro Enamel House* by Robert Smith Jr.; *The Starn-Steel House* by O'Dell and Rowland; *The Masonite House* by Frazier & Rafferty; *The Rostone House* by Walter Scholer; *The Tropical House* by Robert Law Weed; *The Common Brick House* by Andrew N. Rebori; and finally *The Lumber Industries House* by Ernest Grunfeld Jr. For details of these houses see H. Jandl's *Yesterday's Houses of Tomorrow*; also Libbey, Owens Ford Glass (Toledo, OH) special issue "Glass in Architecture," (1933).

[190] Ltr 10/10/29 Sherley Morgan (Dir., Princeton University) to RBF in BFI-CR36.

[191] Undated Notes, ca.1931 in BFI-CR38.

[192] See the listing of drawings in BFI-CR39. The group of drawings, "A Minimum 4D Dymaxion House" (pp.60-66) and "Sketches" 1928 (pp.73-80) in *The Artifacts* (Vol.I) were all from this period. Mostly executed in Corbett's office (draftsman with initials "M.L.") the drawings and sketches were executed between 2/6/31 and 3/1/31. Sketches on p.73 were backdated by Fuller to 1928.

Fuller's own entry in a pocket-size diary, from Jan. 1 through Jan.24 1931, recorded the meetings with Harrison (See Note#3 in BFI-CR39).

[193] Minutes of SSA-Meeting, Nov. 1931 in BFI-CR42, p.2.

(AUDAC) proposed entry for the Fair " in the architect class." The Dymaxion House had a thoroughly worked out plan and model of "a worker's home of the future," in relation to the scope of engineering required:

> (Because of) the widespread knowledge of this project in the architectural field and the discussion it has provoked, an unmistakable sign that it is a work of importance not to be lightly dismissed... Personally I believe that Mr. Fuller's concept runs a good chance of reversing the old order by being carried out by businessmen and engineers and receiving prior recognition at their hands rather than at the hands of men in his own profession.[194]

Other solicitors' interests in the Dymaxion House were drawn to its radical appearance:

> The purpose of the Modern Age Exhibition is to present the most modern products in the field of industry. Air conditioning, modern refrigeration systems, etc. will be on display. Naturally, your model house will conform perfectly to the general theme.[195]

In itself, the Dymaxion House encapsulated an unstated desire of the Fair, namely to provide an escape from the harsh reality of the Depression. It also highlighted some of the broad concerns in the architectural circles over the design of houses free of traditional shackles. One architectural critic grouped the Dymaxion House and Frank Lloyd Wright's Taleisin Spring Green (Wisconsin) as objects of "culture-soul" and labeled both as "creative intelligence and dynamic design unadulterated by architecturalizing."[196] The sensibility of Fuller's Dymaxion was also echoed in the research proposal of Ely Jacques Kahn (Chief of the Industrial Arts section, 1933 Chicago World's Fair). For Kahn, the design quest for the new dwelling would start from a building which worked "from the inside out," and where style "incidental." Further, the new dwelling would be "as elastic as that of an office building," with moveable wall and standardized construction.[197]

Fuller failed to prototype a full-size Dymaxion House by the end of 1932 and the Corbett-Fuller "alliance" proved disappointing. The relationship, however, illustrated the broad ideological differences between Fuller and the architects. Claiming that Corbett was his disciple rather than a patron, Fuller lamented the futility of trying to "make (Corbett) conscious of his social responsibility in incorporating the Dymaxion attitude of design."[198] Moreover, he suggested that Corbett's anxieties about uniformity compromised the thrust of his repro-shelter

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[194]Ltr. 12/11/31 Anon. to Lee Simonson (President, AUDAC) in BFI-CR38.

[195]Ltr. 9/12/32 L. Conan to RBF in BFI-CR41.

[196]Norman Rice, "I Believe," *T-Square*, Jan. 1932 (Vol.2, No.1).

[197]*T-Square*, January 1932, p.4.

[198]R. Hamilton, "Notes on (RBF's) Career," p.15.

program. Referring to Corbett's presentation "Small House Forum" sponsored by the American Institute of Steel Construction (AISC), Fuller accused him of abandoning a cardinal principle of standard that he advocated. Instead, Corbett promoted distinction in consumption, by advocating there would be "Ford house" or "Rolls Royce house" depending on taste preferences.[199]

To have a mere model of a future house exhibited at the Fair was a devastating compromise. Fuller even suggested that perhaps through Corbett's promotional efforts, many aspects of the Fair's design and entries plagiarized his Dymaxion House ideas. For example, Fuller claimed the tensional roof structure of the locomotive round-house by Lombiere, known as the Transportation Building, was a knock-off of Fuller's structural concept, a "potpourri of Beaux Arts trends, Corbusier's modernism and Dymaxion dynamics." Fred Keck's twelve-sided *House of Tomorrow* lifted his programmatic hanger-garage for the mobile dweller [Fig.1.17]. Even the shelters at Chicago World Fair were "skeleton Dymaxion houses."[200] But it was an especially bitter betrayal since all types of "Houses of Tomorrow" at the Fair, according to Fuller, latched on to the aesthetic program and iconic agenda of his 4D-Dymaxion House.

These formal plagiarisms that Fuller described were pale compared to the larger conspiracy that he would eventually paint in *SHELTER*, on the occasion of the launch of Howard Fisher's General Houses Inc. He accused the World's Fair Committee of 'touting' the General Houses project, which had "cop(ied) outright all 4D problem conditions."[201]

1.2.5.3. Promotional Strategies of an Outsider

From 1929 to 1932, Fuller's forums on his lecture circuit were varied: one-man shows and lectures at private gatherings; public exhibitions and features at other artists' exhibitions; talks to genteel private clubs, cultural, professional and art societies; and finally, several well-placed colleges and architectural schools. In tandem with these activities, Fuller skillfully managed and monitored the press releases to obtain the most effective coverage. Fuller was cognizant of the level and the reach of the audience in the printed media.

If frenzy and contradictory described the character of his promotional efforts aptly, it was because Fuller neither appeared to discriminate among the opportunities that were offered nor in

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[199] See Fuller's marginalia on a tear-out, "Mail-order Houses ... Architect Says what Mass-production Will Bring Us to in A Few Years," *N.Y World Telegram*, 24 May 1932 in BFI-CI #1-19-32/34.

[200] R.W. Marks, *The Dymaxion World*, p.86; R. Hamilton, "Notes on (RBF's) Career," p.15.

[201] R.B. Fuller, "Our Intimate Journal of Summer Events," *SHELTER*, November 1932, pp.15-23.

the manner in which he promoted his ideas. On the one hand, one could characterize that this style of promotion was driven by opportunism; on the other hand, perhaps because of paucity in opportunities, the indiscrimination was a pragmatic one. For Fuller, opportunities, in whatever form, could assist in realizing a part of the project, in establishing the prior arts claim of the project or in revealing principles pertinent to the subsequent working of the Dymaxion House project. These promotional activities were conducted under conditions ranging from the genteel setting of gentleman's clubs to those which, by professional measure, could be readily described as disparaging, if not adverse.

Thus, for example, in April 1931, while staying in River Wood Inn-Schenectady-New York during his presentation to the General Electric Engineering Club, Fuller met up with the inn-keeper, a Mr. Hixon. Upon learning that Hixon was embarking on a "recreational building program," Fuller in his finest performance as a traveling salesman tried to convince him of the Dymaxion option. Hixon's needs, he explained, could realize "many important precedents in relation to the industrially fabricated architecture" which he had advocated.[202]

To Lincoln Kirstein, Chairman of the Harvard Society of Contemporary Art, who helped organized Fuller's Dymaxion Exhibition in Cambridge, Fuller similarly offered investment opportunities in his house project. A month after the Marshall-Field Exhibition, Fuller prospected on selling up to quarter interest in his corporation through issues of share subscriptions. With such asset, Fuller proposed that he could safeguard the 4D House patents, and enable "negotiations with the industrial leaders." Nevertheless, despite the projected commitment of $25,000, he cautioned Kirstein that

> they (the subscribers) must consider it a rank gamble of course, if not, downright charity but of such a gamble, it is possible that they may realize vast returns, if the project is intelligently handled and supported.[203]

Fuller concurrently approached John Geary, an old associate from his working days in the cotton mill, with a similar investment deal:

> whatever ultimate disposition is made of the patent by me, whatever I receive in return, whether in the form of my own or any source, shall be divided on a pro-rate basis in the ratio of subscription now being proportioned to the whole being worth 100,000 (dollars)[204]

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[202]Ltr. 5/1/31 RBF to Mr. Hixon in BFI-CR38.
[203]Ltr. 6/3/29 RBF to L. Kirstein in BFI-CR36.

In June 1930, perhaps through Geary or as a follow-up on their previously agreed business arrangement, Fuller toured the factory of one of New England's "industrial leader," the Gillette Corporation. Upon the tour, he prospected on a new plant that would reduce what he claimed as waste in production and inefficiency at Gillette's operations. In reality, his design was more to test his 4D principles. Nevertheless, he explained to Frederick C. Church of Gillette Corporation that what was needed was a tower structure factory. To this end, he would:

> be glad to make a drawing for a whole new plant, supported as with the 4D Tower Units from a central mast on a suspense(sic) privilege principle with continuous ramp flooring from top to bottom of the building, there being no separate floors but a continuous downgrade with central lighting, heating and atmosphere control, the exterior vacuum window plates, etc., if Gillette would be interested in a general contemplation of improvement in the whole problem of attack.[205]

Church did not take up the offer. While there is no extant drawing on this project, its appearance could be inferred in a conical double-ramp tower garage which Fuller claimed he made for "Steel Company" at the Chicago World's Fair.[206]

Operating as an outsider, Fuller had limited access to influencing professional discourses. Nevertheless, this limitation was offset by a larger avenue for him to advance and publicize his work free from the strictures of professional ethics. Yet, Fuller felt compelled to forge and circumscribe his efforts legitimately. This legitimacy would be refined over the subsequent years. However, in the years preceding the conversion of 4D to Dymaxion, public endorsement for the enterprise was the immediate proof of legitimacy. He meticulously recorded the type of news coverage that each of his event produced to a point of compulsiveness: invitation announcement, feature article, inside or front page for newspaper, article, editorial and others.[207] Fuller was convinced that the consuming public did need not have to be persuaded; rather, it was positive mass appeal that would ascertain the veracity of any claims of truth. Personally, his ethical, "deselfed" position would form the continuous measure and reference.

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[204]Ltr. 6/3/29 RBF to J.W.Geary in BFI-CR36.

[205]Ltr. 6/15/29 RBF to F.C. Church (Gillette Corpn., Boston) in BFI-CR36, p.3.

[206]Two drawings on the 4-D garage tower are presented in *The Artifacts* (Vol.I), pp.41-42. The drawing on page 42 is an earlier version, and was probably the one circulated in the original *4D Timelock*.

[207]To gauge the effectiveness of his publicity works, one could peruse the types of coverage over nine months from the launch of the April 1929 and 1930:

Year	Local	State	Professional	International	Syndicated Release	Movie*	Journal	Total
1929	12	20	5	3	3	1	3	45
1930	7	20	4	3			2	36

* Fuller produced a filmlet, "R.B. Fuller Exhibit Model of $3,000 House Hung on Mooring Mast," in which he claimed the Dymaxion House could "outride storms" and was transportable by a blimp (Newsreel-FOX NEWS, Nov. 1929, Vol.11, No.15; copy in BFI-CR36).

1.2.5.4. Romany Marie Days-Eschewing Radicalism, Technocracy and Mysticism

Fuller's reasons for returning to Greenwich Village towards the end of 1929 were also personal and pragmatic [208] [Fig.1.09c-d]. He was physically closer to his potential supporters for prototyping his Dymaxion House. Fuller separately claimed that Greenwich Village provided an "independent place to work," given that he was "so steamed up with ideas" and had found it "impossible to live with (his) family in country."[209] The Village was an old haunt for Fuller. It was also affordable and offered a sympathetic, like-minded audience which suited his selected calling.

Besides Fuller's legendary epiphany, his return to Greenwich Village and his activities centering around the tavern of Romany Marie also received extended biographical attention. Firstly, the biographers generally used the milieu of the Village to locate the source of his own brew of mysticism emerging in later years, and showed how he distanced him from the faddish tavern crowd. Secondly, they also used it to clarify his relationship to radical political positions of the time. However, all accounts overlooked the significant influences that shaped his practice as an outsider and the pertinence of the technocratic discourse that reformed his ideas.

Romany Marie Marchand, a Moldavian (Rumanian Jewess) immigrant launched the first in a series of village eateries in 1912. By the time of Fuller's first visit to her tavern in 1919, she had already earned the title of "doyenne of lazy Village eateries."[210] Fuller was initiated into the circles at Romany Marie's by Tony and Betty Salemme, a New York sculptor and friend of Monroe Hewlett.[211]

Partly because of Marie's generosity in supporting Fuller in his dire moments, Fuller was generally fond of and sympathetic towards her self-presentation as a Bohemian. Despite recognizing the gimmick, Fuller took her self-presentation seriously as a form of cultural negation. In a 1929 promotional flyer, probably penned by Fuller, announcing his design of Marie's new restaurant, Fuller declared:

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[208] Fuller was taking a momentary reprieve from his marital crisis. (See Fuller's intimation in Ltr RBF to A. Fuller 7/31/32 in BFI-CR41)

[209] Ltr. 7/1/39 RBF to Joe Byrant in BFI-CR46; Copy elsewhere in the HE-v20.

[210] Ltr. 11/22/74 RBF to Susan Redd in S. Sharkey's Private Collection of Letters.

[211] S. Sharkey, Transcript of Conversation with R.B. Fuller, 2/2/77.

> A gypsy recognizes no bounds, and when she must renounce ancient customs, she does so with a free gesture.[212]

Public perception of Romany Marie, however, was less than kind. One source recounted: "In her guise as Bohemian restaurateur, Marie wore exotic gypsy clothing laden with jingling jewelry and cultivated a mysterious air that belied her simple peasant ancestry," and tourists sampled her "well-advertised skills at tea-leaf reading & palmistry."[213]

The Romany Marie environment was conducive to the cultivation of its habitués and their various newly-found identities. Two habitués of the tavern attested to the receptiveness of the tavern's host to their needs:

> (Romany) Marie wouldn't introduce by name, it was by profession: dancer, artist, writer, and your name was merely incidental.[214]

The habitués of the tavern with whom Fuller associated were among some of the most prominent people in American culture.[215] Romany Marie was also a place for alternative lifestyles tainted with mysticism and left-wing radicalism. Discourses on radical social change were advanced at the tavern mainly through two factions, the John Reed Society and the technocracy of Howard Scott and Stuart Chase [Fig.5.09d (2)]. Mysticism revolved around Gurdjieff. While Salemme noted the Marchands' sympathy and support for the "extreme left-wing," he offered no statement of Fuller's political affinity.[216]

In Hatch's biographical account, the "Red scare" prompted subsequent Fuller's move from Romany Marie to the uptown Three Hours for Lunch Club. This account was used to distance his association with radical political views.[217] Fuller himself openly chided extreme political positions. Nevertheless, there was no indication that he left the tavern subsequently

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212 _, Promotional Flyer for R.M. New Restaurant, ca. September 1929 in BFI-CR36.

213 *Greenwich Village, Culture and Counterculture*, N.Y.: Museum of the City of New York, 1993, p.109.

214 S. Sharkey, Interview with Paula Martin & Kohana Wyles, 11/16/76, N.Y. City-N.Y.

215 In the mid-seventies, Shirley Sharkey, Fuller's personal secretary, assembled a list of frequent visitors to the R.M. Tavern, based on names she had found in the BFI-archives. Sharkey reviewed the list with known habitué, then alive in the mid-70s. Fuller went over this list and assigned his code of "regulars (A), occasionals (B), only occasional happen-ins (C), were in the Greenwich Village or N.Y. City (D)." Of the significant regulars, Fuller noted: Howard Scott, Will & Ariel Durant, Vilhjalmur Stefansson, Max Eastman, Eugene O'Neill, Paul Robson, Lyonel Feininger, Hugh Ferriss, Edward Hopper, Frederick Kiessler, Isamu Noguchi, Tony Salemme, Max Weber. The significant occasionals included Constantin Brancusi, Alexander Calder, Marcel Duchamp, Norman Bel Geddes, Knud Lönberg-Holm, Georgia O'Keeffe, Diego Rivera, Simon Breines (an active SSA member), Stuart Chase, EE Cummings, Carl Sandburg and Gurdjieff.

216 K. Simon & K. Goodman, Transcript of Interview with Tony Salemme (for a PBS documentary "Thinking Out loud"), 1/13/93, N.Y. City-N.Y., p.4.

217 A. Hatch, *At Home in the Universe*, p.137.

because of its climate of radical politics. Rather he stopped being a regular at the tavern after 1932 with the start of his equally fantastic three-wheel car project, the Dymaxion car at Bridgeport-Connecticut.[218]

Ware's classic study of American urban society, vis-a-vis Greenwich Village, illustrated the social dynamics of "local peoples versus outsiders," where the outsiders were "young people from the South & mid-West escaping the constricting norms of America's 'Middletown'."[219] At thirty-four years, Fuller could barely be considered young, but his general disenchantment with middle-class society and his vision to uproot the lethargy of its established culture were appropriately suited to the Bohemian lifestyle. However, unlike the Bohemians who saw themselves as outsiders to the second-generation of local-Villagers, Fuller recognized their authenticity and the vitality as true outsiders. Despite this conducive atmosphere for cultivating a social outsider, one could argue that Fuller was well on the way towards developing a sensibility about living in and acting on the margin, even before his arrival at the Village.

Unlike the Bohemians in the Village who were searching for life among the picturesque immigrants, Fuller was attracted to mixed racial progeny. This was one aspect of his radical difference from the self-claimed diaspora from the American heartland, escaping the constricting norms of America's "Middletown." Mixed racial progeny, he suggested, was a criterion for the survival and vitality of America; thus his interests in Jean Toomer, whom he was acquainted with in Chicago, and Isamu Noguchi (1904-1988) in the Village, are revealing. Thus, while proclaiming himself a 1917-Harvard man, he lamented:

> (D)espite of (or because of) which I rather fancy the vigor of many foreigners, having found *much inertia and stubbornness in New England*. [220](Id., my emphasis).

The constant public identification of Fuller with technocratic ideology and its political program in the thirties and in later years warranted many of his disclaimers. For instance, in his public discourse to staff at Beech Aircraft during the prototyping of the DDM-Fuller House (Wichita House) in 1946, Fuller felt compelled to reiterate that his notion of industrial performance, measured by weight, had nothing to do with technocracy:

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[218]Ltr. 11/22/74 RBF to S. Redd, p.2.

[219]C. Ware, *Greenwich Village 1920-1930*, Berkeley: University of California, 1994 [1935].

[220]Ltr. 5/31/32 RBF to E. Litchfield in BFI-CR41.

I am not a technocrat, in case anybody has ever been exposed to talks by technocrats, and I am not talking technocracy to you. *There is no political aspect to my talk*[221] (Itl., my emphasis).

Nevertheless, in the thirties, whether as a critic or sympathizer of technocracy, there was a public perception of Fuller as someone in the know who could shed light on technocracy's claim as a political alternative. Alfred Bingham, the editor *Common Sense* (New York), was sufficiently persuaded by Fuller's knowledge to seek his opinions on technocracy:

(Your comments) should be directed along the lines of the following questions. Can the capitalist system meet the scientific criticism of technology? Is its (Technocracy) prophecy of immediate collapse exaggerated? Has Technocracy (any) possibilities as a political movement?[222]

1.2.5.4.1. Technocrats and Technocracy

Karl Conrad's critical biography of Fuller implied rather than proved or analyzed his connection to and influence by the technocracy movement.[223] He based his arguments on the textual analysis of the sources and ideas in *4D Timelock*. Conrad's fundamental concern, however, was the redress of a glaring biographical omission, namely Fuller's careful obfuscation of the first thirty-two years of his life.

Fuller was probably aware of technocracy before returning to New York. At Romany Marie, he personally encountered the primary exponents of technocracy in the Committee for Technocracy and the Technical Alliance -- Howard Scott and Stuart Chase. Technocracy, as an idea and movement, had earlier beginnings before becoming a membership organization in 1933. It was initially set up in the winter of 1919 as a research and study group, the Technical Alliance, under the stewardship of Howard Scott, Henry L. Gantt (d.1919) and Charles P. Steinmetz (d.1923). In later years, as Committee on Technocracy with Scott as its chairman, the organization, then headquartered at Columbia University, tried to develop and concretize the social program of philosopher-economist Thortsein Veblen (d.1929).

William Akin, a historian of the technocratic movement in America, proposed that technocracy was redressing the "victimization" of material abundance by the stasis of traditional economic framework. In the prognosis of the movement, "the ills of the economy were traceable

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[221] R.B. Fuller, "Designing a New Industry," p.11.
[222] Ltr. 12/21/32 A. Bingham to RBF in BFI-CR42.
[223] K.M. Conrad, "The Technocratic Persuasion."

not to the machine per se, but to an inefficient adjustment of the social order to modern high energy technology."[224] The impetus of its activism, besides a belief in progressive society, was an attempt to forge an occupational identity for the engineering profession along the line of the scientific management movement and the ideas of Thorstein Veblen.

Of the two men, Fuller reacted viscerally towards Howard Scott and the strain of technocracy that he singularly represented. Fuller recalled:

> (M)y old friend Stuart Chase... invented the name 'Technocracy.' Stuart invented the name in the mid-20's to identify the concepts and activities then being carried on by a distinguished group of General Electric Co.'s Schenectady laboratory's research scientists including (Charles) Steinmetz and my friend Irving Langmuir. These scientists were deeply moved by the philosopher, economist, and technologist Thorstein Veblen who decried 'conscious inefficiency' and 'conspicuous consumption'.... Stuart Chase's name for their concerns and the book which he wrote, "Technocracy," were designed to consider objectively the general social and economic responsibilities of lead scientists and engineers....
> The large number of young people involved and the novelty of the project produced much publicity. Howard (Scott) then organized many of the students into a movement in which architects and engineers assumed the responsibility of theoretically redesigning industrial affairs in general. Howard appropriated Chase's name, Technocracy, for his movement. Stuart told me at the time Howard did so without consulting him -- Stuart, who had not thought of such an organization when he applied that name to the thinking activities of the General Electric scientists.[225]

Fuller probably meant Chase's book, *The Economy of Abundance* (1934) when he talked of Chase's technocracy.[226] Besides this inaccuracy, his charge that Scott plagiarized the term "technocracy" which he duly attributed to Chase, was also unfounded. His claims were meant to undermine the integrity of Scott's character. Further, there was no evidence to indicate that Fuller was familiar with the political philosophy of Steinmetz.[227] Even as he took a tour of the General Electric laboratory in 1931, he was more impressed with its technological innovations than the effect of Steinmetz's ideas on that organization.[228]

Fuller's familiarity with Scott, however, was more direct:

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[224] William E. Akin, *Technocracy and the American Dream*, p.xiii ff.

[225] Ltr. 12/10/76 RBF to T.H. Gibbins, p.3.

[226] S. Chase wrote the foreword to Modern Library's 1934 edition of "Thorstein Veblen's *The Theory of the Leisure Class; an Economic Study of Institutions.* The choice of Chase was natural, given his earlier study *The Tragedy of Waste* (N.Y.: The Macmillan Company, 1925).

[227] For a discussion of Steinmetz's ideas of a future society modeled on modern aspects of the business world, that is, good society of the future ought to be guided by the best relationships in the business world; see James Gilbert's *Designing the Industrial State, The Intellectual Pursuit of Collectivism in America*, Chicago: Quadrangle Books, 1972, p.11ff.

[228] Ltr. 4/30/31 RBF to L. Kocher (*The Architectural Record*) in BFI-CR38.

> I knew Howard (Scott) extremely well. I saw him daily as we ate the little we ate at Romany Marie's restaurant.[229]

Though sharing similar charismatic attributes, Scott was physically, a diametric opposite of Fuller. While Fuller had a stout frame, Scott was, according to one description, "a huge hulk of a man with no surplus of fat."[230] Both men shared an unrequited enthusiasm for futuristic things and interests in data and knowledge. In all likelihood, Scott imbibed images of futurism from his early associations with Fuller. Ralph Chaplin, the editor of *SOLIDARITY* a mouth-piece of the syndicalist Industrial Workers of the World (IWW) recounted Scott's technological vision:

> (H)e talked of futuristic tear-drop automobiles, flying-wing airplanes, and technological unemployment.[231]

By Fuller's account, Scott was "full of personal ambitions" and, by implication, lacked personal integrity.[232] Though calling Scott his "cafe companion" Fuller clearly viewed him in a competitive way. However, the tension between the two men was beyond mere competition: Fuller saw Scott's ideas as deeply flawed. Despite their general affinity towards the efficacy of technology to bring about social changes, Fuller saw technocracy as rigid ideology. It made "no allowance for 'it happens' and the random element, or non-identity of individual of species of uniformity."[233] This critique of technocracy was later elaborated in *Nine Chains to the Moon*:

> Technocracy failed because it made no allowance for passion, fashion, chance, change, intuition, the mysticism of harmony, and most important of all, for - 'it happens'... Technocracy called for an autocracy of engineers to fulfill its scheme. Political movements that call for autocracy of a special viewpoint are doomed to failure as the trend indicates segregation of issues and recomposed balance of all-time forces. SPECULATION and INITIATIVE in the acceleration of CHANGE, are ALL-TIME FORCES, and are as essential in a scheme of realism as suffrage and the socialization of essentials and plenitude.[234]

Fuller read technocracy as a form of autocracy. The most vivid manifestations of this autocracy, Fuller noted, were the officialdom implied in the uniformity of the blue-gray Technocracy cars and blue military uniforms which the members of Technocracy Inc., "rather alarmingly adopted." In retrospect, Fuller posed the movement as proto-fascistic, "reminiscent of

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[229] Ltr. 12/10/76 RBF to T.H. Gibbins, p.3.

[230] Ltr. 2/28/77 T.H. Gibbins to RBF, p.1.

[231] Quoted in William E. Atkin's *Technocracy and the American Dream, The Technocrat Movement, 1900-1941*, p.29.

[232] Ltr. 12/10/76 RBF to T.H. Gibbins

[233] "Notes to Joe Byrant," under the section "Family & Career," p.3.

[234] R. Buckminster Fuller, *Nine Chains*, p.94.

other colored shirt movements of the Nazis."[235] Such characterizations also resulted from the public portrayal of Scott as a social menace, because of his activism and his anti-labor rhetoric. In particular, an event such as the 1933 National Technological Congress and Continental Convention on Technocracy in Chicago proved detrimental to Scott's political project. At that convention, a gathering of technologists walked out when Scott announced that "bayonets would be used if necessary to put over technocracy." This pronouncement was against the moderate technologists' belief in the "conversion of people."[236] Further, Scott's public decline was exacerbated by a subsequent investigative reporting in the *New York Times* which revealed his suspicious credentials. For instance, his claim of industrial experience turned out to be merely "paint mixing" in his own warehouse.

Fuller was more amicable towards Stuart Chase. Stuart Chase (b.1888) shared much of Fuller's blue-blood New England background. A tenth generation New Englander, he also graduated from Harvard. Though wishing to be an architect, he passed his formative years in the Labor Bureau and his privately-funded Consumer's Research Inc., a commodity and service research organization. He finally settled down as a writer, focusing on the questions of industrial productivity and wastes. It was probably because of these interests that he met Scott through the Technical Alliance in 1921. However, after his publication of *The Tragedy of Waste*, Chase eventually distanced his support of Scott. His own slogan for a new economic program, "a new deal," became the political catchword adopted by the Democratic party under President F. D. Roosevelt.[237]

Even as Fuller spurned the technocracy of Scott, his technologism and technological boosterism aligned him with Chase, and the more academic version of technocracy propagated by Walter Rautenstrauch in the Department of Industrial Engineering at Columbia University. One of the primary internal struggles between the various factions within the technocratic movement was over the ideology of action, namely whether Veblen's "soviet of technicians" should be converted into a passive research body. Unlike Scott or Veblen, Rautenstrauch's route to technocracy was via "engineering managerialism." Its moderate and pragmatic managerialism allowed for emotion - a human trait that Fuller identified as "essential to selective growth and

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[235] Ltr. 12/10/76 RBF to T.H. Gibbins.

[236] "Technocrat Rift leaves Hotel with Food Bill," *New York Herald Tribune*, June 1930, p.33.

[237] Chase would, in the later years, share many liberal forums with Fuller. In 1963, both Fuller and Chase were nominated to the Board of Trustee of the Institute for General Semantics (IGS) (See Ltr. 10/7/63 M. Kendig to RBF in BFI-CR249). In 1964, Norman Cousin, the Editor of *Saturday Review* also nominated Fuller and Chase to participate in the 4th "Dartmouth Conference" in Leningrad (See Ltr. 6/10/64 N. Cousins to RBF in BFI-CR258).

survival."[238] Akin argued that in retracting the technocratic "myth of the engineer" as leader of society, Rautenstrauch relinquished the idea of "popular control" or "unlimited engineering domination of society."[239] Rautenstrauch felt that he was preparing the grounds, for the "maintenance and growth of civilization" and was thus against complete substitution of science for politics. Nevertheless, in both approaches, that was a mistaken overvaluation of the scientific theory of social analysis. In practice, technocracy was eventually eclipsed by the New Deal with its wholesale re-employment in general, and of engineers in particular; thus diffusing their discontents.

Increasingly, the technocracy promulgated by Scott and Chase was seen as an "engineering utopia" moving in the wrong direction. One critic, Claverston, identified the myopia of the two technocratic proponents:

> (W)hat both men fail to see is that the basic problem is one of getting power and not and not of planning or *hieroglyphizing the technical development of future* ...
> Once power is acquired there will be abundant opportunity to reorganize industry in terms of higher efficiency, plan new industrial sectors, reduce the whole mechanisms of our economic live to level of sanity where production and distribution are in harmony and one class of men is not allowed to exploit another.[240]

The fundamental contradiction identified was that between the engineering practicality in economic affairs and a romantic sentimentality in economic solutions. Besides its "political naiveté," the technocratic propositions were either impractically practical or unrealistically real. For Fuller, technocracy should have stayed on its course as "prime design" rather than being encumbered by political trappings. In other words, his primary objection to technocracy was its disguised political objectives, despite its public denouncements of such ambitions:

> I could not be more in favor of the concept of scientists and engineers participating responsibly in the operation of the economic system, but I still maintain that Technocracy, aspires to exercising political power in contradiction to what I call, exclusive preoccupation in 'reducing to practice, and proving and developing artifacts by comprehensive design science initiatives.'
> One of the mistakes society frequently makes is to assume that engineers and scientists working for great corporations have sociological perogatives (sic). They have none.[241]

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[238] R. Buckminster Fuller, *Nine Chains*, p.95.

[239] W.E. Akin *Technocracy and the American Dream*, pp.80-96.

[240] V.F. Claverston, "The First Reader" (book review of S. Chase's *New Deal*, N.Y.: The Macmillan company, 1932), *N.Y World Telegram*, 30 August 1932.

[241] Ltr. 12/10/76 RBF to T.H. Gibbins, p.3. See also Gibbins' retort, Ltr. 12/29/76 T.H. Gibbins to RBF.

Despite denying any technocratic thrust in his project, Fuller has been viewed as either a revamped or a redeemable technocrat. Characterizing Fuller a revamped technocrat, Conrad argued that Fuller revivified and redeemed the mundane "efficiency" of technocracy with "a mythology, a transcendent criteria of virtues and qualities."[242] Despite their basic disagreement over whether technocracy was political, Gibbins a full-fledged card-carrying member of Technocracy Inc., nevertheless viewed Fuller as a redeemable technocrat, and invaluable for promoting the cause of technocracy in the seventies:

> (Y)ou are one of the few, as yet that has much the same insight into REALITY of this very mundane physical planet that we Technocrats KNOW. You are a fine person to have on 'our side' when the 'chips are finally on the table and in the pot. I think you realize, Mr. Fuller, that 'reforms' of tinkering with this system is an exercise in futility and that what is required is a REPLACEMENT of the whole stinking mess. Some individuals seem to think that a valueless and moneyless society is something to be avoided at ANY COST. Really informed Technocrat don't think so.[243]

In spite of their differences, there were many areas of affinity between Fuller, Scott and Chase. With Chase, Fuller shared a belief in a new economic system based on a society that had become socialized, and where the idea of service was more important than profits. However, it was with Scott that their common cause revolving around the energy discourse which appeared more crystallized.

1.2.5.4.2. Sharing a Common Ideology in the Energy Discourse

Fuller shared with Scott a fundamental belief that some kind of natural measure of wealth should be established. Scott saw this standard as a necessity for a "'high energy' civilization" and as a replacement for the anachronistic "price system."[244] The new "industrial credit" based on energy would avert economic manipulation of resources, reduce waste and promote efficiency in general. Most importantly, this new industrial standard would replace all prior economic concepts which were based on scarcity.

In *4D Timelock*, Fuller proposed that this natural unit was a "time unit" standard or "timefaith." "Timefaith" would be a basic for his "Time-Faith-profit-sharing-certificates."[245] The notion of faith was underpinned by his secularized Christian ideals. Scott, on the other hand,

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[242]K.M. Conrad, "The Technocratic Persuasion," p.152.

[243]Ltr. 12/29/76 T.H. Gibbins to RBF, p.2.

[244]See H. Scott's writing in *ONE BIG UNION MONTHLY*, Fall 1920, quoted in W.E. Akin's *Technocracy and the American Dream*, p.39.

[245]R. Buckminster Fuller, *4D Timelock* (1970), p.9.

drawing upon the massive energy survey conducted under the study and research group, the Technical Alliance, affirmed energy as the natural measure and unit intended in economic transactions.

The objectives of the resource study conducted by the Technical Alliance, beginning in 1921 were to establish the scope of waste in industries and to provide strategies for change. It was mainly during the fall through winter of 1933-34 that Scott and Rautenstrauch finalized the statistical survey, an "Energy Survey of North America." It was hoped that the findings would establish "given standards of comfort" to all, and for the purpose of "designing or coordinating" the production system. The crux of this effort was to produce "an energy theory of value." In Scott's energy valuation system, the "Theory of Energy Determinants," energy substitutes price as the basic gauge of production and distribution; payment for productive effort and allocation of resources.[246] However, though Scott introduced an energy-level perspective on social development as well as the notion that monetary mechanisms could be replaced by energy-unit measurements, he hardly originated it.[247]

It is highly probable that Fuller and Scott had informally discussed the energy project at Romany Marie. But it is unlikely that Scott had plagiarized Fuller's ideas, as Fuller seemed to suggest when he unduly claimed his influence on Howard Scott's energy accounting system:

> I was at that time, publishing my magazine, 'Shelter' [1932], in which I was expounding and advocating my concepts first published in 1927 (*4D Timelock*), *on a new economic accounting system for world-industry and world trade in general which I called Time-Energy Wealth accounting (incrementation)*. Howard found these ideas of mine very acceptable in as much as they seemed compatible with the thinking of the celebrated General Electric engineer-scientists. My published ideas on exclusively rentable scientific dwelling machines also appealed to Howard[248] (Itl., my emphasis).

Rather, recognizing the full significance of the energy concept, it appears that Fuller eventually assimilated Scott's energy idea, claiming it as his own. For this reason, he criticized Columbia University's censures of Rautenstrauch's time-energy-studies as a conspiracy dictated by old business. As Fuller supported Rautenstrauch, he implicated Scott for the internal rift within technocracy. He criticized technocracy's failure to manifest the full meaning of its energy studies, namely its survivalist imperative. Rather than showing how a " hungry human" could

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[246] W.E. Akin, *Technocracy and the American Dream*, p.33ff.

[247] H. Elsner, *The Technocrats: Prophets of Automation*, Syracuse University Press, 1967, pp.30-31.

[248] Ltr. 12/10/76 RBF to T.H. Gibbins, p.3.

"interpolate his ergs for eggs," technocracy insinuated an "iron-handed dictatorship" with threats of "machine-gunning and gassing (sic)" instead.[249]

Fuller's hybridized "time-energy industrial credit" which he claimed as an "automatic minimum existence credit" would be socially allocated and "contractible (sic)."[250] However, continuing to prioritize his own time-measure, Fuller associated time directly with the efficiency quotient, thus crediting "intellectual activity" besides industry for time-saving contributions. Ten years later, writing during the thick of World War II, in his bureaucratic position as Head of Mechanical Engineering in the Bureau of Economic Warfare, Fuller abandoned his "time control." At that point, he fully absorbed Scott's energy accounting into his vision of a new world commonwealth based on energy:

> (M)an will soon set up a new accounting system geared into the true wealth of power-potential truly accounting our dynamic mastery of environment by science-educated control of energy - that is of energy all external to man's integral pittance of that all-pervasive phenomenon which uniquely characterizes life as action (motion) or reaction (heat). This is the new concept, *An Energy-Borne Commonwealth of Humanity*, instead of monopoly and patronage affluence, pyramided on the bedrock acre base (Itl., my emphasis).[251]

The technocratic movement viewed socio-economic ills metaphorically as "Lag, Leak and Friction."[252] However, unlike Scott, Fuller proposed neither a radical social solution nor an organizational structure to advance changes to remove these ills. Claiming that he was "never a joiner in any movements," Fuller thus neither prescribed an organized group of cadre technicians nor supported a Veblenesque "soviet of technicians." Rather than seeing industry as revolution, Fuller considered it a process of "evolution." In other words, it exceeded the man-made and the socially-impelled political processes. Thus, he argued, the merits of the energy-studies were previously realized "without any conscious social movement-patronage," namely, through "Ford Company's Time Studies" with a global consequence of "political-boundary jumping organization."[253]

Fuller's technological project differed from Scott's technocracy over the conception of industry. The difference highlighted Fuller's confidence in the social redemptive value of new consumption in a post-industrial society. Fuller was clearly enthusiastic about the possibility of

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[249] R. Buckminster Fuller, "Putting the House In Order," *SHELTER*, November 1932, p.6.

[250] R. Buckminster Fuller, "Universal Architecture Essay No.2," p.79.

[251] R. Buckminster Fuller, "I figure" (1942), *The Buckminster Fuller Reader*, p.102.

[252] K.M. Conrad, "The Technocratic Persuasion," p.140.

[253] R. Buckminster Fuller, "Putting the House In Order," p.6.

industrial capitalism creating greater democratic consumption; Scott, on the other hand, was disturbed by the increased interest in consumption, manipulated or otherwise. For instance, Scott abhorred the dependence of the English Guild Socialist on the open market and the inter-guild competitions to militate against overall scientific administration of production.[254] Fuller valued abundance as an end and measured consumption as a yardstick of democracy. Ironically, while Scott was driven by a social vision, he ultimately valued efficiency as an end. Thus, his energy-based value system was purely conceived of as a functional basis for production. In the interim, however, both men saw laggard government and business as primarily responsible for victimizing industry.

American historian Howard Jones had characterized the fifty-year period form the post-bellum to the eve of World War One as the "Age of Energy." Jones argued that the attractiveness of energy in that age stemmed from its quintessential neutrality; it was, for example "both amoral and ambiguous." As a motive force, Jones noted that energy actuated science, technology and invention, thereby creating a new universe of discourse:

> As soon as one picks up a history of invention and technology ... politics and social history drop out of sight, and the eddies of social and political history are replaced by the clear, untroubled forward -running stream cf science, invention and technology.[255]

Fuller and Scott both accepted that emerging social conditions constituted an energy reality which was only explicable by the neutrality of science. This energy reality was supported increasingly when man, machine and work were related directly to the multi-faceted renditions of energy and its transmutability as physical (heat, electricity, light, motion) or metaphysical (psychic, personal power) forms. Besides these scientific and popular readings, the demonstrable convertibility of energy into usable forms and services readily allowed energy, as opposed to monetary forms to be considered as natural wealth.

The similarity in the technical projects of both Scott and Fuller stemmed from their common identification with the ideological criticisms of American culture by Thorstein Veblen.[256] With respect to the subject of waste, Fuller shared Veblen's cultural criticism of

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[254]W. E. Akin, *Technocracy and the American Dream*, p.41.
[255]Howard Jones, *The Age of Energy, Varieties of American Experience 1865-1915*, N.Y., Viking Press, 1973, p.106.
[256]For Veblen's role in working out social solutions to the quandaries of an industrial America without recourse to an orthodox Marxist analysis, see Harvey Goldberg's *American Radicals, Some problems and Personalities* (N.Y.: Monthly Review, 1969 [1957]), pp.281-88, Thomas Hughes's *American Genesis* (N.Y.: Viking Penguin, 1989); William E. Akin's *Technocracy and the American Dream*, pp.11-24, David F. Noble's *America by Design* (N.Y.:

American "conspicuous consumption" in so far as weight, hoarding and cultural nihilism had to be undone. Fuller was also closer to Veblen's disdain for money and credit as emblems of "pecuniary culture." Their respective discourse on waste was, in essences functionalist; aimed at a reconstruction of society. However, Fuller's discourse on waste was tied to the promise of future abundance, and the concomitant belief that this would improve the social reward system. It was driven by the promise and reward of consumption rather than by the fear of scarcity. Here, he shared President Herbert Hoover's own clarion call for efficiency as a patriotic duty.[257] In tandem with the consumptive demands of post-industrial capitalism, Fuller, more than Scott, saw wealth as dynamically defined; initially with time as a gauge, later by substituting it with energy. As the cultural connection of wealth to material object is dissolved, Fuller believed that industry would then replace business as the primary social activity.

1.2.5.4.3. On the Question of Mysticism

While eschewing the radical ideology of technocracy. Fuller was careful to construct the primary concerns of his project, in general, as pertaining to this-worldliness rather than the other-worldliness. Thus, while identifying Gurdjieff (Russian psychologist and philosopher, b. late 1860s -1949) as a significant occasional habitué of the tavern like Scott, Fuller was careful to distance himself from any kind of "cult" identification. A writer of Fuller's popular legend, Alden Hatch, suggested that Fuller was resistant to Gurdjieffean influence, since he was "brewing" his own modern transcendentalism, with its own "mechanistic-metaphysical universe (and) its Supreme Intelligence." In Fuller's own words on his newly found notoriety at Romany Marie:

> I became a cult, and that was exactly what I did not want to be. In other words, I did not want to get into social movements or special theologies.[258]

Finally in 1948, in a series of lectures to the students at the Institute of Design-Chicago, Fuller noted the mystical content in his direct personal experience:

> In my own philosophy (I) have come to conclusion that many of the mystics who in deep thought have come to the conclusion that the mysteries were unfathomable and yet gave their

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Alfred A. Knopf, 1977); David Riesman's "The Social and Psychological Siting of Veblen's Economic Theory" in *Abundance for What?* (Garden City, N.Y.: Doubleday, 1965)

[257]For an assessment of President Herbert Hoover's engineering progressivism and role in Committee on the Elimination of Waste (of the Federated American Engineering Societies), see Richard Hofstadler's "Herbert Hoover and the Crisis of American Individualism," in *The American Political Tradition & the Men who Made It*; William Akin's *Technocracy and the American Dream*.

[258]Quoted in *Buckminster Fuller, At Home in the Universe*, p.120.

give life to discovering the mystery were not well convince of their concept. It is very typical of Hindu men of religion that they will divest themselves of many of the ponderables in a fanatic manner, but what they are seeking to do is break the fundamental rules of their own concept. They attempt to get at the secret. They attempt to approach the secret of life rather than *taking the phenomena life as we are given it as an experiment and exploring it thoroughly and fulfilling the given problem*. It seems to me that it is possible that by the strict application of our abilities to measuring of universe and ordering of universe that we may really approach enormous mastery of all that is physical but in the end all will is to isolate all that which is physical from importance. *So everything that is important which is the great secret comes into complete relief. That is my philosophy*[259] (Itl., my emphasis).

In order to distance himself from would-be followers and yet create an aura of distinction, Fuller suggested that rather than searching for faith in a world in flux, he was describing its certainties. Nevertheless, Fuller's rhetorical language, shaped by his growing identification with the romantic transcendentalism of New England, were fundamentally responsible for the public reading of his mysticism. However, in the seventies, steeped in his role as a public philosopher, the aura of mysticism was an asset rather than a shackle, although he tried to publicly censure mysticism and avoid the public reading of him as a mystic.[260]

1.2.6. A Research Interlude at John B. Pierce Foundation and Designing the Single-piece Bathroom

Up until March 1931, even with Corbett's support and Fuller's own valiant solicitation activities, the Dymaxion House remained a publicity hype. The necessity to prototype some aspect of the project seemed critical. The choice of the toilet as the prime candidate appeared logical, given Fuller's assessment that the structural technology could be tapped from either the automobile or the airship technologies. Robert Marks, Fuller's biographer, recorded that the production strategy for the Dymaxion House was to use "Detroit-scale tooling-up for parts stamping and assembly."[261] The opportunity to test the viability of the Dymaxion project came when he was appointed as a designer for John B. Pierce Foundation.

The John B. Pierce Foundation was a research arm of American Radiator Corporation. Like the Albert Bemis Foundation-Boston, it was a privately endowed organization attempting to harness new technologies to create affordable housing. At Pierce, there were two groups of projects for considered for mass-production. One was a bathroom unit. The other was a kitchen

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[259] Transcript of Lectures at ID-Chicago, ca. Nov.15 1948, BFI-MSS 48.11.01, p.2.

[260] Gerber, for example, constructed Fuller as holistic philosopher and initiated his "science" into the new physics of Gary Zukav's *The Dancing Wu Li Masters: An Overview of the New Physics*, Michael Talbot's *Mysticism and the New Physics* & Frithof Capra's *The Turning Point* (See A. Gerber, "The Educational Philosophy," p.100).

[261] R. Marks, MSS Notes for "The Dymaxion World of Buckminster Fuller," in BFI-HEv20, p.13.

with heating and lighting utility chambers.[262] These projects, if successful, would integrate the various building trades - plumbing, building and electrical.

It is most likely that Robert Davison [Fig.5.09c (1)] who had just joined Pierce as its Director of Research in June 1931, acted on the recommendation of Clarence Wooley, President of American Radiator. Wooley heard Fuller in a lecture privately arranged by Wallace Harrison at the Civic Club of New York.[263] Davison was a highly regarded editor of Architectural Record. As the "technical director" of "Technical News and Research Department," the centerpiece of Architectural Record, in the late twenties, he was instrumental in forging ideas about architectural research. The purpose of the feature was to investigate technical, economic and functional issues that were "common" to building types and those "peculiar" to the individual building as discovered through "original research."[264] Because of his position, he was familiar with Fuller's industrialized house project.[265]

Clearly, both Pierce and Fuller had much to gain in this association. For Fuller, the opportunity to prototype an unworked portion of the Dymaxion house project complemented the structural and architectural works that were being refined in Corbett's office in New York. Further, Fuller stood to gain direct access to the workshop and resources of a respected player in the housing component industry. The move would ground and ascertain the legitimacy of Fuller's project while giving American Radiator some prestige in encouraging forward-looking design. For this reason, Davison was instrumental in promoting Fuller's ideas, for example, by working on Douglas Haskell's article "The House of the Future" in the *New Republic* (5/31/31).[266]

Regardless of Fuller's limited experience and qualification with respect to the mass-production of mechanical products and despite the hyped commercial promises of the Dymaxion House, the project was still valuable. Probably aware that the Dymaxion House was on the drawing board and the potential of a mass market for service components might issue upon its successful prototyping, American Radiator was enthusiastic about enlisting Fuller. Fuller

[262] BFI-CR38 contains most of the blueprints of combined kitchen unit and bath, done for the Housing Research Department of John B. Pierce Foundation, ca. Apr. 1931.

[263] See Entries 1/6/31-1/13/31 Civic Club of New York in Public Presentations of Fuller and Dymaxion Items" in *Dymaxion Index 1927-53*, p.1.

[264] See "Research Applied to Architecture" (a new editorial policy submitted in competition for the A.B.P. medal for outstanding editorial service to the *Architectural Record*), ca. 1929.

[265] See Ltr. 3/3/31 International Housing Association (Frankfurt-am-Main) to RBF in BFI-CR38.

[266] Ltr. 5/12/31 RBF to E. Schwartz (Note#3) in BFI-CR39.

assumed that whatever innovations accrued under the employment of Pierce would be his, and would advance his 4D art:

> It is tremendously important to put over this first exhibition of results, no matter how inadequate I may think them, with Mr. Wooley(sic) & the other executives to which Davison must sell them... If they are interested in our recent results so far Davison assures me at least a year well paid work of my own research, unhampered by him (and) with plenty of funds will follow & so I am anxious that we shall make good. *It may mean the success or failure in the near future of 4D*[267] (Itl., my emphasis).

Initially, though Fuller claimed that Davison's ideas were "most limited," he was nevertheless confident that he could "handle" Davison and "get (his) way."[268] Under the delusion that this research interlude would advance his Dymaxion project, Fuller committed three months of work at Pierce research workshop in Buffalo-New York. Intermittently, he shuttled to New York for his appointed lectures and exhibition[269] [Fig.1.09e-f].

His confidence would eventually be shattered and the contract turned out to be disappointing for both parties and Fuller resigned. While Fuller had earlier seen this appointment as an opportunity to prototype his one-piece bathroom for the Dymaxion House, he now concluded that the project was compromised either because of Davison's expediency or because of technical incompetence. He characterized his final one-piece bathroom design as an "adaptation of Davison's knockdown."[270] Nevertheless, Fuller recognized that the project allowed him a latitude and opportunity for experimentation:

> I am designing this work to do away with much of the weight & complication of present porcelain equipment and all cracks by not copying the old features and methods of assembly... It is excellent experience for me as well and serves to clarify many of the 4D problems.[271]

Fuller had imagined incorporating the best available technology on portable environment known at this moment, namely, the Pullman coach with the car assembly line technique of Ford. He had just witnessed the latest model of the Pullman coach at Grand Central Station, while returning from Buffalo. Its technical improvements around the roller bearing, sound and heat insulated walls, could be readapted for the one-piece bathroom project:

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[267]Ltr. 5/27/31 RBF to E. Schwartz (Note#3) in BFI-CR39.
[268]Ltr. 5/12/31 RBF to E. Schwartz (Note#3) in BFI-CR39.
[269]Notes in Fuller's Diary notebook, ca. 1931 in BFI-CR40.
[270]Ltr. 5/21/31 RBF to E. Schwartz (Note#3) in BFI-CR39.
[271]Ltr. 5/21/31 RBF to E. Schwartz (Note#3) in BFI-CR39.

> I went over the construction with the Pullman man later. It was excellent, only 5 have been built so far. It is exactly the way Davison the old nut should be building his bathroom if he weren't such a nut. The thing to do would be to hire the engineers of the Pullman Co. & the best German Naval engineers & the best American airplane & bridge & lighthouse designers & get them all under one roof with a man or two __(?) from General Electric + Bureau of Standards & then go to it & __(?) something out that would be something. Then cut him Ford's best production men & go over tenderings from that viewpoint & then get the best endorsing men in the world & subsidize a few newspaper syndicates, movie corporations, etc. + start production. It is the only possible salvation to this economic crises which lacked even leaders in the stock market. No more time for fooling with feelings of weak personalities like Davison. It's time for rapid action. If I can hold my breath there is going to be plenty. I'm getting wild.[272]

The Pierce incident and Fuller's accounting of it highlighted several features which constituted sources of tension for the rest of his creative life. Firstly, there was the question of ownership of creative effort in an institutional setting. Despite being in the "employment" of Pierce and the fact that the bathroom project was undertaken with the support and resources of Pierce, Fuller viewed the undertaking as his. If there were potential patent complications, he clearly overlooked them or was resigned to take the risks. Probably because of industrial secrecy, Fuller was not allowed to divulge much of the undertaking. Yet, the architect Richard Neutra thought that Fuller's undertaking constituted the activities of "Fuller Research Foundation in Buffalo." Neutra's interest in the prefabricated bathroom stemmed from his ongoing interests in the industrialized house. Seeing Fuller's research experimentation as cutting edge work that would complement his, Neutra offered both assistance and the support of a draftsman to "ripen and harvest" their respective ideas.[273]

Secondly, Fuller idealistically believed that a prototype could be perfected in a laboratory setting. However, four month later, as he resigned from Pierce in July, he accused Davison of lacking in "scientific integrity deployment" besides rescinding on many of his "promises" made with regards to the prototyping activities.[274] Despite Fuller's accusations, he could still claim that he achieved "further key design in relation to the industrially fabricated architecture."[275] The "long and hard" work at Pierce captivated him and he was duly satisfied with his contribution as the bathroom was completed and shipped for an exhibition in New York in July 1931.[276]

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[272] Ltr. 5/18/31 RBF to E. Schwartz in BFI-CR39.

[273] Ltr. ca. July 1931 R. Neutra to RBF in BFI-CR38.

[274] Ltr. ca. 7/5/31 Ltr. RBF to R. Davison in BFI-CR38. This is a three-page draft letter, not sent in the end, possibly due to the harshness of the accusation.

[275] Ltr. 7/5/31 RBF to R. Davison in BFI-CR38.

[276] Ltr. 6/4/31 RBF to E. Schwartz in BFI-CR40; Ltr. 6/9/31 RBF to E. Schwartz in BFI-CR40.

These disclaimers were meant to exonerate his own role in the failed collaboration. The blame could hardly be placed on Davison, whose entire professional life, during his tenure at Pierce up until 1944 and thereafter, revolved singularly around well-honed and legitimate research issues pertaining to housing technology. He had also established a firm background in architectural research before joining Pierce.[277]

Davison's complaints about Fuller were measured. Besides suggesting that certain details worked out by Fuller were impractical, he also attributed the growing tension between them to the differences in opinion of "wh' ,vas ethical." Probably aware of Fuller's contact with Neutra and his other self-promotion activities, Davison accused Fuller of a breach of the strict confidentiality over the experimentations which he had promised to keep.[278] Fuller's silence over many pressing questions and his avoidance of Davison concerning the question of personal conduct on the job fueled Davison's suspicion.

Fuller's account of what constituted his end of the contractual obligation and the reasons for abandoning the collaboration is clearly biased. Besides the evidence of Neutra's interests, his own records showed that he used the Pierce's resources and connections to pursue other expanded aspects of his Dymaxion project, including the 4D transport. For example, he identified several individuals interested in "financing and experimentation" of his first 4D Transport -- a Dr. Corke (Physics Dept., Buffalo University) and a Mr. Spraque (Head, Ford Co. in Buffalo); the latter offering to "contribute a Ford chassis for the experiment":

> Deckler (sp.) Bros. who are doing our metal work for the American Radiator Co. experiments have offered to contribute and fabricate the body. So it look as though we ought to be making some real progress in that field.[279]

Fuller also reported that he acquired a new Auburn at a concession price, and that he had "spent evening at the Ford Company doing drawings on the new 4D Transport. It would be, he promised, "a big hit."[280]

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[277]The extant of research work on housing by Davison included "Apartment house design to meet family needs," *Architectural Record*, Mar. 1930, vol. 67:3, pp.267-288; with Howard T. Fisher (U.S. Office of Technical Services, Industrial Research & Development Division), *Development of a Spandrel Wall Construction System*; "How can We Solve the Housing Riddle?" *Dun's Review*, vol. 47:2138, Oct. 1939, pp.5-11; with L. John H. Callender, C.O. Mackey, *Methods: the Engineered Dwelling* (New York, John B. Pierce Foundation), 1944; "New possibilities in low-cost home construction," *American Public Health Association*. Committee on the Hygiene of Housing. Housing for Health, 1941, pp.103-108; "Technological Potentials in Home Construction," *Law and Contemporary Problems*, winter 1947, vol. 12:1, p. [16]-24.)

[278]Ltr. 7/24/31 R. Davison to RBF in BFI-CR38.

[279]Ltr. 6/3/31 RBF to E. Schwartz in BFI-CR40.

[280]Ltr. 6/8/31 RBF to E. Schwartz in BFI-CR40.

Fuller's actions clearly constituted a conflict of interest and impropriety. However, extant biographical accounts of the Pierce incident, based on Fuller's version of the event generally painted a vindictive Robert Davison. For example, they implicated his role in evicting Fuller from his New York apartment in the Starret-Lehigh Building the following year.[281] In response, Fuller launched a more viscous attack on Davison's personality and the integrity of the work. He did this by initiating two promotional instruments - the Structural Studies Associates (SSA), a thinly-disguised cooperative to undertake shelter research that he formed towards the end of 1931, and a journal he acquired in May 1932, *SHELTER*. For example, Peter Stone, a member of SSA and an editor of the *General Building Contractor* insinuated the suspected integrity and corporate ambitions of Davison. Davison, he described, affected a "takeover" of Pierce Foundation after his position as Secretary of the debunked Research Institute for Economic Research.[282] Picking up his own cudgel, Fuller lambasted Davison's mass-housing initiatives as "'doctor(ing) down' scientific solutions, and 'dress(ing) them up' in romantic gables." In attacking Davison, Fuller's accusations bordered libelous:

> This conscious inefficiency (in the repro-shelter industry) is expected of Dr. Davison, it is his pride and joy, but coming from a behind-the-scenes power, whose reputation is based upon extraordinary certified public accounting, it is shocking, unless one is familiar with the merger history of CPA's (certified public accounting's) with publicity 'experts' and super-adv(ertising) agencies.[283]

The scathing review on Davison however did not escape the scrutiny of Fuller's supporters, including Douglas Haskell, an architectural critic of The Nation and the Architectural Record.[284] Though deeply sympathetic to Fuller's efforts, Haskell was dismayed at his actions and those of his SSA-retainers.[285] Putting aside their personal tiffs, the broad conspiratorial tone of Fuller-Davison dispute was heightened because of the entry of Howard Fisher's General Houses Inc. into the industrialized house scene.

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281 "Note 1A" in BFI-CR41, inserted by Fuller(?):
May 7 to 20 (1932). Editing May Shelter. During this period BF (Bucky Fuller) was unknowingly evicted from Starret-Lehigh Bldg...
(He) was evicted at instigation Davison - Am. Rad. Co....

282 Peter Stone, "Experiments with Low-cost Hon es," *General Building Contractor*, Apr. 1932, p.21. See also Peter Stone's report, "Tooling Up" in *SHELTER* May 1932, p.31.

283 R.B. Fuller, "Behind the Scenes. Pass-Age 2" in *SHELTER*, November 1932, p.14.

284 Haskell would eventually assume Davison's vacated post as "technical director" of "Technical News and Research Department" in Architectural Record, after Theodore Larson and Knud Lönberg Holm.

285 Ltr. 6/1/32 D. Haskell to RBF in BFI-CR41.

1.2.6.1. Reacting to Howard Fisher's General Houses Inc.

Fuller explained that he was unwilling to compromise on a mock-up of a Dymaxion House for the Chicago World's Fair. Instead, he requested $100 million from US Vice President Charles Dawes, a Chicago financier and son of General Rufus C. Dawes, supposedly to start a repro-shelter industry based on his Dymaxion ideas. It prompted Robert Marks, Fuller's biographer, to remark that Fuller's rebuff showed his integrity in being "too responsible."[286] In contrast, Dawes lacked vision:

> All (Dawes) asked for was a house; Fuller offered him an industry.[287]

It is of course foolhardy to suggest that three years was adequate for creating an industry of a scale Fuller claimed that would exceed Henry Ford's automobile empire. Dawes or any of Fuller's potential backers, for that matter, were probably aware that his proposition was overtly-hyped; and naturally, they were cautious. After all in the Depression of 1929, why would any industries looking for ways out of their woes, to use their underutilized production capacity, pass up on a promising idea? A mock-up Dymaxion House, more than a compromise, seemed reasonable and potentially effective for soliciting and gauging public interests, as well as to spur investments. Fuller was evidently aware of this.

One could propose a number of factors that might have prevented Fuller from prototyping the Dymaxion House. First, the short research interlude at Pierce showed the gulf of technical difficulties between the imagined end the practical considerations, even in the prototyping of a component like the bathroom. Second, Fuller's actions at Pierce highlighted his inability to relinquish control over the tenor and direction of the project. Publicity of the Pierce experience probably fended off potential sponsors and collaborators. Third, Fuller's general reluctance to deal with "financial" capital, or "Fincap" as he called it, probably locked out remaining avenues of support. Fourth, by viewing his project as a purely industrial one, he saw the competition with the "traditional" building trades and material manufacturer as an open war. More out of his own exaggerated imagination and paranoia, for example, he claimed that financial interests in Chicago, who undertook the 1933 Chicago World's Fair project, represented the "best organized, hard-headed, shrewd opposition" to the "uncompromised Dymaxion repro-shelter industry."[288]

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[286] R.W. Marks, MSS Notes for "The Dymaxion World of Buckminster Fuller," in BFI-HEv20, p.15

[287] R.W. Marks, *The Dymaxion World*, p.25.

[288] R.B. Fuller, "Our Intimate Journal of Summer Events," *SHELTER*, November 1932, p.15.

In 1932, the diminished hope of realizing Dymaxion House as a prototype at the Fair was brought on by the public announcement of Howard Fisher's General Houses project [Fig.1.09g].

Howard Fisher's interests in factory-manufactured houses probably prompted him to arrange a talk for Fuller at the Chicago City Club in May 1929.[289] However, there is neither evidence that Fuller was wary of this engagement nor that he suspected that Fisher's interest was prompted by covert industrial espionage. However, it was conceivable that Fisher's public statement on industrialized housing in *Architectural Record (1929)* drew upon some of Fuller's insights in *4D Timelock*:

> The house, among all the important tools of the twentieth century, is unique in inefficiency and clumsiness of its design. The age has produced the ocean liner, the skyscraper and zeppelin has as yet done but little towards solving one of the most important and basic needs of mankind.... Of all the productions of our present day. The house alone is considered in terms of the past. We do not ride in Louis XIV coaches or wear Elizabethan ruffles - why then should we live in limitations of Cotswold cottages or French eighteenth-century chateaux?[290]

Fisher was not a greenhorn on the issue of the industrialized house. His credentials also gave him an obvious edge over Fuller. Besides graduating from Harvard-Graduate School of Design in 1928, Fisher came from a family of prominent Chicago lawyers. His father, Walter Lowrie Fisher, was one of Chicago's leading lawyer and the Secretary of Interior under President Taft. His brother, Walter, was also a distinguished lawyer and banker. This background of a "fair-haired boy," as Fuller rightly inferred, was an advantaged passport to financial and political connections which Fuller clearly lacked. With this high social network, Fisher was well positioned to surmount the intricate legal implications of organizing as complex an organization as General Houses Inc. After making connections with Robert McLaughlin's American Houses Inc., the developer of *Motohome*, Fisher secured a first nation-wide publicity by signing on heavy-weight corporate sponsors. These included the Pullman Car & Manufacturing Corporation, General Electric, American Radiator, Pittsburgh Plate Glass and Container Corporation of America.[291]

In the public eye, Fisher's standing in high social circle, as belonging to the genteel class, was also implied. The *TIME's* feature which furnished the first exclusive details of General Houses Inc., portrayed Fisher as a "technician and theorist in architecture" and an "expert on

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289 See Entry (5/20/29) under "Public Presentations of Fuller and Dymaxion Items" in *Dymaxion Index 1927-53*, p.1.
290 Quoted in *H. Ward Jandl's Yesterday's Houses of Tomorrow*, p.157.
291 Ibid., p.167.

designing squash courts."[292] In his hand, the industrialized house, cold as it might sound, stood the chance of being assimilated into the genteel realm of art. This was despite the "scientific aura" of the alphanumeric formulas of General Houses which were used to identify the designs.[293] The model houses however were given popular names for the purposes of marketing. Even as Fisher displayed his prefabricated house, model "K3H4DP" at the "Century of Progress" Exposition in 1933, he was careful to refer to it as "Elmhurst."[294] Another General Houses' model, the "K2H40" contained the niceties of a familiar hall entrance, room for four beds and optional extra room. Even this nomenclature was more accessible than "5T-4P" (five module deep with four floors), Fuller's tower model which he claimed is "analogous to Ford auto."

Perhaps to his disadvantage, Fuller tried to eschew his inherited class distinction, as he accepted the media-hype and portrayal of him as a radical futurist. For example, while *Fortune* editor, Archibald MacLeish credited Fuller's pioneering vision for the industrialized house in the essay, "Five Questions ... And the Startling Answer," July 1932, he also suggested that even noted futurist of the day, H.G. Wells failed in his imagination because he could not "encompass the future house" of Fuller.[295]

While Fuller was identifying an audience for his work, taking his project on exhibition and a lecture circuit, and looking for opportunities to prototype components of his project; Fisher found a ready patron within his family. In 1929, his brother Walter Fisher and sister-in-law Ruth Page offered him the first opportunity for prototyping his experimental house. The architectural historian, Henry R. Hitchcock, writing in *The Arts*, February 1930 noted that the design was "very nearly the first in America to which the most rigid international standards of architectural criticism may be profitably applied."[296] Stylistically, of course, Hitchcock was comparing it with avant-garde European works which he and Philip Johnson, Director of the Museum of Modern Art-New York, jointly identified as International Style.

In this sense, the July 1932 *Fortune* special issue on the state of housing was a bitter-sweet ideological victory for Fuller. Archibald MacLeish's essay publicly vindicated his idiosyncratic vision of industrialized housing. MacLeish proposed that Fuller's approach was "a

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292 _, *TIME*, 4 July 1932.

293 *H. Ward Jandl's*, *Yesterday's Houses of Tomorrow*, p.158.

294 In the "K3H4DP" model, "K" represents the basic house design, "3" a subdivision of the K-design, "H" stands for a hall entrance, "4" means that there is room for four beds.

295 *Fortune*, July 1932, p.61.

296 Cited in H. Ward Jandl et.al, *Yesterday's Houses of Tomorrow*, p.60.

free and untraditional attack" on the issue of industrialized shelter and was potentially a "prototype of a new domestic architecture." In stating that "the industrialization of the manufacture of shelter (would be) the greatest commercial opportunity of the age," MacLeish in fact paraphrased Fuller's prognostication.[297] Besides the accolade, MacLeish privately pointed out a retinue of "copycats" of the Dymaxion idea which included the Bowman Brothers of Chicago, S. C. Horsley of New York and Henry Wright. The unconventionality of the Dymaxion, being a windowless, doorless, etc. house particularly struck MacLeish even if the Dymaxion, as a viable low-cost house plan, at this point remained speculative.[298]

The General Houses project was hailed in the *Times'* press release of July 1932 as the "most significant industrial event of (the) time." The press release added that:

> billion dollar assets have associated with General Houses Inc. to revolutionize housing on Automobile Production and distribution line ... $7,000 house will sell for $3,500 on installment plan through dealers who supervises erection in four days by unskilled labor.[299]

The limelight for this pioneering moment in industrialized was usurped by Fisher's General Houses. Besides taking the wind out of his sail, Fuller chided Fisher for failing to acknowledge his conceptual precedent and flagrantly contravening his intellectual property. Even cursorily, Fisher's trademark for his corporation bore resemblance to Fuller's 4D House. General Houses punned General Motors just as Fuller punned Ford. Now, in the wake of Fuller's promotional activities and the generally-positive media coverage of the Dymaxion House, the idea of a house to be assembled on a moving-line like in the automobile industry seemed thinkable.

Besides Fisher's unacknowledged appropriation of his idea, Fuller also argued that it seriously perverted the idea of repro-shelter industry that he had pioneered. Fuller claimed that General Houses "employ(ed) all the descriptive phrases of the Dymaxion research and solution."[300] It also ignored the unique proposition of the Dymaxion House as a "service" industry. As a compromised form of "sub-dymaxion," General Houses was a direct affront and a "'muscle(ing)-in' upon the repro-shelter movement":

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[297] *Fortune*, July 1932, pp.61-67.

[298] Ltr. 5/2/32 A. MacLeish to RBF in BFI-CR41.

[299] Time Inc. press release, July 1932.

[300] R. Buckminster Fuller, "Our Intimate Journal of Summer Events," *SHELTER*, November 1932, p.15.

> (T)he General Houses furvor(sic) is, though ultimately inconsequential, a progressive economic factor ... Though General Houses essayed to extract credit of Dymaxion growth consideration of B_ F_. (Buckminster Fuller) ... It none-the-less represents potential progress. The B.F. credit is not susceptible to dettraction(sic) in the particular matter of Dymaxion development.[301]

Under such circumstances, Fuller angrily claimed that "1932 will go down as the interim era of petty megalomania-fungus richly fertile in the manure rotting structures of selfish perversion."[302]

In spite of Fuller's claims that Fisher appropriated his ideas as well as the difference in the promotional approaches of both men, there are salient differences in the ideological underpinnings of their house projects. While both projects affirmed the virtue of the single-family house, Fuller openly denied his house as an emblem of permanence. For this reason, he called the General Houses, the "'same old' knock-down portable house with its manifold additional requirements of furniture, foundation, sewage pipes, water connections, public utility hook-up and dominance." In contrast, Fuller proposed that the "autonomous" mechanical, electrical and service conduits of the Dymaxion House ensured that mobility was its prime feature.

By promising varieties and variations in the house nomenclature, Fisher was directly addressing the public anxiety of uniformity in the industrialized house. He accomplished varieties by recombining assemblage of standardized prefabricated parts of four-foot by nine-foot panels. Assemblage of the house through bolting with a socket wrench and on-site custom building reinforced and assured a degree of familiarity, despite the general newness of the process. Fuller, on the other hand, saw variation and distinctions as forms of vanity. More than convinced of the uncompromising polemic of uniformity in early Fordist industrial strategy, Fuller also saw standardization was a type of spiritual asceticism.

The corporate maneuvers by Fisher to outpace his competitors in the industrialized house industry and the corporate research controls by Davison rendered further meanings to the business demise that Fuller experienced at Stockade. While the Stockade business was a familiar home-terrain where he could resist external controls, Fuller had little recourse against Pierce or the corporate-legal antics of the industrial conglomeration supporting General Houses. These experiences also highlighted the limited effectiveness of a highly individualistic, lone inventor

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[301]Ltr. 9/2/32 RBF to R. Hussey in BFI-CR41.

operating in a mild corporate-research setting of Pierce or searching for entrepreneurial capital in a business world.

The smell of conspiracy, posed as "shelter industry kidnapped," had prompted Fuller's letter to Ralph Ingersoll, then Editor of Time-Fortune.[303] Treating Fisher's project as a clear competition to his, Fuller argued that the acclamation *Fortune* gave General Houses inferred the buildability of the "practical substitute." In truth, he suggested his "too visionary 4D house" was hot and ready to go. Fuller's confidence in his project appeared unbridled, as he continued to proclaim the imminent repro-shelter industry on the horizon:

> Dymaxion architecture has gone though any necessary stages of its development prior to general industrial synchronization. That point seems to be fairly close at hand. June '33 should see quantity reproduction houses the center of the industrial stage; that is, actual houses coming off the line in many industrially competitive merger groups.[304]

Convinced that the Dymaxion House was still a viable proposition, Fuller privately continued his developmental and promotional activities. Even before the start of his three-wheel DTU project, Fuller had engaged Boyd Donaldson, the partner of Starling Burgess, his subsequent collaborator on the DTU, to provide a year's worth of engineering service on the Dymaxion House.[305]

Rather than attributing the success of the General Houses' coup to his own lack of business acumen, foresight and finesse, Fuller launched a tirade against General Houses, the complicity of the media, particularly *Time*, *Fortune* and *The Architectural Forum*, and their conspiracy with "financial tacticians." The vehicles for to redress his grievances were first through SSA and then through the publication of *SHELTER*.

Fuller's SSA was modeled as an alternative to the Scott's technocratic movement. He had hoped to "fire" up this "volunteer designing association" by what he characterized as the

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[302]R. Buckminster Fuller (as Dramatis Personae),"Our Intimate Journal of Summer Events," *SHELTER*, November 1932, p.21

[303]See Ltr. 10/4/32 R. Ingersoll to RBF in BFI-CR41; also Ltr. 12/2/32 R. Ingersoll to RBF in BFI-CR42.

[304]Ltr. 8/2/32 RBF to G. Keeble (Carnegie Institute of Technology, Pittsburgh) in BFI-CR41. See also Ltr. 9/2/32 RBF to C. Clarke in BFI-CR41, in which Fuller claimed that "the first experimental house will be completed before the winter is out."

[305]See Ltr. 9/16/32 B. Donaldson to RBF in BFI-CR41.

highest art: conversation.[306] Naturally he was the primary convenor of the group, and had prefigured the agenda of the organization before the group's first meeting; leaving it to endorse and authorize Fuller's design philosophy and strategies[307] [Fig.1.10]. The organization was short-lived; a total of eight known SSA-meetings were conducted.[308] Its activities culminated in August 1932 at Hotel Winthrop on 47th Street & Lexington Avenue in New York where it launched the first public exhibition of a series of projects under the rubric of Dymaxion research.[309] Three projects were exhibited, all variations of Fuller's ideas. They included a new model of a streamlined high-rise 4D-tower, a miniature model of the Russian House, and models of 4D Transport Unit executed by his sculptor friend Noguchi. The Exhibition was an attempt to demonstrate the expansiveness of his Dymaxion principles in new applications, like the offices and cars.[310] Fuller also explored Russia as a prospective site for his "universal architecture" project. He believed that his own five-year "longevity shelter unit" would supplement Russia's own first five-year, heavy-industries development plan.[311] They were subsequently published in November 1932 issue of *SHELTER*.

In August 1932, Fuller described the SSA as "an ever-increasing large group" of people in "editorial, engineering and designing work" sharing a focal interest in his 4D principles. In reality, the initiates into the fold of SSA did not exceed twenty. Nevertheless, Fuller was able to attract several influential participants who shared either his interests in industry-produced building or his effort to reexamine architectural practice from anew. These included Theodore Larson and Knud Lönberg Holm, both of the recently revamped *Architectural Record*; Frederick Kiesler a recent European emigre avant-garde and Peter Stone, an editor of *General Bldg. Contractor*.

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[306]R. Buckminster Fuller, Flyer on "Symposia" (ca. Jan. 1932). Fuller had initially intended the project to be a dry-run for a paid seminar series modeled. The seminars would be conducted from his pent-house in the Starret-Lehigh Cooperative Bldg. at 601 West St., N.Y on Jan. 12-29 '32 @ 0.50 cents/evening and $5.00/monthly:

> Buckminster Fuller will discuss current scientific, economic, sociologic and industrial phenomena, with interpretation of their potentialities, as developed from viewpoint of his PHILOSOPHY OF INDUSTRY... (A) voluntary group conversant with these interpretations will meet... to develop (by research, analysis, design and practice) a program purposing a practical creative link between present confused condition, caused by high frequency evolution, and the future condition of industrial synchronization - it being hoped that the destructive chaos wrought by the unheeded inevitable selective practice process may be avoided in attaining certain universal adjustment, through interpretive design.

[307]"Structural Study Associates (SSA), Notes," 11/1/31 in BFI-CR42.

[308]The first and last of these meetings were recorded as 11/7/31 and 12/30/31 respectively. See also "SSA Development" ca. Dec. 1931 in BFI-CR42.

[309]See SSA announcement, dated 8/5/32, probably penned by Fuller.[Getty Center for the History of Art & the Humanities, Document F006B10]

[310]Germain Barett's notes of the Winthrop Exhibition (ca. May 23' 32) in BFI-CR41.

[311]See R.B. Fuller, "Universal Architecture Essay No.1," Shelter November 1932, p.59.

Fuller encountered little difficulty in convincing his SSA associates of the impending trend towards the industrialized house and the role that it would play in national economic recovery. However, he was less successful in convincing them that the Dymaxion House was not a personal hobby-horse. Despite Fuller's attempt to suggest that it was merely an embodiment of principles synonymous to his 4D idea, Fuller privately called SSA a "Dymaxion organization."

SSA was primarily Fuller's front to fulfill a number of agenda. Fuller initially intended to channel the energy of the group towards developing a Dymaxion House prototype for exhibiting at Chicago World's Fair. He noted the potential publicity that such a project could be generated towards repro-shelter cause:

> We know that people go there - go through the model houses; sometimes there are as many as 10,000 people going through one of these model houses on Sunday – this is not at all unordinary. It is perfectly reasonable to suppose that the exposition house may pay for itself; this house at the World's Fair might make many times its original costs.[312]

However, by July 1932, the announcement of Fisher's General Houses project convinced Fuller that the enemies of his "universal architecture industry" were not figments of his imagination, but real. Fuller orchestrated the group's consensus to forge a legitimate opposition to General Houses. While he argued that General Houses was "factually established as a contractual organization," it was still behind in terms of real production. Instead, he claimed that the Dymaxion Houses under his management would be the first actually of the line in time quantity production.[313]

The SSA served as an objective front for Fuller to solicit funding support. It was, Fuller characterized, an organization of "entirely abstract association without official management etc.," with associates drawn from many corners of the world now.[314] Thus, SSA allowed Fuller to advance his cause by averting what would otherwise be read as a project belonging essentially to him. Writing to Falk Foundation in Pittsburgh, Fuller explained:

> The Association (SSA) was motivated by a desire to set up standards in the new realm of design, typified by Dymaxion Houses, which standards might be quite unsullied by business compromise and instrumental to the rapid, healthy and harmonious growth of this seemingly all-important subject. The group is doing good work and its cohesion increases.[315]

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[312]Minutes of SSA-Meeting, 11/18/31, p.2.

[313]Notes on J. Sherman's proposal, ca. 6/1/32 in BFI-CR41.

[314]Ltr. 8/4/32 RBF to H. Beatty in BFI-CR41.

Finally, however, the organization was ravaged by general uncertainty over its purpose and by tensions over the scope, framework and strategy for addressing the housing problem. For example, Roger Sherman, a SSA associate, suggested that housing study could be approached from theoretically, either by examining plans and the organization of community, or from a closer study of housing units. Fuller rebutted against these approaches, pointing out their implicit bias towards land-owning considerations.[316] Still, Fuller's anti-style rhetoric, especially in response to the International Style Exhibition at MoMA, received sympathy and support. His SSA associates readily accepted his characterization of the Johnson-Hitchcock's project as a stylistic displacement, an activity of formal "readaptation."[317] For this reason, Fuller carefully opted to label his alternative as "Universal architecture":

> Universal architecture is a new school of architecture...just as good in Alaska as in Russia, designed by some unknown person to do for everybody, a very unselfish manifestation.[318]

Against a different front, Fuller launched a direct assault on Le Corbusier. He noted how this "man abroad by virtue of perspective" had seen the American industrial forms and had "refined them" by making them aesthetically beautiful.[319] However, like the exponents of International Style, Le Corbusier did not achieve a design that would take the place of the forms they worshipped. Their aesthetic simplifications remained "manifestly a (form of) tailoring." The architectural potentials of industry, and vice versa, had not been fully realized

1.2.7. Acquiring the *SHELTER* Journal

Fuller preferred the efficacy, immediacy and ephemereality of the news release, newspaper features and the lecture circuits to advance his projects. Whenever possible, Fuller planned syndicated press releases like those with Associated Press/United Press and architectural journals, like the *Architectural Forum* in order to effect even greater coverage of his project. Believing that with the "weight of public support" behind him, he was better positioned to "negotiate with industrialists generally."[320] This was the primary impetus for him to acquire *SHELTER*. For these reasons, his first substantive book project, *Nine Chains to the Moon,*

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315 Ltr. 8/2/32 RBF to G. Keeble (Carnegie Institute of Technology-Pittsburgh) in BFI-CR41,

316 Minutes of SSA-Meeting, 11/18/31, p1. Not persuaded by Fuller, Sherman subsequently expanded Fuller's agenda by proposing an investigation of housing in general and the investigation of housing units, mechanical and structural development (See Minutes of on SSA-Meeting, 12/2/31, p.1).

317 Minutes of SSA-Meeting, 12/2/31, in BFI-CR42, p.2.

318 Ibid.

319 Ibid.

summarizing the fate of the Dymaxion House project, among other aphoristic offerings, was undertaken only later in 1938.

1.2.7.1. Creating Public Opinion through *SHELTER*

In Fuller's self-history, he claimed a role as publisher, editor and co-founder of *SHELTER* journal [Fig.1.16a]. Under Fuller's editorship, the journal's subtitle was changed in July 1932 from "Magazine of Modern Architecture" to "A Correlating Medium for the Forces of (Industrializing) Architecture." Fuller openly professed that *SHELTER* was acquired to propagate the findings of SSA. A broadside probably penned by Fuller directly suggested this intention:

> (*SHELTER*) has agreed to act as the official organ of the Structural Study Associates in the announcement of its many and rapidly developing ideas.[321]

SHELTER started as the *T-Square Club Journal* under the initiatives of the Philadelphia architect George Howe in December 1930. It was primarily a local forum for the Beaux-Arts-trained architects to discourse on modern art and architectural practice. Within a year, under Henry-Russell Hitchcock, Alfred Barr and Philip Johnson as associate editors, the magazine became the premier forum for discourses on modern practices in American architecture. It was due to this editorial change that Maxwell Levinson, the editor of *T-Square*, solicited for a write-up on Dymaxion House to be featured in the February 1932 *T-Square* issue.[322] Fuller's initial contribution, in galley-proof form, on the exposition of his Dymaxion ideas was titled "Archaeology Abandoned in Recreative Housing Design"; but it was subsequently published as "Universal Architecture, Essay One."[323]

T-Square, as a member-subscribed magazine, was already facing financial difficulty before Fuller arrived on the scene. The financial Crash jeopardized its viability and continuation. Fuller was aware of its dire financial state, and as "visiting fireman" at *SHELTER*, he was already contemplating on ways to acquire it.[324] Probably under the assumption that Fuller would raise sufficient funds to continue the publication of *SHELTER*, both Howe and Johnson acquiesced their behind-the-scenes role temporarily to Fuller. Fuller redeemed his life insurance policy to

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[320]Ltr. 6/3/29 RBF to Martin & Janet in BFI-CR36.
[321]"Hotel Winthrop 47th. Street & Lexington Ave., New York, N.Y," p.2; copy in Getty Center for the History of Art & the Humanities, Document #F006B10
[322]Ltr. 12/17/31 M. Levinson to RBF in BFI-CR38
[323]Ltr. ca. Feb. 1932 M. Levinson to RBF in BFI-CR41.
[324]Ltr. 5/18/32 R.C. MacDougall to RBF in BFI-CR41.

pay the expenses for the journal.[325] Nevertheless, upon the publication of the May 1932 issue, both Howe and Johnson publicly denounced their association with the journal and relinquished in storm their roles as associate editors. George Howe's subsequent letter to Fuller further implied that Fuller muscled into the control of the publication.[326]

Fuller saw the two issues, May (Vol.2, No.4) and November (Vol2, No.5) issues of the *SHELTER* publication as his creative production. He would rework their layout in a 92-page "reprint," which he termed "second edition," probably for promotional rather than subscription distribution. In the May "reprint," Fuller consolidated his "Universal Architecture" essays. They were previously published in two parts, February (*T-Square*, Vol2, No.2) and April (*SHELTER*, Vol2, No.3). He added a five-page Bulletin, which basically lambasted the Chicago World's Fair and General Houses.

To understand Fuller's interest in the acquisition of *SHELTER*, and the risks that he was prepared to undertake, one could peruse this meticulous strategy that Fuller laid out in these notes he made in 1932:

> 1 If I had enough time (to do it personally) or money (capital to employ others) I would go about and redirect established potentials along not(sic) conflicting specific radii of synchronized wave ... spheres towards quickest Dev(elopment) (of) Univ(ersal) Arch(itecture).
> 2 Lacking unlimited funds - I could fabricate convincing models for reproduction.
> 3 With less funds, I could personally or indus(trially) design and specify on paper harmonious brochure - for industrial envisionment.
> 4 With less time and money, I can by adequate thought write and illustrate so adequate a book as to convince, inspire and fire human industrial activity.
> 5 Having less time and money - through essential thought, true conduct - personal unselfish intelligent dev(elopment) I can through highest art, i.e. conversation - inspire fire humanity.[327]

At the start of 1932, the first strategy was clearly out of reach. The second option had been stalled in the Corbett and Pierce collaborations; the third had been developed largely without any further consequences; and the fourth and last strategies were the only ones remaining. Certainly, the act of cashing his life insurance to finance a speculative project was reckless by any standards. However, it was probable that by 1932, the diminishing options made both SHELTER and his "volunteer designing association," attractive strategies. Collectively, they meant that time

[325] Invoice, 6 July 1932, in BFI-CR41.
[326] Ltr. 8/29/32 G. Howe to RBF in BFI-CR41.
[327] R. Buckminster Fuller, Notes, n.d. (ca. 1932) in BFI-CR43.

and effort were to be spent in persuasion rather than in prototyping activities.[328] In the light of these circumstances, Fuller's decisions were not acts out of desperation, but rather, calculated recklessness for a cause. He was also encouraged by the possibility of writing as a way to sustain his livelihood. He was encouraged by the significant effect of a mass-circulated article that he had just completed, and published in all forty Scripp-Howard syndicated papers. Claiming that the article reached "23 million readers" Fuller added that it "carried great weight and had stirred up more excitement" than *Fortune* announcement of the General Houses.[329] The positive reception his May issue *SHELTER* further fueled this writing ambition.[330]

Still, why did Fuller assume the risk? Why did Fuller need *SHELTER* when he was already receiving adequate local, national and international press coverage, at the public and professional levels? How would *SHELTER* further advance his cause or achieve new targets otherwise not achieved by the other journals with wider circulations?

1.2.7.2. Editorial Policy

For Fuller, it was not the volume of circulation of the journal per se which edged him towards acquiring *SHELTER*. Rather he believed that the medium guaranteed that his message would be communicated with fidelity and without compromise. Further, both *SHELTER* and SSA represented platforms to advance ideas to potentially-sympathetic readers. Fuller intended *SHELTER* to be a legitimate public forum to discuss the issue of repro-shelter without the appearance of self-promotion and publicity. To render an appearance of objectivity, Fuller felt compelled enough to outline an elaborate editorial policy.[331] Despite being its publisher, Fuller carefully characterized his role in relationship to Maxwell and Leon Levinson, the official editor and managing editor of *SHELTER*, as a "tactical escort of their convoy" and being "under (his) tutelage." This was to avert any reading of his total power. Further, to render *SHELTER* a non-profit project and to substantiate the transparency of its cause, Fuller rescinded advertising. The Levinsons, perhaps pressed by the need to keep the journal going, nevertheless voluntarily adopted Fuller's espoused editorial policies.[332] Despite these moves, the two issue of *SHELTER* that Fuller published and edited did not quell public opinion that they were blatantly his vehicle for self-promotion and personal vendetta.

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[328] Fuller's other options for funding was similarly closed. In March 1932 his research proposal to the Guggenheim Fellowship was rejected (See copy of Fuller's application for research grant in BFI-CR44).

[329] Ltr. 7/31/32 RBF to A. Fuller in BFI-CR41. See *N.Y World Telegram*, 19 July 1932.

[330] Ltr. 5/31/32 M. Levinson to RBF in BFI-CR41.

[331] See "Shelter's Editorial and Economic Policy," *SHELTER*, May 1932, Vol.2, No.4, p.2.

The November 1932 issue of *SHELTER* exemplified this point. Writing under the cover of "Dramatis Personae," Fuller wove an intricate conspiracy theory linking media, finance and front men over the coup of the General Houses. General Houses Inc. as one among many representatives of the Mid-west entrepreneurial initiatives was, Fuller accused, henchmen of financial interests. Its choice as "'fair-haired boys' of the moment by the financial tacticians" was because it lacked ethical integrity and was malleable by big business. Media was rewarded in this charade, with a news scoop of an unfolding race in the new industry. Finally, Fuller argued that the "financial tacticians," the last beneficiary of this unholy trinity, gained "dominance of repro-shelter development" in order to protect their capital interests rather than advancing industrialized housing as a social cause.[333]

In this sense one could see *SHELTER* as something more than an instrument of self-promotion and publicity. It was in Fuller's hand, a "muck-racking" device to show there was a general corporate conspiracy to undermine works of individuals, particularly Fuller's, who lack the legal resources and financial connections to protect themselves. The conspiracy theory spun by Fuller, however, was more extensive. It reached a national level when Fuller implied that Clarence Wooley of American Radiator had U.S. President Herbert Hoover in his pocket. By successfully lobbying for the reactionary findings in the President's Housing Conference, Wooley disadvantaged the industrialized house initiatives.[334] At another level, presumably both Dawes, Rufus and Charles, whom Fuller characterized as "virile" mid-west industrialists and bankers, muscled Wall Street's financial interest over to Chicago, by favoring Fisher's General Houses.[335]

Upon the publication of the November 1932 issue, *SHELTER* folded as a business, and the printers, Westbrook Publishing Company (Philadelphia) undertook a suit to retrieve costs.[336] However, Fuller and his biographers rendered a more heroic account of the fate of journal. Lloyd Sieden, for example, citing Fuller's lecture at the University of Oregon-Eugene in 1962, verified Fuller's account that he "abandoned the project so that he could participate in (President) Roosevelt's' great liberal experiment."[337]

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[332]Ltr. 9/6/32 RBF to G. Howe in BFI-CR41.
[333]See "Our Intimate Journal of Summer Events" in *SHELTER*, November 1932, pp.20-21.
[334]Ibid., p.15.
[335]R. Buckminster Fuller, "Universal Architecture Essay No.1" *SHELTER*, May 1932, p.62.
[336]Ltr. 1/24/33 Berriand & Throner (Collection Agency, Philadelphia-Pa.) to RBF in BFI-CR44.
[337]L.S. Sieden, *Buckminster Fuller's Universe*, p.140.

In practice, Fuller's personal agenda, self-publicity and promotion intentions prevented *SHELTER* from becoming the open forum to debate the implications of modernism. Even his anonymity, using the pen-name "4D," to avert the "terrific" jealousies of the designers and artists did not help.[338] This was despite Fuller's attempt to set aside the first issue as a platform for both Philip Johnson and H. R. Hitchcock "to plea the cause of their devotion (to the International School of Architecture [sic])." He had openly posed their project in opposition to the findings of his own "research" group, the SSA.

However, Fuller's attempt to surface the potential ideological conflicts failed; and the silence of the oppositional voice was complete with the resignations of Johnson and Howe.[339] Nevertheless, because Fuller's views deeply contrasted those represented by Johnson and Hitchcock, *SHELTER* is significant in demonstrating the differences in the meanings of American modernism. Marc Dessauce, assessing the modern architectural discourses in the thirties, argued that the challenge *of SHELTER* constituted a significant location for "the current discrepancy between historiography of the style and the history of American modernism."[340]

The fundamental differences between Fuller and his opponents were over the definition of architecture, the identity of the architect and the meaning of autonomy in design discourse. Fuller argued that industrial America demanded a new disinterested personal service. This requirement, purged of the personal aura of the designer, contradicted the culture and profession of architecture. The large-scale effects and instruments of industry, Fuller believed, would replace the cultural habits of architecture with its new standards, established in the form of service. For these reasons, the narrow strictures of architectural design, promulgated by *T-Square,* would be transformed by a new mission:

> *SHELTER* will become progressively the standard reference text for the now developing structural sciences, in the same manner as *Bowditch's Practical Navigator*, and Knight's *Seamanship* are Standard text-books for American, maritime world. These two publications despite the demise of one author years past, are revised 'to include and develop' with each edition, as are dictionaries to conform to evolution.[341]

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[338] A. Hatch, *At Home in the Universe*, p.120.

[339] "Shelter's Editorial and Economic Policy," *SHELTER*, May 1932, p.1. Fuller's editorial challenge was not taken up. Sieden nevertheless perpetuated Fuller's claim that under his tutelage, *SHELTER* attracted aspiring architects like Philip Johnson to contribute. Likewise, Hatch erroneously attributed Philip Johnson as *SHELTER's* first "guest editor" (See L.S. Sieden, *Buckminster Fuller's* Universe, p.138 and A. Hatch, *At Home in the Universe*, p.119).

[340] M. Dessauce, "Contro lo Stile Internazionale: 'Shelter' e la stampa architettonica americana," *Casabella*, Sept.1993, p.71.

[341] Ltr. 9/6/32 RBF to G. Howe (Philadelphia-Pa.) in BFI-CR41.

Thus, in acting as clearing-house to "correlate industry," Dessauce argued that *SHELTER*, under Fuller's editorship, transformed from a local journal of Beaux-Arts system into a "productivist tribune."[342] The productivist mission is evident in the journal's editorial statement:

> Not only will the publisher correlate industry, but he will provide an unbiased service to the inventive mind, speeding the latter's findings, through university laboratory development to industrial synchronization, and thence to consumer avail, without duplication or exploitation. SHELTER is pioneering such service, and if it succeeds in establishing at least a new ideal service, its achievement will be truly great.[343]

In contrast to Dessauce's interpretation, Philip Johnson suggested that Fuller the "dreamer poet" opposed the notion of building; instead, he valued the notion of publishing. Paradoxically, Johnson thus claimed that he along with his "cadre (of) practical people" at *SHELTER* became "natural enemies" of Fuller.[344]

For Fuller, architectural practices provided neither clues nor convincing responses to a primary trend in house design, which he viewed as the impending commodification of shelter. The "looming shelter industry" with its "two billion" customers was imminent to Fuller and fueled his optimism. It promised a future of "industrially-edited, scientifically conditioned environments."[345]

Howe resigned as an associate editor of *SHELTER* because he was unmoved by Fuller's agenda of reforming architecture based on mechanical and industrial imperatives. The significance of Howe's decision, revealed in a series of letter exchanges between him and Fuller, is in the ideological difference between Fuller's "productivist" trend and the cultural modernist trend which Howe, Johnson and Hitchcock represented. Howe's opposition to Fuller illustrated this:

> However interested I am in the potential good to be extracted from a mechanical civilization I am at present time so strongly opposed to the extension of the mechanical principle ... (A)esthetics and social reforms have in my mind nothing to do with each other. As a designer, it is a matter of indifference to me whether the mechanical civilization is moral or immoral. If, on the other hand, you ask me to join a movement of social reform, then I say the mechanical civilization is spinach.[346]

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[342] Marc Dessauce, "Contro lo Stile Internazionale," p.70.

[343] R.B. Fuller, "Shelter's Editorial and Economic Policy," *SHELTER*, May 1932.

[344] K. Simon & K. Goodman, Transcript of Interview with Philip Johnson (for a PBS documentary "Thinking Out loud"), p.10.

[345] R.B. Fuller, "Shelter's Editorial and Economic Policy," *SHELTER*, May 1932, p.2.

Fuller's rebuttal to Howe, contained in his essay "Our Intimate Journal of Summer Events" was that neither SSA nor *SHELTER* was a "social movement," rather Howe was clouded by his own prejudice and self interests, perpetrated by "business tacticians."[347] Howe and Johnson's resignations, Fuller suggested, were "due to the apparent fearfulness on their part to be ranked with social, economic, reform movements." Howe's interest, Fuller implied, was business and publicity; and this was proven by his employment of the media publicity-wizard Edward L. Bernays to publicize his PSFB (Philadelphia Savings and Financial Bank) story in *Fortune*.

The more serious accusation implied in Howe's letter of resignation was the impropriety of Fuller in his capacity as behind-the-scene editor of a free forum. In response, Fuller felt compelled to publish an open letter of explanation arguing that the direction undertaken by *SHELTER* had developed naturally and that he had not advocated social revolution. Fuller denied harboring "socially iconoclastic promotion in any publishing policy." Nevertheless, for the first time, he publicly argued for the efficacy of design over political revolution; thus underpinning the technocratic strain in his ideology:

> I have been for years of the opinion that the only sure means of avoidance of complete social breakdown and chaos, known as revolution, was through completely fearless demonstration and publication of the true findings of our intellectual gyrations, so refined as to be demonstrable in inanimate structures. When sufficiently clarified to be so articulated, it is my confirmed notion, that *only inanimate rather than animate revolution is resultant.*[348]

Paradoxically, in seeking clarification against Howe, Fuller revealed to the readers of *SHELTER* the crux of Howe's primary objection. Howe accused that *SHELTER* had become a tool for Fuller to pursue his own agenda and to redress the injustice he had experienced. Fuller clarified that he was not against business per se, but rather "rigid and static business system." In characterizing business as such, he revealed his felt betrayal by the industrial conglomerate over the General Houses announcement. Probably more to the distaste of the middle-class readership was Fuller's claim that his victimization was caused by the complicity and conspiracy of control orchestrated by business interests

> I have realized seemingly inexplicable and sudden disaffections of otherwise enthusiastic supporters or potential backers.
> ... I am aware that other less broad-minded, and some who have had no breadth of understanding at all, have, through personal prejudice growing out of an intuitive distaste and fear of any activity potential to change that might jeopardize their estate having been in so

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[346] Ltr. 7/13/32 G. Howe to RBF in BFI-CR41.

[347] R.B. Fuller, *SHELTER* November 1932, p.16.

[348] Ltr. 8/1/32 RBF to G. Howe in BFI-CR41.

high a position of financial prerogative as to necessary impose credit on their reflections, but established not only derogatory but almost ruinous reports on my credit status...I have been in no tactical position to parry such registration and have been confident that eventual record of performance would serve as ample vindication of conduct.[349]

Howe, like most architects, accepted the limited role of the architectural profession in affecting social changes. As a "humble artisan," Howe professed that the social and economic vagaries that form the object of Fuller's agenda were merely "subject-matters (to be) depict(ed) architecturally, implying neither praise nor blame." Thus, he did not have to constitute himself as its "advocate or judge."[350] He was more adversely affected by what he read as "the mechanistic vices" of technocracy in Fuller's project:

(T)he mechanistic principle is destructive through its baneful deteriorating influence on the individual, and I am convinced that if man were ruled by an all-seeing autocrat he must begin by reducing the world to the blissful state of Erehwon.[351]

Despite these criticisms of his ideological affiliation and personal shortcomings, Fuller managed to dispel Howe's primary criticism that his project promoted a persuasiveness of "mechanistic existence." In retaliation, Fuller evoked the images of slavery, thereby portraying Howe's culturally-conservative position as a rear-guard effort to curb the impending emancipatory repro-shelter. In posing the humane aspect of his imagined future architecture, Fuller described the slavery of the past as "humano-mechanistic":

The de-roboting of humanity by transfer of labor-slavery from life processes to the inanimate instruments, represents the converse of a 'mechanistic tendency'...Life must complete the equation, and alone articulates selection in the universe of initial chance.[352]

Fuller radicalized his agenda by attacking Howe's "paternal-hero epics" which he argued, sustained power past against "retrogression of their own estate." At a more personal level, in caustic words, he scoffed:

I am sure that a surfeit of aesthetic pish-pish gags your intellectual being. I am sure that you are experiencing a hangover from the contents of the hit-and miss 'business' cocktail shaker, that you should seek to justify the extension of its stupidity, inefficiency and futility of manipulated exploitation, by bandying such meaningless words as 'morals' and 'reforms.'[353]

349Ltr. 8/1/32 RBF to G Howe in BFI-CR41.

350Ltr. 8/29/32 G. Howe to RBF in BFI-CR41.

351Ibid.

352Ltr. 9/6/32 RBF to G. Howe in BFI-CR41.

353Ibid.

Equally and vehemently opposed to Fuller's behind-the scene maneuvers was Philip Johnson. Johnson's resignation in July 1932, preceded Howe's and for very different reasons. Firstly, he and William Lecaze (George Howe's partner) had provided the initial credits; and hence he felt entitled to "a voice in the policies of (*SHELTER*)" and its content.[354] Secondly, he objected to how Fuller veered *SHELTER* away from its objective to advance "the art of architecture." Illustrating this second point, Johnson cited the works of two SSA "associates": Breine's proposal to convert the New York office skyscrapers into housing and Frederick Kiesler's experimental theater. They were, he argued, "sophomoric" and "intelligible to none" respectively, while the writing of their ideologue was "obscurantist." Arguing for a continuous editorial policy and for someone who "knows" architecture, Johnson was probably instrumental in lobbying the Levinsons to drop Archibald MacLeisch, an associate editor at *Fortune* whom Fuller had slated as pro tem editor for the November issue of *SHELTER*.[355] MacLeish, viewed by Johnson as Fuller's man, had just undertaken a six-part series on the state of industrialized housing, in which he lionized Fuller's pioneering position in that field.

The ideological difference between Johnson and Fuller with respect to the place of architecture as a cultural emblem remained throughout their lives. In later years, Johnson assessed Fuller as a "wordsmith first, last and always." Thus, he chided Fuller's arrogant portrayal of himself as a "great artist" and his "pretense" as an architect who had no feel for "culture and the esthetics of architecture." Concerning the Dymaxion House, Johnson recounted how Fuller had submitted it for the MoMA "International Style" Exhibition. However, it was rejected because he was unable to find a "compatible picture" of this "pretense at a dwelling space." Johnson suggested that the Dymaxion House, this "mechanical looking thing," had "nothing to do with architecture." Further, even as a mechanical proposition, it lacked originality - it was an "old hat," strategy that Le Corbusier explored earlier in his Cubist phase with greater sophistication. Nevertheless, Johnson acknowledged that the Dymaxion House was "a trumpet that intrigued" many of his generation to the potentiality of the machine as a salvation tool. The task, Johnson argued, was to take responsibility to "express it properly," which by implication of his criticisms, Fuller did not. By proper expression, Johnson meant planning the dwelling and making it work "architecturally." For instance, he cited the strangeness of the arch door of the Dymaxion House conceived in terms of lines and triangles; and the contradiction between its

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[354] Ltr. 5/27/32 Philip Johnson (MoMA, Dir. of Exhibition) to M. Levinson in BFI-CR41.
Johnson substantiated this claim with a debtor note, which showed Fuller owing George Howe, Philip Johnson, William Lecaze & Westbrooke Publishing Co., $10,066 (Copy, dated 5/24/32 in BFI-CR41).

[355] See Ltr. 5/27/32 P. Johnson to M. Levinson in BFI-CR 41.

formal and structural expression, namely, in "holding it (the house) all up and then pull it down again." Overall, Johnson felt that:

> ideologically (Dymaxion House) makes wonderful sense ... you could see the poetry (though it) had *nothing at all to do with architecture and all to do with dreams and pseudomechanics*[356] (Itl., my emphasis).

Fuller's own productivist position, issuing from his discourse on the 4D-Dymaxion House project, is contained in his "Universal Architecture" essays. Fuller had envisaged six essays, of which only three were subsequently published.[357] Essay One was a statement of problem with specific and general solutions. Essay Two pontificated on the replacement of "Feudal Land-Economics" by "Universal Time-Energy-Economics." Essay Three provided a review of past attempts at shelter industry; Essay Four was to have focused on the implementation of ideas, via an SSA project, "A Workers' Shelter for the Soviets"; Essay Five was to have offered an overview of the abstract and instrumental nature of Universal Architecture; lastly, Essay Six was meant to illustrate special applications of Universal Architecture.

Fuller argued that the emerging practice of buildings produced by industry would eventually subsume the architecture of craftsmanship and diversified trades. Thus, the question of autonomy that plagued architectural discourses, according to Fuller, was falsely-hatched; and the fear that industrialized buildings would cause technical unemployment, was groundless. Within the productivist discourse, Fuller's eyes were trained not so much on techniques but rather on the consequences and ramifications, that industrial production had on the commodification of architecture in mass society. In this respect, buildings, like mass-produced tools, fell under the rubric of economy rather than remaining as emblem and conservator of culture. Under such dynamic situations, buildings assumed the status of process rather than ends.

For Fuller, the "industrially-reproduced, distributed-serviced and recalled" shelter or repro-shelter was not merely the consequence of the increased in or the growing sophistication of industrial capacity. It would, in turn, actively vivify the automobile, airplane and other industries,

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356 K. Simon & K. Goodman, Transcript of Interview with Philip Johnson (for a PBS documentary "Thinking Out loud").

357 See "Universal Architecture, Essay One" containing two components "Archaeology Abandoned in Recreative Art of Housing Design (A 1927 Forecast)" and "Universal Conditions of Industrially Reproducible Shelter (A 1932 Aphoristic Essay)" (first published in *T-Square*, Feb. 1932, Vol.2-No.2); "Universal Architecture, Essay Two (*SHELTER*, April, 1932, Vol.2-No.3); and "Universal Architecture, Essay Three, Industrial Emancipation Conditions" (*SHELTER*, May 1932, Vol.2-No.4).

exceeding their previous standings. These effects would be created when industrially-reproduced housing became decentralized and spurred population exodus from the cities. For this reason, Fuller was against the "prissy" suburban zoning controls and their consequences in encouraging the "dumping of repro-houses."[358] His preference for the evacuation of cities was paradoxically based on his belief that it would assist in fusing the "unfused" ethnic enclaves in the major cities like Chicago, New York, Philadelphia and Detroit.

In its rhetorical graphics and style, *SHELTER* was confrontational and aimed at provocation. In the May issue, for instance, the ideological divide between productivist and establishment architects was immediately established in the associative identities assigned to the contributors. In his own jargon, Fuller elaborated the scope of the productivist collaborators in the SSA. It was a:

> group mechanically cohesive through a positive creative and progressive urge, no personal names being identified with the work, members being designated by numbers, as compared to designer's associations boastfully exploiting past records of members. Self-effacing and service-minded, somewhat of the manner of the Ford planning department, they concern themselves not alone with the final structure, to be reproduced in quantity but also with the complete ramifications of the industry, from elemental source to the site; and thereafter, throughout service and replacement cycles, calling even for searching consideration of contiguous sociologic development and its potentials for further growth, through design.[359]

Using the SSA and his own rhetoric, Fuller tried to expose the complicity of Beaux-Art monumentalism and style regardless of its political patronage [Fig.1.16b]. The visual discourse in *SHELTER*, employing photographs placed in dramatized juxtaposition, is refreshingly radical. The weight of the rooted Manhattan skyscrapers is contrasted to the lightness of the biplanes. The code of visual values of these photographs was based on opposition, a technique that Fuller owed much to after his reading of Le Corbusier's *Towards a New Architecture* (1927) [Fig.1.16c]. The typography was direct, unornamented and almost stencil-like to complement the pervasive productivist agenda.

While supporting the spirit of Le Corbusier's direction, Fuller was careful in steering the visual discourse away from the stylized modern or any aestheticized image of American industry. Clearly alluding to Le Corbusier's fascination with and iconic treatment of ocean liners, he labeled one photograph, "Cancer"("High art on the High Seas"). In his own photo-essay on planes and ships, Fuller de-aestheticized these images by calling them:

358 "Universal Architecture Essay No.3," p.42.
359 "Universal Architecture Essay No.1," p.66.

Mobile Shelters -Designed for what they will do, not do what they look like. All products scientific-totality of date of issue, no arbitrary withdrawal of efficiency. Giants of strength in which fractions ounces considered.[360]

Similarly, in the photograph-commentary, "Via Evolutionary Paradox to (an Abstracting Paradise)," Fuller lined up a progression of "formal" development towards "ephemerality" or non-form. In addition, in illustrating "Monuments and Instruments," an essay of Lönberg-Holm, a SSA associate, using a photograph of Ford River Rouge Plant, Fuller proclaimed:

The industrial ideal is not the tallest smokestack but elimination of smokestacks.[361]

The most stunning of these photo-commentaries used as propaganda, is one labeled "Chronic Disorders of Architecture"[362] [Fig.1.16d]. Using diseases as metaphor, Fuller also attacked contemporary stylism ("eczema" and "piles"), cultural excess ("ringworm") and structural redundant constructions ("spinal meningitis" and "infantile paralysis").

SHELTER engendered a broad range of criticisms by its iconoclastic content, and its combative editorial posture. Fuller spared no one, not even a sympathetic patron like J. Ely Kahn. Kahn was angered by the slanted comments and rudeness, beyond the convention of "good taste," in Fuller's presentation of his design.[363] *SHELTER* 's conservative readers saw its popular posture as "peasant mentality" and "inchoate"; its works that of rebellious "youth gone astray" or "an army with banner."[364]

Among *SHELTER*'s avant-garde retainers and well-wishers, however, the journal created opportunities, albeit momentarily, to hedge over the details and definitions of an agenda for a new architecture. Knud Lönberg Holm, who would remain one of Fuller's life-long supporters, supported his "anonymity of invention and community of growth." Holm also raised some of the topical concerns among the group, particularly that of steering the project of reform away from the politically-charged technocracy.[365] Other "establishment-type" supporters of *SHELTER* included the industrial designer Norman Bel Geddes and Douglas Haskell. Whether agreeing with its "main direction" rather than tactics, they generally considered *SHELTER* a "magazine of

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[360]Ibid., p.39.

[361]R.B. Fuller, *SHELTER*, May 1932, p.10.

[362]Ibid., p.19.

[363]Ltr. 5/31/32 J.E. Kahn to M. Levinson in BFI-CR41.

[364]See Ltr. 11/13/32 Prof. F. Cunningham (U. of Nebraska, Lincoln) to *SHELTER* in BFI-CR 42 and Ltr. 5/21/32 A. Jackson to *SHELTER* in BFI-CR41.

[365]Ltr. 5/16/32 K. L. Holm (F.W. Dodge) to RBF in BFI-CR41

courage."[366] Other more enthusiasts, who dubbed themselves "agents of SSA," saw Fuller the as a true prophet of the mass-produced house and a "divine" guiding spirit against "pisscuts(sic) Johnson-Hitchcock etc."[367]

Between accolades and charges of disrepute, the most critical and perceptive criticisms of *SHELTER* came from the left. In particular, John Kwait, a contributor to the radical left magazine *The New Masses* posed more than trepidation of Fuller's actions in undermining *SHELTER* as a "public forum."[368]

1.2.7.3. Criticism from the Left

Both *SHELTER* & SSA were leavened with left-wing rhetoric and intimations of socialism despite Fuller's denouncement of political revolution. This is because Fuller distinguished his strategy as industrial "scientific-good-faith" Communism, as opposed to the Russian variety, which he called "politically-arbitrated" Communism.[369] He was convinced that the new social collectivism defined by industrial phenomena, epitomized in Henry Ford's success, was emerging. For Fuller, this was a palpable form of "industrial communism" that was "unselfconsciously established." More industrial successes of Ford's sort, on a larger magnitude, would also ameliorate the economic depression by increasing the share purchase of scientific-industrial stocks.[370] With this rendition of industrial communism, the choices in and of social associations were paramount.

The radical left was undeterred by Fuller's so-called "proletarian autocracy." Writing in *New Masses*, John Kwait advanced the most systematic criticism of Fuller's misplaced confidence in "industrial communism," and particularly in architecture as a "social instrument" and housing reforms as a "substitute for revolution."[371] Kwait's essay was in part spurred by *SHELTER*'s rejection of an essay which he submitted for its May issue. In retaliation, Fuller differentiated his work from the propaganda activity of *New Masses*. He also lambasted the "iconoclastic message" of *New Masses* and Kwait's erroneous rendition of Johnson's

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[366]See Ltr. 5/31/32, N.B. Geddes to M. Levinson; Ltr. 6/1/32 D. Haskell to RBF, both in BFI-CR41
[367]See Ltr. 8/11/32 M. B. Erlich to M. Levinson in BFI-CR41; Ltr. 2/27/33 L. Atwood to RBF in BFI-CR44
[368]Ltr. 11/15/31 J. Kwait to RBF in BFI- CR42.
[369]R. Buckminster Fuller, "Universal Architecture Essay No.2," *SHELTER* May 1932, p.77.
[370]Ibid., p.78.
[371]John Kwait, "Architecture under Capitalism," *New Masses*, Dec. 1932.

International Style as "art-in-revolution movement," rather than merely as an aesthetic and arbitrary activity.[372]

Kwait agreed with Fuller's observation that housing was impossible under capitalist production; however, he was skeptical of Fuller's prognosis. Maintaining that conflicts of class-interests could only be resolved in political revolution, Kwait attacked Fuller's silence on the question of control of the new industry:

> For how can one suppose that a new device for manufacturing cheaper houses, controlled by corporations, which are by their very nature, party to overproduction, competition, wage-slashing, unemployment, speculations will by itself work any appreciable change on the structure of capitalist society?[373]

Kwait's charges echoed Frederick Engels' earlier analysis, in *The Housing Question*, on the state of housing in industrial societies which attacked the Proudhonist strategies of social reform through housing. Kwait concluded that the "automatic purification by technique" of SSA and *SHELTER*, that giving priority to and maintaining the sanctity of techniques, bellied their complicity with capitalism. Fuller's strategy, Kwait continued, had no intention to "accelerate the decay of capitalism, and (had) as the basis of its social philosophy an assumption of evolution and the good-will of capitalism."[374] Though "humanitarian," SSA was neither a radical nor a progressive group; rather, it was "an ineffectual parasitic cheerleader to boom the building industry." The dependence of Fuller's "liberal architecture" on the existing structure and interests of finance and industry for action, Kwait argued, was a "reactionary tendency." Kwait also suggested that the mysticism of Fuller, particularly in the "oracular, telegraphic style, with a sort of stream of conscious flow of ideas," made him and his organization, the SSA, potentially "the first allies of Fascism." For instance, referring to Fuller's confessed "faith in the progressive intellectual revelations of the truth of unity and truth of the eternal now," Kwait scoffed:

> That might have been said by a Hindu adept to a ladies' club for the promotion of panpsychic mysteries. That it should appear in the manifesto of a group of fifty 'radical' technicians is *a sign of the credulity and helplessness of a professional group in America, which can rally to make a leader who announces these rhythmic truths as part of a social program* [375] (Itl., my emphasis).

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[372]R.B. Fuller, "Our Intimate Journal of Summer Events," p.16.

[373]John Kwait, "Architecture under Capitalism," *New Masses*, Dec. 1932, p.10.

[374]Ibid., p.10.

[375]Ibid., p.11.

Fuller's project, Kwait concluded, was a "professional fallacy" which exaggerated housing as a social leverage. Kwait's criticism identified two significant blind spots in SSA, vis-a-vis the implicit political philosophy of Fuller's project. Firstly, SSA had confused egalitarianism in consumption with social arrangement of technology; the latter, remaining, Kwait argued, as a vehicle of class interests and was in itself a means of exploitation. The crucial questions on the ownership of the means of production and class relationships remain untouched by SSA's strategy. Thus, Kwait concluded that the SSA was

> a confused liberal group of architects, who are still tied to the ideas of their masters. Though opposed to aestheticism in architecture, they remain bohemian and arty in their sentimental view of technology and social mission of architecture.
> ... The technicians who offer their brains to capitalism are offering a commodity which may be bought or cast aside like any other goods.
> ... The capitalist honors techniques when it brings him profits; but the technician himself is only his tool. The technicians have power to reorganize society only as members of a solid working class movement. For a group of architects to trust technology as an automatic principle of social evolution is to commit themselves to the exiting rulers of industry and to support the status quo. How clearly (SSA) concludes that the revolution has already taken place! It is the reduction to absurdity of the whole position of the SSA.[376]

Secondly, Kwait argued that SSA falsely identified "money-grubbing" as the primary cause of social problems. In doing so, it reaffirmed the "Americanly(sic) preferred evolution" as the method of social change, or in Fuller's phrase, "not (to) fight forces, but (to) use them."[377] Though not identifying the basis of Fuller's view in the ideological thrust of American exceptionalism as such, Kwait nevertheless explained how it annulled the radical and political responsibilities in repudiating outmoded customs or institutions. Thus, behind the SSA's "smoke-screen of 'social service'" there remained a half-repentant industry.[378]

However, the significance of *SHELTER* and SSA lie beyond their technological boosterism, their fantastic tales of national-industrial conspiracy and the caustic attacks on General Houses and all the corporate industrial alliances that supported it. Fuller's Dymaxion House project, beyond its emblematic image of technology, also left behind a trail of theoretical discourses on American modern architecture. At one level, they continued to shape the direction and conduct of Fuller's subsequent strategies on the industrialized house. At another level, they articulated generally home-grown views towards the incursions of European ideas about modernism and modernity. In the context of a historiography of modern American architecture, *SHELTER* remains singularly significant because it contrasted two emerging trends in modernist

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[376]Ibid., p.12.
[377]Ibid.

discourse in architecture. In form, it embraced a "scientific" discursive tradition over literary style since Fuller believed that the "scientific demonstration and reference" would supplant other existing knowledge systems. The exemplar of Fuller's approach was probably pivotal in light of the growing fundamental editorial changes then happening in several major architectural publications.[379]

1.3. DDU: A return to the Repro-shelter Project (1940-46)

Fuller's activities in SSA and *SHELTER* brought him to full public view. Because of his activism, Clare Luce Booth at *Vanity Fair* nominated him to its "Hall of Fame" as a "tract-writing leader of the movement to change housing into a modern industry."[380] However, from 1933 to 1941, Fuller's 4D-Dymaxion repro-shelter project was momentarily shelved. During that period, Fuller organized, with the support of several venture capitalists, the Dymaxion Corporation in Bridgeport-Connecticut (1933-35) to prototype a stunning and novel three-wheel all-terrain transport unit, the Dymaxion Transportation Unit (DTU). Strapped by a wide-ranging set of technical issues and presentational problems, not unlike the Dymaxion House, the project was abandoned in 1935. For the next six years, Fuller secured gainly employment with Phelps Dodge Corporation and *Fortune* magazine.

At Phelps Dodge Corporation (1935-38), he assumed a sundry of research responsibilities. These included his study of the deployment of various metals that proved to be significant to the strategic positioning of the corporation and the planning of its metallurgical research. Fuller also finally prototyped his one-piece bathroom, a project he had envisioned since his abortive works with John B. Pierce Foundation. However, this stunning domestication of metal-forming technology for a lowly use, also proved infeasible and unpractical despite its hyper-functionality and practicality.

Between 1938 and 1940, Fuller took refuge at *Fortune* magazine as its technical consultant. At *Fortune*, he effectively displayed his previously unnoticed brilliance in charting

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[378]Ibid.

[379]Pai Hyungmin's "From the Portfolio to the Diagram: Architectural Discourse and Transformation of the Discipline of Architecture in America, 1918-1943 provides a good background to the transformation of American architectural media after the 1929 crash (pp.107-131). Of interest is the rationalist project of the Architectural Record's "Technical News and Research Department" under the tutelage of Lawrence Kocher with the assistance of Knud Lönberg-Holm, D. Haskell, T. Larson & R. Davison - all of whom were actively involved with Fuller in some capacity during this period.

[380]See "Hall of Fame," *Vanity Fair*, December 1932.

skills and industrial analysis which he had developed since Phelps Dodge. However, during this period, the prospect of reviving the repro-shelter project was not far from his mind. For example, under the auspices of *Fortune-LIFE*, Fuller advanced and organized a public forum, "Conference of House Building Techniques" at Yale University. He also tried, during this forum, to display and to publicize the Phelps Dodge bathroom to the building professions and housing authorities.

In tandem with his research and journalistic appointment at *Fortune*, Fuller published a collection of aphoristic essays, enmassed over the years, in the book, *Nine Chains to the Moon*. With its publication in 1938, Fuller embarked on a more concerted effort to account for the genesis of his artifacts, neatly contained under the rubric of a neologism that he increasingly identified as his: Dymaxion. He also supported several alternative schools in New York and contributed to their curriculum. These included the Federation Technical School (N.Y.) sponsored by Federation of architects and engineers; and the Design Laboratory/Laboratory School of Industrial Design in New York, also known as the "Poor Man's School."

Between 1940 and 1942, Fuller worked in the state bureaucracy in Washington D.C., ending with his highest appointment as head mechanical engineer at the Board of Economic Warfare (BEW, later Foreign Economic Warfare, FEA) in 1942. In this position, he actively espoused, among many industrial reforms, strategies for converting American industrial productivity to its housing needs and for post-war Europe. However, his concerns for housing exceeded national security issues. He even proposed, in a pre-Cold War tone, that American industries should participate actively in the re-housing of Europe, particularly Russia, to stem the tide of communism. From Washington D.C., and in between what he characterized as extra-curricular time, Fuller sought new opportunities and patronage that would advance his repro-shelter project.

The efforts during this period were to weave the repro-shelter into a larger complex. At one level, they advanced and publicized his enterprise. These activities, along with the passage of time, made the prospects of his fantastic projects less daunting. On another level, these activities allowed Fuller to incrementally prototype components and ancillary paraphernalia to support the repro-shelter as an organic industrial undertaking. Collectively, these activities broadened his undaunted beliefs that a new type of industry, centered on housing, would emerge to forge a new society and simultaneously displace all the instruments of politics. The opportunity to revivify, in full scale, the abandoned repro-shelter project arose in 1941. By this time, Fuller had sowed the seeds for collaboration with Butler Manufacturing-Kansas City. The project, a stunning "make-do" artifice in the history of architecture is the Dymaxion Dwelling Unit (DDU) project [Fig.1.11].

1.3.1. The Context and Emergence of DDU

The DDU or the Butler-Dymaxion marked a significant turning point in Fuller's research agenda on shelter. By Fuller's account, it was a "phase" in the evolution of the Dymaxion House.[381] Fuller also assessed the undertaking as "the first actual mass production housing set-up."[382] Like its predecessor, the 4D-Dymaxion House, the beginnings of DDU were equally legendary in the biographical accounts of Fuller.

Passing through Hannibal, Missouri in the lazy summer of 1941, Fuller recounted that the sight of the ubiquitous "bins of delight" in the Prairie wheat fields. These grain-bins immediately fired up his imagination to adapt them as his "second Dymaxion"[383] [Fig.1.12]. The writer Christopher Morley, a confidant and patron of his first book, *Nine Chains to the Moon* (1938) had accompanied Fuller on this momentous trip. Moved by Fuller's enthusiasm, Morley supported the latter's impulse for "the house of the future." Using proceeds from the sales of his successful novel, *Kitty Foyle*, Morley paid for Fuller's exploratory trip to Butler Manufacturing Company, the manufacturers of the galvanized steel grain-bins. There, in Wichita-Kansas, Fuller persuaded Butler to undertake this unusual re-adaptation of their proprietary farm contraption into a dwelling.

1.3.2. The Big Picture from Washington DC

Prior to and during the DDU-undertaking, Fuller was attached as a Special Assistant to the Deputy Director of the Foreign Economic Administration (FEA), Washington D.C. From this privileged position in war-time bureaucracy, Fuller was keenly aware of mounting public pressure on the State to redress the housing situation of defense workers. For this reason, Fuller had to carefully steer his interests lest they be misread as opportunistic, even if the conditions seemed ripe to realize his "second" Dymaxion house. To the Coordinator of Division of Defense Housing, Fuller's project was known as "Dymaxion Deployment Unit" (ca. Feb. 1941); to his patent lawyer, "Dymaxion House Unit," elsewhere as "Dymaxion Round House" and "Dymaxion

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[381] R. Buckminster Fuller and Louis Morley Cochrane, "A Sense of Significance," p.189.
[382] Ltr. 5/20/41 RBF to C.F. Palmer (Defense Housing Coordinator) in BFI-Hev18.
[383] R. Buckminster Fuller and Louis Morley Cochrane, "A Sense of Significance," pp.159.

Emergency House" (ca. July 1941). These name were carefully used where confidentiality mattered, or specifically chosen to the directed client.

In the war years around November 1940, while perusing the housing statistics and projecting from the implications of these figures, Fuller became convinced that there were two potential markets for his proposed industrialized shelter. One, immediately used as "defense housing," was for workers who were mobilized in increasing numbers into aircraft and war industries to augment the Allies' war efforts in Europe.[384] The other area, not in the far distance, was for replacement housing in the resettlement and protection of the affected civil population in war-torn Europe. In these ways, the DDU like his early 4D-Dymaxion project was presented as a panacea for social woes; while the latter emerged from the economic Depression, the former was exacerbated by war. The housing situation for defense workers was generally viewed as hampering the American war effort. Eleanor Roosevelt, the First Lady, herself proclaimed that "in the long run, all housing (was) defense housing."[385] DDU, which Fuller characterized as "emergence by emergencies," would offer immediate opportunity to advance his repro-shelter project after a long hiatus.

Between November 1940 and February 1941, while still in the employment of FEA, Fuller managed to line up the interests of Robert Colgate, an investment banker from New York to finance the prototyping of DDU, and Victor Norquist of Butler to undertake the conversion project. The cost was minimal, given that Butler used only existing dies and required no retooling. Shortly thereafter, Fuller's entrepreneurial hunch was affirmed by official prognosis on the urgency of the defense housing shortage.[386] At this juncture, the war in Europe appeared very far away from the American shores.

1.3.3. Defense Housing and the Professional Architectural Community

To give DDU its public profile, Fuller simultaneously enlisted the help of Edward Durrell Stone and several New York-based architects as critics. Most noteworthy in the list was Ruth Goodhue, publisher of *The Architectural Forum*, who served as head of a steering committee for

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[384] For the scope and effect of the mobilization, see Joel Davidson & Donald Albrecht, (eds.) "Building for War, Preparing for Peace: World War II and the Military Industrial Complex" in *World War II and the American Dream* (Cambridge, MA: The MIT Press, 1995). Albrecht documented that from the initial quarter million people, eight million were finally involved in three areas of focus, namely aerospace industry, government-owned arms industry, defence-academic cooperatives.

[385] "Let Them Eat Summer Resorts," *TIME*, 3 Feb. 1941.

the project, and the architect, Walter Sanders, who provided the interior design.[387] According to plan, *The Architectural Forum* and *Fortune* would feature the Dymaxion-Butler project in their respective March 1941 issues.[388] After four months of work at Butler, the DDU was ready. With its public display at Haynes Point in Washington, in July 1941, Fuller was cited in *The Architectural Forum* as its "Man of the Month" for his bold solution to the issue of the defense housing market.[389]

Despite the initial indications of tussle over the over the issue of "patent proprietorship," Fuller was able to forgo this concern given the "superior asset" that both names, Dymaxion and Butler, produced in the public mind.[390] Thus, he recommended the filing of an omnibus claim to include himself, Norquist and Butler. The omnibus claims were based on the examination of prior arts in wall construction; construction of the hip roof joints; I-beam floor construction.[391]

Fuller's iconoclasm aside, *The Architectural Forum* variously characterized him as a "prophet of civilization," "arch-theorist of housing" and a "genius in a business suit." Though not an architect, *The Architectural Forum* clearly counted Fuller as one of its supporter for tactical reasons.[392] The issue of rapid housing for defense workers was a national concern. It directly engendered concerns over the role, status, and identity of the architect with respect to the war efforts and the implication of the eventual post-war situation on professional activities.

The Architectural Forum predicted that building in general, and industrialized building in particular, would play "major role of cushioning" the aftermath of the war" by resolving extant social, political and economic dislocations. The urgency of the project opportuned the enlistment of methods of factory-prefabrication long resisted by architects. Fuller himself enumerated the advantages of his DDU to account for why it should get effective priority to manufacture the house for public sale: namely that it had proven to meet "overall economy and efficiency in National Defense viewpoint" in terms of weight ratios, man hour production in field and factory

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[386]Ltr. 2/5/41 C.F. Palmer (Coordinator, Division of Defense Housing) to RBF in BFI-CR80; and "Let them eat summer resorts," *TIME*, 3 Feb. 1941, p.59.

[387]Ltr. 1/14/41 RBF to Edward D. Stone in BFI-CR79. The credibility of Fuller's proposal was buoyed by an earlier feature, "The Mechanical Wing," created for the "Design Decade" feature in *The Architectural Forum* (Oct. 1940). The contraption consisted of an A-frame that is detachable to be used for luggage, fuel or water carrier; or as a crane for manipulating heavy objects.

[388]Telegram (transcript) 2/6/41 RBF to Robert Colgate in BFI-CR80.

[389]*Architectural Forum*, July 1941.

[390]Telegram (transcript) 2/6/41 RBF to Robert Colgate in BFI-CR80.

[391]See Ltr. 2/8/41 W. Philip Churchill (Fish, Richardson & Neave, N.Y.) to R.B. Colgate in BFI-CR80.

combined.[393] In brief, it was a tangible strategy to ameliorate the "avoidable waste of technical skills and instruments."

The Architectural Forum also concluded that deployment housing might be one of many solutions for the aggravated situations of cities, towns and housing in the post-war years. Among the post-war patterns identified by *Forum* were a broad rational standardization of building and planning, integration and coordination of building operations, and the development of a "new favorable concept of Building." This patterns would expose the entire building process to intensive, broadminded research, while recognizing technological advances that provided lower cost & more flexible buildings and redefined the relations of the building profession with Government.[394]

The success of Fuller's DDU, as an exemplar of "prefabricated house," would validate future participation of architects in this project. Further, the success of Fuller's DDU would also cushion public criticism against architectural practices as hoarding critical war materials for non-defense housing.[395] At worst, its failure would lay to rest criticisms against prefabrication, or satisfy the curiosities and desires that the discourse on prefabrication engendered. *The Architectural Forum* was sufficiently persuaded by the technical feasibility of DDU to stake its reputation in endorsing it as "100% 'demountable', (costing) less than $3000." This was a response to an open challenge by John M. Carmody, Federal Works Agency's mogul of defense construction, for the architectural fraternity to find a viable design solution to the problem of defense housing.

Between August and December 1941, the Battle of Britain and the Pearl Harbor event changed the fate of the DDU and its perception in public eyes. The possibility of a home-front war became real, and the national control of strategic war materials such as steel, the primary constituent of the DDU, became more focused and urgent.

The potential significance of the DDU as a tactical ordnance was raised by the strategy of air warfare, then enacted in the Battle of Britain. With the intensification of air warfare, the definition of fronts became increasingly problematic. Particularly, with growing parity in air

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392 The editorial response (probably Douglas Haskell's) to the criticisms of the DDU project is indicative of the scope of this support (See "Letters (to Bell Knapp)," *The Architectural Forum*, July 1941, p.22).

393 Ltr. 5/20/41 RBF to C.F. Palmer (Defense Housing Coordinator), in BFI-HEv18.

394 "Post-War Pattern," *The Architectural Forum*, May 1941, p.x.

power, home-fronts graduated into the new battle-fronts. In this way, civil defense and population deployments were viewed as new offensive strategies. Air warfare annulled obstacles of physical boundaries, making even the suburb fair game in the spoils of war. Further, the air warfare demanded new requirements of fleetness and quick replaceability in ground forces. The qualities of portability and ease in assembly advantaged the DDU as an effective tactical ordnance for speedy replacement of affected air-bases, military installations or the redeployment of new ones. The British Forces, air rather than army, made orders of the DDU, partly to replace and rebuild affected military installations; hence Fuller's diagram on ballistics and the Butler's illustration of DDU on new air-field installations [Fig.1.13]. While Fuller conceived DDU initially as an emergency housing for civilian use, the new war scenarios cultivated niches for its deployment in defensive and retaliatory uses.

1.3.4. DDU at MoMA

The transformation in meaning of the DDU project, engendered by the new war priorities, was partly demonstrated in October 1941. Under the auspices of MoMA's Department of Architecture and Industrial Design, DDU opened as the "first" modern house exhibit in its new sculptural garden. In all likelihood, Edward Durell Stone (then Philip Goodwin's co-designer for the MoMA) played some part in persuading MoMA to host the DDU Exhibit. In the hallowed grounds of MoMA, the DDU was double-billed in the museum's press release as "portable defense housing and bomb shelter"[396] [Fig.1.15]. This characterization signaled an initial phase of DDU as an ordnance of war, albeit a defensive one. The dawn of American direct entry into the war placed strict controls over the deployment of tactical metals for non-military uses. This effectively dashed the plans of Dymaxion-Butler to use the DDU as "defense housing" or civilian housing.

The war also stirred MoMA into examining its patriotic duty and its self-search to link art, beyond mere appreciation, to life. This was probably the impetus for Alfred Barr, then MoMA's Director, to consider DDU as the first "house" exhibit during the war. The DDU gave the museum some leeway to re-evaluate its role and that of art in times of war.[397] It appeared to answer, in part, Barr's probing questions about the basis for reprogramming of MoMA activities:

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[395]See "How total is the blackout for non-defense building?" *The Architectural Forum*, November 1941 and "Defense Housing," *The Architectural Forum*, July 1941, p.22.

[396]MoMA Press release, dated 10/10/41. See also Geoffrey Hellman's "Dymaxion Bomb Shelter," *New Yorker*, 4 October 1941.

[397]The DDU-Exhibit was originally scheduled for July 1941 (See MoMA Bulletin, September 1941).

> What good is art in a time of war? What good are art museums during a national emergency? Why maintain our cultural interests and activities when air hums with bombers and news of battle?[398]

Philip Johnson who had been the Director of MoMA-Department of Architecture was on a leave of absence. Because of his long standing feud with Fuller over *SHELTER* and his anti-International Style polemics, Johnson would have probably opposed the appointment of the DDU. Nevertheless, for Fuller, the opportunity to feature the DDU at MoMA, transformed its status beyond that of a mere contraption, and thus set a stage for introducing to the public, the radical shape of post-war civilian housing.

In a recent revisionist history of Fuller's DDU, Beatrice Colomina pointed out that MoMA's retrospective history, "The Museum of Modern Art: The History and the Collection" (1984), failed to attribute Fuller's house as the "first architectural structure built for public exhibition.[399] Instead, that credit was assigned to the 1949 Marcel Breuer House. Fuller was not a new-comer to MoMA; and had previously exhibited his model of Dymaxion House at MoMA in 1939, as part of the museum's tenth anniversary exhibition.

One could either interpret this discrepancy in MoMA's self-history as selective amnesia or that MoMA did not deem the DDU as a "house." Even if the DDU was described as a "housing" solution, the museum probably viewed the DDU as a stop-gap and a reluctant exhibit. Referring to the MoMA Garden House Exhibition series in his memoirs, Peter Blake, one of MoMA's former insiders, recounted that Fuller's design "would have (been) accused of being (as usual) out of touch with reality."[400] Blake explained that it was out of "political and practical expediency" that the "fantasies of a Buckminster Fuller" had to give way to "the eminently realistic solutions of a Marcel Breuer."[401]

The DDU was clearly a difficult object, if considered under a narrow and elitist definition of architecture as art. Alfred Barr, the trustees of the museum and subsequent curators of MoMA probably faced this dilemma. Even Colomina, who attempted to reinstate the DDU in MoMA's

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398 Quoted in B. Colomina, "DDU at MoMA," *ANY17*, Architecture-New York, p.17.50.
399 Ibid.
400 Peter Blake, *No Place Like Utopia (Modern Architecture and the Company we kept)*, N.Y.: Alfred A. Knopf, 1993, p.136.
401 Ibid., p.167.

history, did so by canonizing the DDU as a category of Marcel Duchamp's "ready-mades." [402] In 1949, Lewis Mumford, the architectural historian and critic, writing a sympathetic account of Breuer House as a preview of things to come, also reflected on the DDU. From his humanist angle, Mumford explained that in contrast to Fuller's DDU, the Breuer House was more than a "cozy bit of prefabricated domesticity":

> The whole concept of what is modern has been changing. A few years ago, this same back yard contained the latest version of Buckminster Fuller's Dymaxion House (sic), conceived in single-minded fashion, strictly as a machine for living, with the accent on the mechanical equipment, the possibility of mass production, the notions of portability and self-sufficiency. The Breuer house does not carry on this Jules Verne-Buck Rogers idea. Instead of being more standardized, more mechanical, more scientific, brittle and metallic, more free of any kind of sentiment, it returns very definitely to the humanist tradition of William Morris and HH Richardson, with which modern movement in domestic building began almost a century ago.[403]

1.3.5. The DDU Project - Opportunism, Necessity or Complicity?

Fuller had assumed that his deployment unit, as an exemplar of prefabricated house for defense workers, would add to the recent major improvements to the building process to address the aggravated housing situation.[404] However, DDU did not fulfill its primary objective as emergency civilian shelter; rather, it was finally installed as "steel igloos" for the Air & Signal Corps in Africa and for other tactical purposes [Fig.1.14a]. Moreover, in a prudent conversion, the sixth model of the DDU project (ca. April'42), was offered as suitable for defense, evacuation dwellings, army barracks, guest house etc in MoMA Exhibition, October 1941.

The conversion of DDU into a military ordnance was more than a chanced, ad-hoc readaptation of a homely bin that Fuller had portrayed. The DDU was shaped as much by the "flyable" shelter agenda of the 4D-Dymaxion project as it was informed by Fuller's intimate knowledge of the new military logistics. For example, David Cort, one of Fuller's associates at

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402 I have separately examined Colomina's effort in "Fuller's DDU project (1941-44)," (unpubl. MS. presented at the Portable Architecture Conference, University of Liverpool, May 1997). I have argued that the DDU was purposeful, and that Fuller had taken extraneous measures to establish his own markings on the Butler bin in order to claim a whole new patent-object altogether. First, the pragmatic business tussle over the issues of patent and ownership of rights to parts and production processes of the DDU; second, Fuller use of the qualifier "Dymaxion" to demarcate the object was a continued search was for a unifying industrial trade-mark which is substantially, different from Duchamp's notational inscription and serialization. Lastly, in choosing the bin, Fuller saw a landscape of old-style decentralized farming which were remnants of the early pioneering spirit, set against the growing centralized corporate-industrial type farming of the concrete granary-silo complex. Thus, while Le Corbusier and Walter Gropius saw the new "monument," in the latter, Fuller, true to his productivist sensibilities offered the former as "instrument." Under these circumstances, Colomina's criteria of "inscription" and "rendezvous" which she extrapolated from Duchamp to qualify the DDU as a "ready-made" are highly problematic.

403 Lewis Mumford, "Design for Living" (The Skyline), *The New Yorker*, 25 June 1949, p.72.

Fortune reported that in 1941, prior to Pearl Harbor, he and Fuller were part of a secret study group in Washington D.C. "discussing how the United States should win the war."[405] Among one of Fuller's strategies was a new way to fight on the Russian front. The strategy entailed moving freight across the polar regions using "huge towed gliders" where "at the front, (these gliders) could be converted into logistical warehouses and as the front moved forward, towed ahead to new positions."[406]

In an attempt to redirect the destiny of the DDU, Fuller tried to ascertain the viability of his structural adaptation to the construction of air base facilities. Fuller sounded out Hal Watson, a family friend who was then a young career Air Corp Intelligence officer stationed at Wrights Field in Dayton, Ohio. Watson provided, rather nonchalantly, some of the working premises of the Air Corps which would constitute the pragmatic guidelines for Fuller's DDU and his subsequent projects:

> Air Corps units are constantly on the move from one place to another, one of their prime requisites for all their equipment being their agility to air transportation. You can imagine two of the questions they will ask you will be, 'How much does it weigh?' and 'Can we transport it by air?' In view of the fact that they have been interested for some time in mobile shelters, and from all reports, they have not found a suitable type to date.[407]

Seizing upon the obvious coincidence of his shelter research program and the logistic needs of the Air Corps, Fuller drafted a letter, presumably to interested military authorities, in which he described features of his "Dymaxion round-house" that would be "of great importance at air base."[408] These qualities, he described, included being fireproof, insulated & termite-proof, demountable, concussion-resistant, bullet-resistant, mass-producible, camouflageable, easily-ventilated and heated, and economical in material and cost. Primarily, Fuller argued that despite its apparent setback, namely the use of steel sheets, a war-controlled material, the DDU design compensated by gains in savings of other more significant war materials:

> It is my opinion that in building our air bases, Dymaxion Houses could be erected on the job and thereby conserving rubber, gasoline, etc. in transportation. After the air base is

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[404]See issues raised in this context in James Y. Newton, "Prefabricated Housing Brings $150,000,000 Headache," *The Evening Star*, 3 April 1942.

[405]D. Cort, *The Sin of Henry R. Luce*, p.290.

[406]Ibid.

[407]Ltr 4/17/42 Capt. H.E. Watson to RBF in BFI-CR 86.

[408]Ltr ca. April 1941 RBF to Anon. in BFI-CR86.

completed they could be used for housing the air base personnel ... After the War, the re-use of these houses by underprivileged civilian population is an important consideration.[409]

In other words, not only was DDU a significant tactical object, it was also a strategic advantage in the larger picture of the war, as far as the issue of saving on "strategic materials" was concerned. Fuller also suggested later, in a secret document prepared for the O.S.S., that "by proper design there is ample supply of every material for every problem in the whole economy."[410] Therefore, the DDU-project was neither, as historian Martin Pawley claimed, a "New Deal effort to reactivate the agricultural life in the Mid-west" nor was it innocently "side-tracked" for military use by World War II.[411] Rather, a project that started as an ad-hoc adaptation was quickly realigned for emerging opportunities engendered by the war. This observation is offered neither to suggest that Fuller was driven by militarist fervor nor by the commercial opportunism of war; rather, the war created an opportunity and legitimacy to field-test his contraption as a logistics ordnance.

In public discourses since the thirties, of course, Fuller demonstrated a general ambivalence towards wars. On the one hand, war was the highest form of waste, contrary to his technocratic sensibility; on the other, it was also a regenerative and creative moment of "emergence by emergency." Cort characterized this latter position as Fuller's "realistic liberalism."[412] Fuller explained:

War emergency forced industrial realm to refine its arts and to step up its production of heretofore extravagantly scarce materials to meet the strict specifications of air technology.[413]

In seeing war as an inevitable, evolutionary condition to refine the techniques of society to a higher level, Fuller's philosophy fundamentally continued a lineage of American middle-class liberal view on war, like those of his hero, Henry Ford.[414]

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409 Ibid. As early as January 1941, Fuller was already seeking waiver on steel from C.F. Palmer, the Chief Coordinator of The Division of Defense Housing Coordination, who was overseeing the issues of strategic building material.

410 D. Cort & R. Buckminster Fuller, "Energy focused to Win" [also as "Foot-pound Hitting Power of an Air-borne Economy"], unpubl. MS. ca. May 1942 in BFI, p.7.

411 K. Simon & K. Goodman, Transcript of Interview with Martin Pawley (for a PBS documentary "Thinking Out loud"), New York, ca. 1996, p.14.

412 D. Cort, *The Sin of Henry R. Luce*, p.15.

413 Ltr. 7/17/44 RBF to Virginia Thorndike (J. Walter Thompson, N.Y.) in BFI-HEv4.

414 See especially H. Ford & S. Crowther's "The Wealth of Nations" (Ch. XXIII) in *Today and Tomorrow*, pp.250ff.; also, H. Ford's *My Philosophy of Industry [An authorized interview by Fay Leone Faurote]*, N.Y.: Coward-McCann Inc., 1929, p.68.

1.3.5.1. Early Military Contraptions Unveiled, ca. 1941

Fuller's design contribution to devices of war was neither confined to DDU alone nor was this effort, new. At the break of World War II in Europe, Fuller sought the support of Governor Charles Edison of the State of New Jersey, and a personal friend from his DTU-Bridgeport days, to recommend his return to active service. Fuller confessed that he would be ineffective in "approaching the (Navy) Department cold." With the completion of tooling process for the DDU-project and its first demonstration, Fuller explained that he was ready to advance a new series of projects that would be directly beneficial to the Navy:

> I have several technical devices which might, I believe be developed into important weapons, fairly easy to produce in mass. How to get them into production swiftly and secretly is the problem. I believe that it could best be done within the structure of the Navy Department ... To do a good job, I will need some real authority, materials and machine work, and considerable latitude and patience on the part of the Department.[415]

The details of those "important weapons" and his covert activities were divulged separately in a subsequent letter to a Col. Charles B Hazeltine of the Continental Army Command, Fort Monroe Virginia.[416] These included, Fuller explained, the conversion of his DTU, a three-wheeled multi-terrain and media vehicle, for the Army:

> (I)t has never been publicly reported, that I did develop the drawings and models for two special Dymaxion 4-D Transports for the Army in 1941. You may find them in the archives of the Army War College in Washington DC. One of these was of about the same size as the Jeep, very lightly armored, in which the three wheels were independently powered with vertical splined drive. The crew of three could ride horizontally to reduce the gut jolting effects of cross field belly-bouncing. The vertical struts for each of the wheels consisted of aircraft Aerol mechanisms, as well as hydraulic telescoping whereby these pneumatic, hydraulic sprung legs could be lengthened to give clearance over high obstacles. It could therefore 'crab' or rotate in place or zig-zag forwardly or backwardly while rising and lowering upon its 'legs' in transit. It would be a difficult target, especially if there were many of them so 'milling about'. The War College studied this item and pronounced it desirable for the African campaign, but too late to meet the production scheduling[417] (underlined word by Fuller).

Another DTU-contraption called the "The Crocodile" was developed, though not submitted, for use in the Pacific islands and Japan:

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[415] Ltr. 1/30/42 RBF to Charles Edison (Gov., State of New Jersey) in BFI-Hev18.

[416] Fuller was responding Hazeltine's interest in the cross-country mobile and lighter vehicles/tanks. See Ltr. 8/24/55 Charles B. Hazeltine (Hdqrs., Continental Army Command, Fort Monroe-V.I.) to RBF in BFI-CR166.

[417] Ltr. 8/31/55 RBF to Col. C.B. Hazeltine in BFI-CR166.

It was designed for one man with an orientable gun mounted on his 'Crocodile' back. The Crocodile was an 'armored' man operating as a trailer with articulating joints pulled by a miniature hand-guided caterpillar (as though the front sled on a bobsled were a miniature 'tank'). The function of the caterpillar was that of a lightweight mechanism giving the foot-soldier a mechanical belly-bump armored box (will full-length cover) easy to get in and out of and to have along with him as he might have a bicycle (but to far greater advantage) giving him extraordinarily low frontal area of profile and strongly armored face. Vision is provided by a periscope mounted on the back of his prone head. This device could scrabble-claw-climb over vertical embankments and fences, with hydra-pneumatic landing gear to arrest its precipitous head-long or roll-over descents. The 'Crocodile' has fore and aft and twartships external tubular-metal rolling hoops.
Best of all now, I suggest to you the serious, full-scale experimentation with my jet and 'stilts', which strapped on to a properly clothed individual would, with great fuel economy, permit individual grasshopper zooming maneuvers.[418]

1.3.6. The Looming Post-war Market, National Security & Boosterism of American Design

By late November 1943, with the imminent close of the war and the lifting of the prohibitions on strategic materials, Fuller was convinced that the repro-shelter industry was ready to be engaged directly. He believed that
European recycled metal inventory, particularly the war-scrapped European aluminum stocks, could be converted into emergency dwelling shells, given that his DDU-technology was "reasonably 'bugless.'"[419] "Seventeen years of customarily tortuous original development," Fuller confided to a captain of an aeronautical industry, had finally borne fruits.[420] He had successfully secured proprietary patents on the DDU project and the direct experience he gained at Butler on the mass-production of frame and shell, appeared on the brink of a breakthrough.[421]

Fuller now appeared less eager, however, to advance his project in the market restricted by the requirements Army-Air Corp or Butler. Nevertheless, he recognized their significant influences on his pioneering work; even describing the patronage of the former positively:

> Professional generals are engineers of total mobility. Military science is only that special phase of technology which must always be invoked in due course *to clean up cumulative inefficiency imposed by inertia (of political economy).* They clean up by instituting the new technical efficiencies which peacetime experts in compromise either failed to recognize, or, recognizing superficially, ailed to be convincing of to their business patrons.

418Ibid.

419Ltr. 11/30/43 RBF to Dr. Louis Marlio (The Brookings Institution) in BFI-HEv4.

420See 12-page solicitory, Ltr. 12/10/43 RBF to W.J. McGoldrick (VP, Aeronautical Engineering, Minneapolis Honeywell Regular Co.), in BFI-Hev4, in which Fuller offered a "technical history of emergency of (his) scientific dwelling machine."

421The two patents filed by Fuller in conjunction with DDU in terms innovations in sheet and frame, were granted on 3/7/44 (U.S. Patent #2,343,764) and 6/13/44 (U.S. Patent #2,351,419) respectively.

Professional military men do not institute war. They return to a ruptured world potential peace by direct scientific action. It is at this point that a new rupture is usually allowed to take seed[422] (Itl., my emphasis).

1.4. DDM and Dymaxion Wichita/Fuller House, Post-war Housing (1944-46)

The new challenge after the war, Fuller explained to Kenneth Stowell, editor of *Architectural Record*, was just as critical. The post-war market for factory housing, exemplified by Winston Churchill's announcement of a one-billion dollar project for a one-design emergency "dwelling machine" was waiting to be exploited. Fuller's own analysis, arising from an in-house conference on prefabrication which he conducted at the Foreign Economic Administration (FEA) suggested the threat of the Russians in advancing such a "scientific model" of dwelling.[423] More than an economic threat, Fuller so much proffered "this force" as a Red scarce - which, if successful, "would eliminate the real existence of the American democracy known as the U.S.A."[424] Thus seeking Stowell's editorial support of his repro-shelter project, Fuller explained that the project, more than a personal enterprise, was a matter of national emergency. The technological destiny of the America was on tethers. Hence:

We need your editorial support to see that we, too, prototype a scientific unit demonstrative of American ingenuity.
The natural external shapes of these living machines will be developed with *equally impersonal logic*. It is of the greatest importance that the trade journals and thereafter the press philosophy of our country be articulated in this direction.
Let's try to lift American sights towards making constructive contributions to world affairs consistent with our enormous starting advantage. *In that way alone we may obtain our front row position in world affairs*. Let's get over our inferiority complex about aesthetic and psychological validity of our simple & forthright concept[425] (Itl., my emphasis).

And even as Fuller sounded the alarm from the hallway of war-time government bureaucracy, he was careful to steer the strategy of such a large national undertaking away from sole purview of the State. While he proposed that the effort would require "vast government subsidy," he reiterated that actions and materials "must be provided by private enterprise."[426]

[422] Ltr. 11/2/43 RBF to Alfred C. Bossom (British Building Mission in North America, Washington, D.C.) in BFI-Hev4.
[423] See R. Buckminster Fuller & Cynthia Lacey, "Suitability of US Prefabricated Houses to the European Emergency Needs," 1944 in BFI-HEv11.
[424] Ltr. 2/9/44 RBF to Elmer Davies (Director, Office of War Information) in BFI-HEv4.
[425] Ltr. 3/28/44 RBF to Kenneth Stowell (Editor, *Architectural Record*) in BFI-HEv4.
[426] Ibid.

In August 1944, Fuller found an eager supporter for his project. He was Herman Wolf, a member of the American Socialist Party and an active in the labor movement. Wolf, like Morley did earlier, financed Fuller's trip to Wichita again, but this time to Beech Aircraft. Wolf became impressed with Fuller's ideas about the industrialized house, particularly its prospects in solving labor's problems at the close of the war. In all likelihood, Wolf was also taking the cues from the expressed interests of Walter Reuther, President of United Auto Workers (UAW) and Harvey Brown of the Machinists union. By October, a pre-organization agreement, which Fuller characterized as one between "labor and capital" was drafted, after which the formation of the Dymaxion Dwelling Machines Inc. was announced a month later.[427] Jack Gaty of Beech Aircraft agreed to convert part of its bomber assembly plant to provide factory space, machinery and overhead for the project. Fuller paid for labor and materials in producing the prototype house.

The Dymaxion Dwelling Machine (DDM) was, as the distinction implied, a dwelling rather than a deployment unit. This difference was crucial. With the "emergency" over, Fuller's DDU project, based on the rhetoric of scarcity, was transformed to address the issue of abundance created by the high productivity of the war industries. Whereas Applewhite had suggested that the word "unit" was also used to evoke the "clinical" and to severe any association with the home and hearth, the "dwelling machine" now was a concerted drive for an "industrial technological aesthetic."[428] The moment of this transformation appeared to epitomize what Fuller had confidently prophesied five years earlier, in the tenth-anniversary issue of *Fortune*:

> Almost all the serious problems that now confront U.S. have their origin ... in the achievements of the U.S. They are not problems of poverty, but problems of abundance.[429]

1.4.1. Shaping a New Research agenda – The Separation of Shell and Mechanics

The thrust of DDM research agenda is contained in the "Digest of Proposal" drafted by Fuller, with the assistance of Cynthia Lacey, his colleague at FEA, in spring 1944. It was prepared with a view to advance DDM as a post-war version of the DDU.

The primary significance of Lacey-Fuller's "Digest of Proposal" rested in its attempt to formalize, for the first time, what was tacitly articulated in the DDU; namely, the relationship and the distinction between its "superficial shell architecture" and its mechanics. The technical

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427 See "Pre-Organization Agreement (of) Dymaxion Dwelling Machines, Inc." in BFI-CL-2.
428 Author's Notes of Robert Duchenay's Video-Interview with Ed Applewhite, Washington D.C., ca.1993.
429 "New Era," *TIME*, 5 February 1940, p.46.

advances in the mechanics of services, the digest offered, had reduced the house to a lighter and smaller shell. Further, Fuller estimated that the cost of structure versus mechanics had reduced from 90% to 50% of the total building cost between 1900 and 1934.[430] While the latter received the attention of industry, and was driven by the dynamics of consumer's needs, the former remained relatively unchanged. The aircraft industry, however, encapsulated advances in both realms, prefiguring it as the technology for future "dwelling machines." Fuller enthusiastically assessed the compactness and efficiency of a "surface-combustion equipment" developed for Trans World Airway's plane, which he felt could be assembled into a vertical tubular frame chassis to support his DDM shell.[431] Thus, the Lacey-Fuller's proposal prescribed:

> The dwelling machines begin with skillful grouping on a chassis of all the mechanics necessary to effect a high standard of living ... The mechanical core will be enclosed by a light, reflective shell which has been specifically designed to afford efficient operation of the mechanics it protects.[432]

The rhetoric of separating shell and mechanics was not merely novel. It was carefully hedged by Fuller to ward off potential attack of project as niggardly sensationalism. Secondly, the distinction enabled him to distance his work from panel-box construction, then the publicly perceived exemplar of prefabrication. In prefabrication, Fuller observed:

> The box is primary. It is symbolic of the traditional house. The mechanics and people are accessory and superficial... Prefabricateds(sic) add a thimble-full of industrial techniques in the rendering of their knocked-down sections, but their colonized or inter-nationalized scenic effect still gives the clients that good old permanent feeling.[433]

In contrast, the DDM, like its predecessors, the DDU and Dymaxion, was veering towards the ephemeral. This quality followed from Fuller's teleology of pragmatism. In his teleology, the shelter gets lighter and impermanent because technology moves towards lightness until the eventual dissolution of the shelter. Ultimately, all that remains is an impermanent, industrially fabricated shell. While the 4D-Dymaxion House was premised on a careful integration of the building shell and mechanics; the austere requirements of the defense housing, and his experiences at Butler directed Fuller to concentrate on the shell. Now, even more cognizant of his own research resources and the phenomenal miniaturization of mechanical and electrical service packages, Fuller made a tactical choice to focus on the shell technology. In the

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[430]Ltr. 12/30/43 RBF to Joseph Stevens in BFI-HEv4.

[431]Ltr. 12/14/43 RBF to J.E. Haines (Mgr., Air-conditioning Controls Div., Minneapolis Honeywell Regular Co.) in BFI-HEv4.

[432]Cynthia Lacey & R. Buckminster Fuller, "Digest of Proposal," 8/14/44 in BFI-Hev4 and BFI-CR134.

[433]Ltr. 7/17/44 RBF to V. Thorndike (J. Walter Thompson, N.Y.) in BFI-HEv4/CR134.

geodesic phase of Fuller's work, it will be shown that the integral quality of these two parts, the shell and mechanics, was finally reconstituted in its domical shape.

1.4.2. Peace-time National Security – Labor and Capital

Like many post-war industrialized house projects, the DDM project objectified public and professional enthusiasm with housing as a panacea for post-war socio-economic problems. Fuller so much as suggested that unless an adequate solution was found, a "social lesion" in America would ensue.[434] In his capacity, as Head Mechanical Engineer in the Bureau of Economic Warfare (BEW) Fuller argued for the conversion of certain major areas of the war production ability. In particular, while referring to the suppliers of materials and components parts for the aircraft arts, Fuller argued for their redeployment in a "mass production of appropriate components of a scientific dwelling machine service."[435]

The hype on the industrialized house was attractive, and understandably so. Firstly, in the broadest stroke, the project promised housing employment in America and elsewhere. Secondly, the project seemed to be an effective outlet for over-productivity of war industries, given the scale of its mass market. It would be sufficient to consume the productivity of the aircraft industry and its suppliers. Thirdly, it immediately assured the redeployment of over-skilled labor in the aircraft industries, thereby conserving high-security skills and allayed fears of the attrition of workers. Thus by the end of 1944, less two months into the announcement of the DDM project, Wolf confidently reported that DDM or the "Beech-Dymaxion" postwar job prospects were being realized with a net gain of eight-hundred workers.[436] Fuller similarly alluded to the increased employment at Beech, adding that there were obvious improvements in industrial production and logistic advantages.[437] In reporting these achievements to Walter P. Reuther, Fuller lobbied his influence to persuade Robert P Patterson, the Secretary of War, of urgency of the DDM project as a "military policy."

Though DDM was premised on the realignment of the productive capacity of the aircraft industry for civilian dwelling, its direct implications and significance for national security were not lost to Fuller. Even the opening clauses of the pre-organization agreement of DDM Inc.

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[434]Ltr 12/10/43 RBF to W.J. McGoldrick (VP, Aeronautical Engineering, Minneapolis Honeywell Regular Co.) in BFI-Hev4.
[435]R. B. Fuller, "Ltr of Transmittal," [BEW- Departmental] 1/10/44 in BFI-HEv4.
[436]Ltr. 12/31/44 Herman Wolf (Secretary, DDM Inc.) to Officers DDM Inc. in BFI-CR 104.
[437]Ltr. 2/8/45 RBF to Walter P. Reuther (United Auto Workers) in BFI-CR105.

spoke of the potential stability and advance to democracy that would ensue from the cooperation between capital and labor through the formation of a corporation. The preamble of the agreement reads:

> Whereas, it has become evident to Fuller and the representatives of labor and capital that private enterprise rewarded by profit is essential to the advancement of the standard of living in a democratic society and that there can be full cooperation between labor and capital without detriment to profit...[438]

Fuller recounted the charter of the corporation in this way:

> The purpose of the corporation was to provide through a corporate medium an organization to be managed by labor, capital and science to their collective profit, for the advancement of the standard of living in a democratic society and to demonstrate the advantages in private enterprise of mutual trust and cooperation between labor, capital and science ...[439]

The significance of this was realized with the inauguration of DDM Inc., when Harver W. Brown, the President, International Association of Machinists-AFL, was elected for the first time in the history of the union to serve on the board of a private corporation.

This first prototype DDM began at the end of March 1945 with all the parts for mass production ready in July. However, it was not intended for civilian use. Known as an *AIRBARAC* (aircraft-barracks for war devastated areas), it was one of two pilot model barracks commissioned by the Army-Air Corp [Fig.1.14b-c]. It was meant to be stripped-down version of its eventual "standard" and more luxurious model, containing fifty types of parts instead of five hundred [Fig.1.14d-e]. Though *AIRBARAC* was received favorably by the Army and a production rate of 42,000 units was imagined at one point, the project was canceled after Japanese surrender.[440] Nevertheless, the Armed Forces recognized its "air technical intelligence value(s)." Col. Harold E. Watson enumerated its broad tactical values: it was a ready product to maintain an operational 'stand-by' plants; as an industry it preserved knowledge, skills & labor of aircraft industry, preparing them for "any new emergency"; it revivified a ready market for light metals and synthetics, both over-productions of the war industries; it was potentially supportive of the Air Force's plan for the expansion of the aeronautical industry and conversion of other industries to aircraft production; and finally, it was in line with Robert P. Patterson's quest for a

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438 "Pre-Organization Agreement (of) Dymaxion Dwelling Machines, Inc.," ca. September 1944 in BFI-CL2.

439 Excerpts from Fuller's personal chronology of the DDM-Fuller House project: "Chronological Order of Ideas, Formation and Termination of RBF and Fuller Houses (Wichita)," undated, in BFI-HEv19.

440 See Memo, "Dymaxion Dwelling Machine," 12/17/45, Comdr. K. Lovell (USN) to Chief of the Bureau of Yards and Docks, Navy Department in BFI-HEv16, p.2.

"postwar air supremacy," by supporting the industrial mobilization of another huge aircraft industry.[441]

1.4.3. DDM as Dymaxion Wichita House/Fuller House

At this point, Fuller's DDM faced a marketing dilemma similar to the one he faced previously in the DDU-enterprise. Then, he was torn between extending sale into private industry or soliciting the patronage of governmental agencies like the Federal Works Agency (FWA) of Farm Security Agency (FSA). Robert Colgate, his business partner, offered his reasons for the preferable business strategy:

> (F)rom our point of view it would be much harder to sell the general public than the government as we would have to erect individual houses all over the country instead of mass housing in one location for the government. Also, individual credit would not be as good as government credit.[442]

While the DDU was dependent on the army for its limited order, Fuller now wanted to avoid any public identification with this source of patronage. Likewise, he did not want his "luxurious" DDM to be seen as a replacement for a military barrack. Even the Armed Forces implied that the success of the *AIRBARAC* as a military barrack, would be a "psychological obstacle" for the public, considering its eventual conversion into residential units.[443] This was despite the perception of the DDM as the precision object of the aircraft technology as opposed to its lowly cousin, the grain bin:

> The fabrication of the complete dwelling employs the same hydro-presses, stretch presses, drop hammers, brakes, shear and heat treatment, as well as the standard machine tools presently employed in the fabrication of airplanes.[444]

Partly for these reasons and also because he was convinced that the opportunity of a post-war civilian repro-shelter market was promising and profitable, Fuller re-capitalized the stocks of DDM Inc. into Fuller House Inc. in January 1946. The accompanying name change was also strategic. What appeared to be a reversal of his earlier decision to depersonalize his invention by

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441 See Col. H. E. Watson, Memo, "Dymaxion Dwelling Machine," TSDPL (T-2), 1/7/46 in BFI-Hev16, pp.2-3; also Memo, "Inspection of 'Airbarac'," 10/18/45, Lt. Col. O. O. Price to Deputy Chief, Air Installations Division (Washington D.C.) in BFI-HEv16.

442 Ltr. 5/9/41 R.B. Colgate to RBF in BFI-CR82.

443 Memo, "Dymaxion Dwelling Machine," 12/17/45, Comdr. K. Lovell (USN) to Chief of the Bureau of Yards and Docks, Navy Department in BFI-HEv16, p.2.

444 Memo, "Dymaxion Dwelling Machine," TSDPL (T-2), 1/7/46 in BFI-Hev16, p.1.

using the trade-marks 4D or Dymaxion, however, was purposeful. Fuller House Inc., bearing his name, allowed for a more personal touch to the product. "Fuller House" was intended to appease and reassure the customers, despite their familiarity with consumer household gadgetry, that the factory-produced house was as a personal as the crafted home. After all, the radical and forward-looking aspects of the object were already implicit, given Fuller's track record.

1.4.4. Dymaxion Wichita House - An assessment

However, at the end of war, the labor shortage in the aircraft industry was not as acute as Fuller had envisaged. Besides, the problems of housing shortage were distant from and unrelated to the labor deployment of the aircraft industry. Beech Aircraft quickly returned to private aircraft production. Fuller was straddled with the insurmountable problem of raising ten million dollars for mass production tool-up. Three months into the inception of the Fuller House, in March 1946, Fuller's optimism once again turned into general dismay; and he took the necessary plans, this time, to quit.[445] However, even as he took this drastic step to leave the project, he was already making alternative plans to continue his work elsewhere. He sent his trusted collaborators, Leland Atwood, Ed Applewhite and O'Niel, under a mission, code-named *Amazon Project*, to gauge the interests of leading West Coast aircraft manufacturers, including North American, Douglas, Lockheed & Northrop, Consolidated Vultee and Boeing. From them, Fuller hoped to obtain a "business-like yardstick" by which to gauge Beech bids on the prototyping costs of the Dymaxion Wichita House.[446] However, nothing transpired.

Fuller and his biographers offered many reasons for the demise of the Dymaxion Wichita House, none of which was surprising. Despite his confidence in the sophisticated aircraft technology, he raised the specter of technological time-lag or the gestation period required for such a project. Fuller would continuously evoke this factor of "technological prematurity" throughout the rest of his life.[447] In the end, he would convert this "failure" into a virtue, relegating the whole meaning of the enterprise to a process:

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[445] "Chronological Order of Ideas, Formation, Termination of RBF & Fuller Houses (Wichita)," in BFI-Hev19. See also Ltr. ca. November '46 RBF to E.D. Stone in BFI-Hev19.

[446] See Report, "Amazon Project", 3/29/46 in BFI-CR104.

[447] R.W. Marks, *The Dymaxion World*, p.36.

> Now as far as I am concerned in this whole project, I don't know how many years or centuries man will be getting a real industrialized house, but I myself intend learning all I can about that process, and learning by each opportunity.[448]

In a more fantastic account of the project's failure, it was suggested that Jack Gaty subverted what would otherwise be a successful project. A. Hatch, for example, explained that Gaty's "extreme right-wing views" led him to reject "socialist subsidy" implicit in the DDM project.[449]

It was true that though there was a stripped-down prototype of the DDM, the market version was far from complete. The stock-holders impatient on reaping gains on the project were nevertheless prepared to compromise its design integrity in all aspects.[450] While there was no pervasive resistance to the radical image of his aero-house, the financing of the house was uncertain, given that there were no "traditional" component in the construction. From the consumers' end, the actual siting of each "dwelling machine" was still unsettled since many municipality codes required contractors' participation, which added to the cost of the house. These were the unresolved quandaries in deploying the house on-site, once it left the assembly plant.

It is highly problematic to claim, as Pawley did, that the DDM was "the greatest lost opportunity of the year of post-war building recovery."[451] Similarly, the defense of the project as an idea "too advanced for society in which it was projected" is weak.[452] Public expectations and desires, like those engendered earlier in the Dymaxion House, were products of Fuller's self-hype and orchestration. For example, Fuller claimed that there were unsolicited orders for 37,000 units which were worth $3/4 billion.[453] Most of the problems, one could suggest even nominally, should have been readily anticipated. Only this time around, the promotional activities were sleeker and assumed a scale and presence that was nationally unprecedented. Even the host city Wichita joined in the exaltation of the project.[454]

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[448] "Industrialized House Forum," Proceeding of Course Conference, School of Architecture & Planning -MIT, Jan. 6-7, 1950, p.66.

[449] A. Hatch, *At Home in the Universe*, p.174.

[450] J. Baldwin, *Bucky Works, Buckminster Fuller's Ideas for Today*, N.Y.: John Wiley, 1996, p.52 (Henceforth as *Bucky Works*). See also R.W. Marks, *The Dymaxion World*, p.37.

[451] M. Pawley, *Buckminster Fuller*, p.13.

[452] S. Rosenberg, "The Man in the White Suit," unpubl. MS., in BFI-CR164, p.6.

[453] "Industrialized House Forum," Proceeding of Course Conference, School of Architecture & Planning -MIT, Jan. 6-7, 1950, p.10.

[454] See headlines "Wichita May be Modern Kitty Hawk of a New Industry" in *The Democrat-Wichita*, Kans., 17 Aug. 1946.

Technically, the primary failure of the Dymaxion Wichita House arose from the radical shift in the technology. While the DDU-technology based on a well-worked and field tested grain-bin structure, the Dymaxion Wichita House literally reworked one technology to another, albeit from high to low, in a rather untested field and under different conditions. The differences were not merely confined to the machine tools, but also the general organization of work.

Jay Baldwin, author of the recent book on Fuller's legacies, "Bucky Works," provided the most careful technical assessment of the Dymaxion Wichita House.[455] He had supervised the dismantling of the extant Dymaxion Wichita House, known as Graham's DDM-Fuller House in 1992 for restoration by the Henry Ford Museum and Greenfield Village in Dearborn-MI. Baldwin noted that the design reeked with many unresolved details.[456] First, the house as designed was an object of precision, requiring proper setting out, precision knowledge of metalwork and structural behaviors. General difficulties arose when the installation team consisted mainly of carpenters. In this instance, Baldwin noted that the anchoring wires were replaced by posts so that the fine adjustment to produce a circular plan was impossible. As installed, the house was oval. The working drawings used nomenclature of naval architecture to purge the impression of wood and masonry construction. Such terms for instance would have been quite unfamiliar to the building trade: "cowling" instead of ceiling, "deck" instead of floor; "bulkhead" instead of wall, and "purlin" instead of rafters. The floor system of stretched metal produced a drum-like condition, creating resonance besides creating problems for replacement and maintenance, especially when vermin were trapped in the air-intake conduit of the floor-board. Further, there was no provisions for containing leaks in the floor system; water entered the end-grains of the floor board and split the plywood lamination. Finally, there was no evidence that natural circulation pattern of air which Fuller attributed to the domical shape worked.[457] Despite these fundamental flaws, Baldwin explained that the real problems of the house were exacerbated by "improper installation" and, thus, the house was nonetheless a conceptual success.[458]

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[455]See J. Baldwin, *Bucky Works*, especially pp.56-61.
[456]"Dymaxion Dwelling Machine" in *TRIMTAB*, Vol.7, No.1, 1992, pp.6-9.
[457]Notes from Author's Interview with J. Baldwin, Santa Barbara-Calif., 8/31/94
[458]J. Baldwin, *Bucky Works*, p.56, 61.

1.5. Conclusion

The historic significance of the 4D-Dymaxion episode in American architectural history is twofold. At the most general level, it illustrated the potentials and problems of industrial assembly-line applications for the house and housing question. In this context, the projects rallied and focused the interests of the avant-garde American architects on this issue. Secondly, 4D-Dymaxion episode was the first conceptualization and formal demonstration of a new type of architecture, spurred by a distinctive, albeit idiosyncratic iconographic program. This program based on efficiency and performance was deduced by Fuller directly from the trends in industry towards ephemeralization.

Fuller's aphoristic essays in *4D-Timelock* and its preparatory manuscript, "Lightful Houses" alluded to a new ideological and symbolic agenda. They are also seminal documents because they manifested the broad optimism of American technologism. This optimism was advanced at two levels - in the subject matter of the house, and the unrequited belief in the egalitarian nature of corporation.

For Fuller, metal assumed a particular iconic significance, with tension, lightness and lighfulness as its primary leitmotifs. Besides forming the foundation of Fuller's life-work, these writings projected a possible future of American architecture. Emblematically, Fuller's Dymaxion projects articulated, what historian Scully characterized as "vehicles of transcendence and escape."[459] In the deep throes of the depression of the thirties and in the uncertainties of the post-war years, these artifacts and the desires they engendered were deeply meaningful.

Mobility and temporality became salient features of Fuller's 4D-Dymaxion projects. As Fuller drew on a Fordist philosophy and a Veblenesque-technocratic critique of culture, he also advanced his brand of iconic-aesthetic agenda which wove together the elements of light and time. In Fuller's iconology of material, the discourse on waste moved towards efficiency; but he began to distance himself from the cult of the engineer as he tried to forge an argument for a transcendental technology. The source of his transcendental technology is an introspective form of Christian self-help.

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[459] V. Scully, *American Architecture and Urbanism*, N.Y.: Praeger Publishers Inc., 1969, p.14.

Although the writings were a curious form of personal divination, they demonstrated Fuller's brilliant skills in translating the meanings of a consumer-industrial landscape into an agenda befitting a new American middle-class domestic culture. Socially and symbolically however, Fuller's Dymaxion House projects contradicted the traditionalist image of the house of the American middle-class. This image, Joan Oakman proposed was intimately tied to "purchasing a lifestyle."[460] Further, Fuller intended to use his project to redeem the middle-class, whose identity, he argued were fixed by the old structure of access to good life, namely, property, prestige and power. The new subjectivity was to be sited in the new industrial collectivism.

A number of ideological positions underpinned Fuller's industrialized house project. From Henry Ford, Fuller inherited a belief that industry constituted a new form of social power beyond and exceeding the influences of governmental policies. Industry, Fuller believed, exercised this power legitimately, formally, and transparently over the redefinition of what constituted good things in life. Society under industry, organized as industrial capitalism, increasingly proved its ability to realize psychic gratification abundantly, thus replacing the scarce and limited property, prestige and personal power. Industry exercised this power through its entrepreneurial decisions and influences and enjoined society in deciding on the type of service and goods via public consumptive patterns. Thus, Fuller viewed the stock market and advertising as augmenting, not replacing, the social imperatives of industry. From technocracy and particularly through Howard Scott, Fuller developed a heightened awareness of a new natural unit of reckoning with reality - namely energy. Energy as a gauge and leitmotif of social reality would eventually replace his time-measure of the 4D-phase. The full significance of this transformation will be discussed in the next chapter.

The Dymaxion artifacts and writings were also discursive and rhetorical devices used by Fuller, as an outsider, to legitimize his practice by appealing to a higher spiritual authority for directing future actions. Fuller's role of an outsider was created by circumstances, but it was subsequently inhabited out of choice. The outsider role was a productive one which Fuller carefully nurtured with great effect. As a tactical choice, this role gave Fuller public attention while allowing him to sustain his personal integrity as a lone inventor. At a practical level, it had a structural weakness that continually challenged his undertakings, as the experiences at Pierce

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460 J. Oakman, "Mirror Images: Technology, Consumption and the Representation of Gender in American Architecture since World war II," in Diana Agrest, P. Conway, L.K. Weisman (eds.) *The Sex of Architecture*, N.Y.: Harry Abrahams, 1996.

and Beech Aircraft illustrates. Also, for a project destined for a mass industry, with implied broad associations with many other technical specializations, Fuller's projects remained, uncompromisingly, the craft of a single hand and highly individualistic. Even as he flirted with technocracy, radical communists, mystics, Bohemian Villagers at Romany Marie or the industry and governmental bureaucracy in Washington D.C., Fuller remained a quintessential outsider. Further, the "failures" paradoxically vitalized Fuller's culture as an outsider.

In the corpus of Fuller's work, the DDU and the DDM episodes at Wichita highlighted the issues of architecture as new instruments for national security against new external and internal threats. These war-time experiences also directly shaped his analysis of architecture in the post-war scenario. These experiences forged his deep appreciation of the new logistic and strategic requirements of air warfare and directed his research agenda towards shell-design. Despite his general professed abhorrence for its purpose in later years, the experiences nevertheless convinced him that the military was the only patron with a history of tactical needs, the technological capacity and a world-around vision to ultimately advance his research program for a world-around deliverable shelter. Fuller's connection to the military, thus, was far from innocuous, as it had been generally portrayed, either by Fuller or by his biographers. Despite the hiatus, the DDU-DDM industrial prototypes on the factory floor emboldened Fuller's imagination that a "new industry" was appearing on the horizon.[461]

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[461] For Fuller's appraisal of the DDM-Fuller House experience, see "Designing a New Industry."

Ch.2 Early Years of tne Geodesic Domes, 1947-55. Private Process of Invention, Public Process of Promotion

In September 1956, during his lecture-cum-project presentation to the School of Architecture at McGill University, Fuller's assistant-at-large, John Dixon, prepared a review and update of Fuller's creative endeavors. For the first time, ten years after its establishment, Fuller's "work, problems, philosophy and strategy" under his research corporation-cooperative, the Fuller Research Foundation (FRF), was neatly packaged; and its beginnings were recounted as follows:

> 1927 to 1946 – 19 Years of the Dymaxion phase
> 1946 – the incorporation of FRF in Delaware
> 1946 to 56 – ten-year series of Fuller Projects at universities and colleges inaugurated at Kansas University in June 1946.[1]

In this post-rationalized schematization, FRF signaled a new phase in his work upon his departure from the Fuller House enterprise in Wichita. It was based on a new set of agenda assisted by new alliances with colleges to advance his new line of invention, the geodesic dome. This chapter examines the processes taken by Fuller in discovering the potential of spherical geodesic patterns for a new type of spatial structuring, and which forms the basis of the geodesic dome. It also explores the public processes he undertook to advance and publicize his new discovery -- in teaching, prototyping and seeking support.

2.1. Fuller's Legacy and Nomenclature in Geodesic Art

> (G)eodesic is about Fuller(sic) ideas, not just about geodesic domes.[2]

> (L)et's talk real geodesic domes, not just pie in the sky ideas.[3]

In public use and popular imagination, the geodesic dome is intimately identified with Fuller [Fig.5.03 & 5.07a]. Such an identification was, in no small part, due to the broad success of Fuller's effort in publicizing the invention from its earliest inception. Fuller singularly nurtured the definitions and concepts of geodesic structuring. These efforts colored the rendition of all subsequent histories of the structure and even those which preceded it. Indeed, the

[1]Ltr. 5/20/56 J. Dixon to C. Rubenstein in BFI-CR174. In "Basic Biography" (prepared by BFI-Philadelphia, March 1983, p.11), Fuller was listed as the Chairman, Board of Trustees of the Fuller Research Foundation, Wichita, Kansas.
[2]Excerpts from "Geodesic Log 9702" 01/12, List for the discussion of Buckminster Fuller's works <GEODESIC@LISTSERV.ACSU.BUFFALO.EDU>, 2/13/97.
[3]Ibid., Excerpt dated 2/14/97.

uniqueness of Fuller's voice and neologism had effectively immortalized the terminology associated with the geodesic dome structure. It is no small wonder that discussions of the geodesic art generally proceed, unaware by many and with impunity, utilizing Fuller's terminology: in describing the pattern of structure as an "omni-directional, three-way grid," or in explaining its structural workings as a "synergetic" action of "islanded tension and compression."[4]

The geodesic dome is a category of lightweight spatial structures. The rectilinear space-frames, now deployed in many large-span buildings, are the garden varieties of spatial structures. The geodesic domes, like all spatial structures, are characterized by one common principle in structuring. The physical forces acting in this type of structure are transmitted three-dimensionally rather than along two-dimensional planes or in a hierarchical fashion. The primary uniqueness of Fuller's patented version of geodesic dome is in the geometrical alignment of its structural elements. The geodesic geometry in his patent stemmed primarily from the spherical icosahedron, although Fuller had developed variations based on the dodecahedron and an earlier one based on a spherical cube-octahedron. Technicalities of structural construction aside, these dome geometries have become trademarks if not novel features representing a class of geodesic domes invented by Fuller. There are, however, varieties of geodesic domes that do not conform to his original adopted geometry.

If one adheres to the technical definition of a geodesic as the shortest distance between two points on a given surface; then a geodesic dome would thus be constituted primarily of structures deployed along geodesic lines; that is, the dome would be constituted from a criss-crossing of great circles. Fuller's first experimental great-circle domes were indeed true geodesic domes unlike his patented dome, which though based on spherical icosahedral geometry, had to be stiffened by intermediate struts not along the geodesic lines. However, so influential was the image of Fuller's geodesic patent that even the historical precedents, though not truly geodesic structures, were dubbed as such. For example, in the sixties, the Radiolaria, a class of zooplanktons, were touted as the earliest representation of polyhedral skeletons with "geodesic" configurations based on the icosahedron[5] [Fig.2.27h].

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[4]Ed Applewhite, Fuller's close associate, for instance, recognized the inaccessibility of these terminologies and concepts to the public. In a gargantuan effort to decipher Fuller and his work, to make both more accessible, Applewhite valiantly assembled in a "dictionary," extant definitions, categories and concepts in Fuller's grandiose knowledge framework. See *Synergetics Dictionary: the Mind of Buckminster Fuller*, New York: Garland, 1986(4 volumes).
[5]See the exquisite plates assembled by Ernst Haeckel in *Kunstformen der Natur* (Hundert Illustrationstafeln mit beschridenden Text, Allgeime Erläuterung und Systematische Übersicht (1906) based on John Murray's Voyage *of H.M.S. Challenger Monograph* (1887).

2.2. The Central "Problem" of the Geodesic Dome

2.2.1. An Overview of the 'Problem'

The geodesic "problem," one could propose, is a practical quest to approximate a particular type of spherical form. It entails a process for creating a polyhedral form that approximates a sphere where, if planes are taken connecting all the chordal points of the polyhedral form, they would lie in the planes of great circles. The chordal arcs would constitute the sphere's geodesic, that is, the paths of minimal length between two points on the spherical surface. The great circles or diameters, are technically the geodesic lines of a sphere. In practical terms, particularly in trajectory and navigation, routes along the great circles are favored as they circumscribe the shortest possible distances.

One might propose that such a pursuit for form is purely mathematical. The solution could be approached geometrically, namely using gnomonic projection which uses a system of central projection from the center of a sphere. With known radius of a sphere and known angular relationships of chordal points, chordal lengths could be calculated. In Fuller's case, as it will be shown, he employed spherical trigonometry.[6] In the early fifties, this process of calculation was tedious but was by no means insurmountable. However, and despite gaining access to seven-point trigonometry tables at MIT, Fuller continually used many student-collaborators in numerous colleges that participated in his research enterprise to crosscheck these calculations.

Fuller's patent for the "geodesic structure," however, was not based on the original geodesic configuration of his initial great circle (GC) dome-geometry developed at Black Mountain College (BMC) and Institute of Design-Chicago (ID-Chicago). This was based on the spherical projection of a cube-octahedron. The parameter which Fuller inserted, requiring as many as possible of the constituent chordal members of the polygon be of equal length, was motivated primarily by production and assembly considerations.

In requiring a maximum standardization of parts to produce any portion of a sphere, Fuller eventually chose the icosahedron as the preferred base polyhedron. This was because the

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[6] This method contrasts the analytical geometry of later researchers. See especially, Joseph Clinton's "Advanced Structural Geometry Studies Part 1: Polyhedral Subdivision Concepts for Structural Applications," NASA CR-1734, Washington DC, Sept. 1971 and also "Geodesic Math" in *Domebook 2*., Bolinas-Calif.: Pacific Domes, 1970 (pp.104-113) which entails the use of the coordinates of the vertices on a spherical surface. Wenninger, however, had demonstrated that spherical polyhedra could be calculated from elementary plane geometry (See M. J. Wenninger, *Spherical Models*, Cambridge: Cambridge University Press, 1979).

icosahedron is formed using one constituent stable polygon comprising twenty equilateral triangles. In practical terms, however, especially in a large dome, more tessellations of the spherical triangles are needed. The extent of the tessellation is measured as the frequency of the spherical icosahedral. Thus a three-frequency icosahedral spherical geodesic means that edges of its base icosahedral face are tessellated into three equal segments, presenting a total of nine spherical triangles; a four frequency, six segments, and so on [Fig.2.00d]. Further, in moving towards domes with larger clear spans over 60 meters, Z.S. Makowski reported that the arrangement of the bars of the framework in a single layer of a dome could no longer provide the necessary rigidity.[7] This necessitated the use of a double-layer trussed arrangement which inevitably meant more chordal parts, and hence, a more critical need to curb their varieties further.

While the chordal data and angular information related to the chordal information are, to use contemporary parlance, "trade secrets", they would not qualify as patentable information. They are, using the stipulations of patent law, 35 U.S. C.A7 101, neither "novel" nor "useful." Further, the process seems to be based on principles of nature and the "obvious." Gnomic projection of a polyhedron onto a sphere could hardly be considered an invention. It would be considered a matter of natural principle. In Fuller's experimentations, he developed alternative methods of tessellating a sphere. For example, in the Class II geodesic dome, he achieved this end by segmenting the base triangle of the icosahedron [Fig.2.00e]. But Fuller's original claim remained his discovery of uniqueness of the "geodesic geometry." For this reason, other dome innovators had consciously steered away from any dome patterning where chordal arrangements could be reduced to geodesic lines based on the icosahedral family of symmetries.

Fuller's fundamental contribution was in translating the geodesic "problem" into a patentable invention. This entailed a twofold procedure of convincing the U.S. Patent Office that a useful structure could be built from the pattern of chordal arrangements that he had developed. Further, its novelty was in the strength of the resulting structure, which appear to exceed projections based on conventional methods of testing.[8]

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[7]Z.S. Makowski, "A history of the Development of Domes and a Review of Recent Achievements World-wide," in *Analysis, Design and Construction of Braced Domes*, London: Granada, 1984, p.42. Henceforth as Z. S. Makowski, "A History of the Development of Domes."

Z.S. Makowski was the founder of The International Journal of Space Structures and directs the Space Structures Research Centre at University of Surrey (Guildford, U.K.).

[8]Several consulting engineers contributed to the analysis of the geodesic structure in its opening years, primarily using either empirical loading testing or approximations of thin shell theory. For example, T.C. Howard's report on "Geodesic Dome Research & Development Program," (12/23/58) cited Ezra Meir and Associates as consulting engineers.

2.2.2. U.S. Patent #2,682,235

U.S. Patent #2,682,235 [Fig.2.00 a-c] described an invention of a new "framework for enclosing space."[9] Fuller claimed that by aligning the main structural elements "in a geodesic pattern of approximate great-circle arcs intersecting to form a three-way grid, and covering or lining this frame with a skin of plastic material," a structure of high efficiency in area coverage is produced. Efficiency, he offered, was measured by the area coverage per pound of structural material. The primary feature in the "definition of terms" of the patent that would eventually become a subject of general contention and subsequently a source of numerous infringement episodes pertains to the "schematic" geometry of the structural framework. In the broadest stroke, Fuller proposed that "visible patterns ... do not necessarily show grids of equilateral triangles, for the visible grids may be equilateral triangles, equilateral diamonds, or equilateral hexagons," rather; "individual structural elements are so arranged as to be aligned with great-circles of a common sphere."[10]

2.2.3. Prior Arts and Contestations

One could propose that the geodesic problem is not a new one. Under the rubric of a more general problem of tessellation or tiling, some artists and craftsman, from ages past, had delved into this problem of tiling a spherical surface. This problem of spherical tessellation, Arthur Loeb, a Harvard crystallographer explained, was based on polyhedral configuration[11] [Fig.2.36a, b & c]. However, the close relationship of the problem of spherical tessellation to polyhedral forms was not generally, and not fully, recognized -- with the exception of perhaps, Walter Bauersfeld, the chief engineer at the Zeiss works in 1922 [Fig.2.27b]. In the seventies, Lloyd Kahn, a disenchanted Fullerphile, brought wider public attention to Bauersfeld's prior geodesic art. He simultaneously launched a wider public challenge to the authenticity and originality of Fuller's geodesic invention, and offered this earnest correction of an "error" in the popular do-it-yourself manual of the seventies, *Domebook 2*:

> (There is) an error in *Domebook 2* in stating that Buckminster Fuller was the inventor of the geodesic dome. *Fuller's contribution*, rather than origination of the great circle principle, or its earliest structural utilization, *is rather application of the word geodesic to this type of*

[9] "Geodesic Dome (1954)" in *Inventions*, pp.127-144.
[10] Ibid.
[11] A. Loeb, Foreword in M.J. Wenninger's *Spherical Models*, p.ix.

polyhedral building framework, and its popularization and commercialization in the United States[12] (Id., my emphasis).

2.2.3.1. Walter Bauersfeld's Zeiss Dome

Walter Bauersfeld demonstrated and patented the first geodesic structural network in 1922 with the Zeiss dome in Jena. Dubbed "The Wonder of Jena" by Kahn, this geodesic structure was realized some thirty-two years before Fuller received his geodesic patent [Fig.2.27d & e]. Z. S. Makowski, one of the foremost space-frame and shell structure engineers, called the Zeiss ferro-cement dome the "the world's first light-weight steel structural framework" and "the first thin-shell concrete structure in the history of civil engineering."[13] Oddly, however, because of Makowski's own specialized interest in space-frame rather than shell structures, he did not consider the Zeiss dome as the first geodesic structure.[14]

The Zeiss dome had a clear span of 25-m. (82 ft.) It was achieved with a reinforced concrete shell with a remarkable thinness of 60.3 mm (2.3 in). Despite its engineering promise, Makowski proposed that the enthusiasm for its wider usage was dampened by several drawbacks. Firstly, the proposed shell technology required elaborate and very expensive formwork which slowed down construction. Secondly, the technology was often not economical in cost.[15]

Bauersfeld's account of the design process for the dome-planetarium is contained in "Projection Planetarium and Shell Construction" which was published at the height of world interest in the geodesic structure.[16] He proposed that his design addressed several outstanding problems in planetarium designs, namely; the long queue for each cycle of the planetarium presentation. There was also a limited representation of the stars despite the use of complicated peripheral mechanical devices attached to the dome. Instead of the cumbersome and heavy machinery for moving the dome to simulate the heavenly skies, Bauersfeld's conceptual break was the design of an optical apparatus to be placed in the center of the planetarium. Thus, he created a revolutionary planetarium not by designing a new planetarium shell; rather it was

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[12] L. Kahn, "The Wonder of Jena," *Shelter*; Bolinas, Calif.: Shelter Publications, 1990.
[13] Z.S. Makowski, Ibid.,p.2.
[14] Notes from Author's Interview with Z.S. Makowski, Singapore, 11/14/97.
[15] Z.S. Makowski, "A history of the development of domes and a review of recent achievements world-wide" in Analysis, *Design and Construction of Braced Domes.*
[16] W. Bauersfeld, "Projection Planetarium and Shell Construction," Occasional Paper, The Institution of Mechanical Engineers-James Clayton Lecture, London, 10 May 1957.

achieved "by optically projecting the pictures of the heavenly bodies on the interior surface of the sphere"[17] [Fig.2.27c].

The Zeiss projector contained a central spotlight dispensing light across an array of spray nozzles of thirty-one projector-openings. The projection from each opening mapped a hexagonal or pentagonal section of the image of the fixed star background onto a section of the spherical projection wall. In this way, the geometry of projection and the truncated icosahedral projector sphere-complex prefigured the reticulated sphere that encloses the room as a projection screen. The device, Bauersfeld explained, would convincingly "reproduc(e) that mysterious and soundless world-movement of nature." Further, he hinted that the surface problem of the planetarium was a low priority. Zeiss was, after all, a manufacturer of precision optics, not a building construction outfit; and Bauersfeld's expertise was in optics and precision engineering:

> The cost of the building exceeded the cost of the instrument almost in all cases. It is interesting to see how architects in the different towns and countries have treated the problem of finding suitable forms for the buildings. The construction of the instrument itself is practically the same in all these planetaria. *We had no reasons to alter the fundamentals of the construction.....*
> When we approached achievement of the first instrument at Jena in 1923 we still lacked a hemisphere-shaped ceiling for controlling the combination of all its projectors....
> My personal work, and also of my co-worker Dr. Geckeler, in the shell investigations ended with the difficult boundary problems of the cylindrical roofs. *Both of us were too much engaged in the optical and mechanical problems of our firm of Carl Zeiss*[18] (Itl., my emphasis).

Bauersfeld also suggested that because of the uniformity of the instrument, a variety of dome sizes could be accommodated. However, the serendipity in his decision to make a dome of "a hemispherical network" of iron bars "screwed together by five or six by means of a suitable device," was the creation of the first geodesic dome structure.

Joachim Krausse's article, "The Miracle of Jena," is the most recent study of Bauersfeld's Zeiss-Jena dome to confirm its geodesic nature.[19] Krausse also tried to redress the absence of the Bauersfeld Dome in modern architectural history. The dome, he proposed, had "sparked off one of the greatest revolutions in building history." He detailed the exquisite character of Bauersfeld's nodal construction:

> The essential feature is the configuration of the nodal points. The rods stand on end, they are grooved at the ends and are held firmly together by round plates fitted with appropriate necks.

[17]Ibid.
[18]Ibid., pp.7-9.
[19]J. Krausse, "The Miracle of Jena," *Arch+, Zeitschrift für Architektur und Städtebau*, März 1993.

A high degree of rigidity of the nodes was thereby achieved. The dead weight amounted to only nine kg per square metre. Of course, the lengths of the rods had to be very exact, with a tolerance of 1/20mm, in order for the spherical dome to work out exactly. Some 50 different lengths of rods were required, and close to 4,000 rods in total. You will recognize in these details the involvement of the designer geared towards precision engineering.[20]

The initial plan to cover the framework with a fine network of thin wire and with a layer of gypsum proved problematic. It was upon the suggestion of Dyckerhoff & Widmann AG (*Dywidag*), Zeiss' ferro-cement consulting engineers, that a solution was found in the progressive sprinkling of viscous cement through a fire-hose on the dome surface over a wooden shuttering.

Whatever other personal agenda Kahn might have harbored against Fuller, he professed that he wanted to correct any public impression that the Zeiss project was an obscure historical aberration. He thus cited at length Helmet Werner's description of Walter Bauersfeld's "1919(sic) invention."[21] Further, he explained that in 1938, no less than the Franklin Institute of Philadelphia awarded its distinguished Edward Longstreth Medal to the firms of Carl Zeiss and Dyckerhoff & Widmann for the shell-form construction of the Planetarium. In other words, with this American citation as evidence, Kahn implied, and short of accusing Fuller of plagiarism, that there was no way that Fuller, an inventor well-versed with prior arts, had not known of the work of Bauersfeld-Dyckerkhoff & Widmann. Finally, to warrant his argument, Kahn wrote to a Dr. W. Degenhard at Carl Zeiss to establish if a patent had been awarded either for the planetarium mechanism or the dome.

Dr. W. Degenhard had described the five-year (1914-1919) design process that produced the hub-strut system of "extraordinary exactness, common otherwise in an optical factory" in his letter to Kahn:

The projection of the starry sky required a certain number of projectors, arranged in the center of the dome. Each projector should illuminate an area of the same size as the dome. *If the vertices of an icosahedron are cut in such a way that the new surface consists of 12 pentagons and 20 hexagons, the area within each is nearly the same size.* The projectors are arranged in the centers of the pentagons and hexagons and produce 32 star fields on the dome. (Actually only 31, since one area is used for the support)[22] (Id., my emphasis).

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[20]Ibid., p.82.
[21]L. Kahn's primary source material was Helmet Werner's *From the Arratus Globe to the Zeiss Planetarium*, Stuttgart: Gustav Fischer, 1957.
[22]Ltr. 6/19/73 W. Degenhard to L. Kahn quoted in L. Kahn, "The Wonder of Jena," *Shelter*, p.119.

Unfortunately, Kahn reported that neither Degenhard nor Zeiss was able to locate any patent and concluded that perhaps it was lost to or taken by the American/Russian occupational forces after World War II.

Following upon where Kahn had left off, Tony Rothman successfully secured the patent document that Kahn had desperately sought. The patent, "*Patentschrift Nr 415395, Klasse 37a, Gruppe 2*," dated 1925, was secured by Dyckerhoff-Widmann and made out to Zeiss Company-Jena based on the first dome. It claimed a:

> (m)ethod for the fabrication of domes and curved surfaces of reinforced concrete. The method is based on a spatial network of iron bars which bears its own weight as well as part of the total weight of the concrete. A lightweight form is placed behind the network while spraying the network with concrete, thereby implanting the network in concrete and giving the shell its full strength.[23]

Though the patent does not provide detail on the nature of the network, the illustrations clearly describe Bauersfeld's geodesic network was based on a truncated icosahedron, that is a mix of twelve pentagons and twenty hexagons.

The subject matter of Rothman's essay, however, was not to debunk Fuller's contribution to the geodesic debate. Rather, he was more interested in representing the significance of geodesics not only as an analogy for gravitation, but also as having a natural and central role in the general theory of relativity. The special theory of relativity, one the other hand, he argued, created the province of Euclidean spaces.[24]

Writing of the Zeiss Dome in *Science à la Mode*, Rothman indirectly affirmed that the Bauersfeld geodesic structure arose from his radical conception of planetarium design based on optics and the geometry of projection [Fig.2.27]. However, Rothman was careful to note that the primary consideration for the constructors of the Jena dome was not the development of the unique geodesic gridding to produce greater strength; rather, it was "the ease with which (the dome) could be assembled and sprayed with concrete."[25] As a result, Bauersfeld's original geodesic gridding was quickly abandoned because Dyckerhoff and Widmann found other configurations more desirable and practical.

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[23] "Patentschrift Nr. 415395, Klasse 37a, Gruppe 2" quoted in T. Rothman, *Science a la Mode,* Princeton, N.J.: Princeton University Press, 1989, p.56.
[24] See T. Rothman's *Science a la Mode*, especially Ch.3 "Geodesics, Domes and Spacetime," pp.51-74.
[25] Ibid., p.58. Rothman referred primarily to Franz Dischinger's personal account in "Fortschritte im Bau von Massivkuppeln," *Der Bauingenieur*, Vol. 10 (1925), pp.326-366.

While these findings clearly attribute the first geodesic structure and geodesic dome pattern to Bauersfeld, Fuller's earliest recorded reaction to and assessment of Bauersfeld's work are instructive in showing how he had developed his own work independently, through a different route of trial and error.

2.2.3.2. Early Questions about the Zeiss Dome

Unbeknownst to many, including Kahn, Fuller had to contend with earlier questions raised privately by K. A. Bauer, the President of Zeiss Works in Jena. On the eve of Robert Marks' retrospective book project on the works by Fuller and encouraged by the general ascendancy of public imagination and interests in geodesic structures, Bauer queried Marks over the similarity of Fuller's geodesic structure to a concrete reinforcing rod system developed by Bauersfeld for the Zeiss planetarium at Jena.[26] While there was no photographic record of the version of the dome structure which Fuller received from Bauer, in all likelihood, it was not Bauersfeld's first dome that he saw. Rather, it is clear from Fuller's description and from an extant sketch he made that it was a dome based on a later non-geodesic pattern of small-circle geometry [Fig.2.27i]. Oddly, Fuller called it an "older, non-geodesic system." He further remarked that between his dome and the version shown to him, there was:

> certain picture similarity ... (due to) its omni-triangulated webbing in which triangles, diamonds or hexagons appear according to the perceptions of the viewer. *There the similarity ends, for it is visual rather than functional and the Jena is not in fact a geodesic structure*[27] (Itl., my emphasis).

Fuller concurrently wrote his patent lawyer, Don Robertson, with full confidence that he had tested Bauersfeld's "prior art" previously:

> It seems to me (Bauer's) letter affords a logical opportunity to introduce, into the record, our knowledge of the doubts of those unfamiliar with my thinking as to whether I am aware of the existence of prior art in the area if omni-triangulated, parallel polarized structure. My own inventions in this area and my own experience with horizontally compressioned parallel rings, triangularly intertensioned and prevented from collapse by their centrally supported mast, as used in my Wichita House of 1944 and Dymaxion House of 1927, makes clear how thoroughly versed I am and how truly unique and synergetically surprising therefore, was my later discovery and invention of means for employing by man of the structural ability to enjoy the greatest stability, with the minimum of effort, in ways exactly avoiding the weakness inherent in the Jena tensional network....[28]

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[26]The letter, dated 8/28/59, was mentioned in Ltr. 9/30/59 RBF to K.A. Bauer in BFI-CR202.
[27]Ltr. 9/30/59 RBF to K.A. Bauer (Carl Zeiss Inc., New York, N.Y.) in BFI-CR202.
[28]Ltr. 9/12/59 RBF to D. Robertson in BFI-CR256.

Fuller further offered the primary differentiation in his geodesic invention as one developed from great-circle rather than small-circle geometry. This, he claimed, epitomized "the principal ingredient" which could be considered "the breakthrough of Buckminster Fuller":

> The essence of my geodesic dome is the *adherence to great circle construction* ...
> MY patented geodesic construction covers my discovery of the way in which the inherent weakness of polarized (Latitudinal) systems can be avoided. It will be noticed that the Jena system employs *latitudinal structural lines in parallel plane perpendicular to the vertical axis of the system whose successively higher horizontal rings are of lesser radius, constituting, as seen from above, concentric rings*[29] (Id., my emphasis).

Clearly, Fuller was describing a later version of the Zeiss domes rather than referring to the Bauersfeld dome at Jena. Thus, it is impossible to conclude, if indeed, whether Fuller had seen the first dome or that he had purposefully chosen to describe the later version. Bauersfeld's first geodesic geometry eminently fulfilled the criteria he considered was his breakthrough, namely, "the discovery of how to avoid using small circle latitudinal elements."[30] For Fuller, his own special contribution was not a geometrical meshing of reinforcing rods to make a reinforced concrete structure, rather, it was creating a "synergetic" structural quality through the rational control of the positions of the rods:

> My great circle gridding(sic) represents the antithesis of parallelism. It is omni-triangulation accomplished without allowing any one of the three sets of grid lines in a finitely closed system to be in comprehensive parallelism.[31]

Even after the photographs of Bauersfeld's first dome came to public light in the seventies, Fuller continued to deny that it was a geodesic configuration. His revised explanation now focused on what he construed as the structural redundancy of the German dome:

> It was not a geodesic structure. The engineer-designer of it designed the triangular steel network only as reinforcing for a later applied heavy concrete dome shell system ... *He assumed that in order to carry all its working loads, the steel reinforcings would have to be imbedded(sic) in the continuous compressional system*. He thought of it as a continuous compression system, as all engineers have thought of reinforced concrete. He and they thought of continuous materials as solid ... *He used the omni-triangular system as a means of guaranteeing the geometrical perfection of the dome's radius* as a projection surface for the Zeiss Planetarium showings[32] (Id., my emphasis).

Fuller was, of course, aware of the German technological innovation in shell structure. In 1948, under unclear circumstances, the Chicago architect Myron Goldsmith sent him a sketch of a

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[29]Ltr. 9/30/59 RBF to K.A. Bauer in BFI-CR202, p.1.
[30]Ibid., p.2.
[31]Ltr. 9/30/59 RBF to K.A. Bauer in BFI-CR202.
[32]Ltr. 3/1/80 RBF to K. Snelson in BFI-EJA Green.

German planetarium that he had copied from an unspecified article in *Neues Bauen in Eisenbeton*. Goldsmith's sketch featured rings of equal spacing with equilateral triangles at the equator. Clearly a description of a later Dyckerkhoff-Widdman shell structure, Goldsmith noted that it was made from a "partial form apparently and spray the dome with gunite."[33]

In Fuller's mind, the Zeiss dome remained a dome of lesser circles and not geodesic chords. Even after he secured, as a present from Bauersfeld's sister[34], her brother's treatise, "Projection Planetarium and Shell Construction," Fuller continued to explain the significance of the paper this way:

> (The paper) made it very clear to me that *he* (Bauersfeld) *had not anticipated the behaviors which I envisioned and employed when producing the geodesic structures* ... Geodesic structures are unlimited in spanning diameters because they are tensegrity structures and the Universe's tensegrity structuring is of unlimited spanning capability. If the Zeiss engineer had in 1922 anticipated geodesic dome's unlimited spanning capability, Goering would have geodesic domes for his Luftwaffe hangars during World War II. The largest World War II hangars were transverse-trussed, and the largest that could be practically produced were of 250-foot width[35] (Id., my emphasis).

Finally, at a point when the geodesic structuring and ideas have become so closely identified with Fuller and etched in the American public mind, he orchestrated a turn-around. He even proffered that his geodesic structure was not an invention in the true sense of the word. Rather than the squabbling over the proprietorship of ideas, Fuller pointed to a larger project looming ahead:

> No one was the inventor of geodesic structure. I was *the conceiver* of the engineering theory which showed that they had no limit of clear span enclosing capability and of their practical and economic realizability(sic), and I was the conceiver of the significant advantage to humanity existing in the as-yet largely untapped tensegrity principle. *My patented inventions were of specific technical ways of producing and assembling domes, and later of their tensegrity geodesics....*

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[33]Ltr. 9/16/48 M. Goldsmith to RBF in BFI-CR131. Between 1947-53, Goldsmith studied under Mies van der Rohe at the Institute of Design. His interests in the concept of structural purity partly explained why he keenly followed Fuller's dome-work there (1948-49). Goldsmith continued to update Fuller on other dome-works and even unknowingly pointed to symptoms of a serious conceptual error in regular breakdown of the geodesic structure even before the patent was issued. Goldsmith's preference for bold skeletal structural expressions in his later works at SOM (ca.1958) could be attributed as much to Fuller, as they had been to Nervi and Mies (See John Winter, "Myron Goldsmith" in *Contemporary Architects*, pp.297-298).

[34]Fuller recounted that the reprint was a gift made to him during his lecture at Harvard Science Center (ca.1975). In a reprint of this article (Copy with the dedication "For Bucky in reverence -- (signed) Ruth van Hilst geb. Bauersfeld" in BFI-EJA Blue), Fuller triumphantly penned, in a marginalia, a vindication of his originality implied in the Bauersfeld's article:

> Given to BF by sister of the man who designed Zeiss planetarium in the 1920s. She agreed with BF Fuller) that her brother was only interested in reinforcing concrete with his frameworks.

[35]Ltr. 3/1/80 RBF to K. Snelson, p.25.

> (The purpose) to employ structural principles on behalf of humanity in order to do more with less to make advantages realistically acquirable by all humanity— how also to help all humanity understand science and technology through the omniconceptual modelability of nature's mathematical coordination -- *Synergetics-Tensegrity-Precession*[36] (Itl., my emphasis).

To establish whether Fuller was aware of Bauersfeld's prior art is not the primary subject matter of this thesis. In all likelihood, given the evidence, he did not. Even the cursory evidence seems to suggest this. For example, Krausse's description of the details of the Bauersfeld dome revealed its joint-system as one of great engineering precision and sophistication:

> It takes account of the fact that 'in a network, the various nodes by no means present the same geometrical pattern at every point. The number of rods is not the same at all nodal points, and the same is true of the angles of inclination of the rods to each other and to the plates'. In order to guarantee this, *the Zeiss nodes have notches running around the plates and the rods have ball point pivots. The two angles in space are not fixed in advance; the nodes can be used both for varying geometric figures and for differing sphere radii*[37] (Itl., my emphasis).

These exquisite qualities and fine tolerances, had Fuller been aware of Bauersfeld's dome, were neither visible in his early experimental great-circle domes nor were they fully attained even in his later prototypes. Despite his hype on dimensional tolerances, Fuller's geodesic joints are pragmatic objects of tinkering [Fig.2.22a]. Further, Bauersfeld's work does not invalidate the originality of Fuller' geodesic invention, especially when one examines the nature of his inventive step. The primary evidence for this assertion will come in the later part of this thesis, in the discussion of his experimentation processes.

In post-World War I Europe, Bauersfeld's geodesic structure did not reach the public domain as a new use. This prior art was, for all intents and purposes, an aberration, assisted in no small way by the success and lucrative prospects of Bauersfeld's primary invention, the optical-planetary device. It was the singular ingenuity of Bauersfeld's optical invention for use in the universal planetarium which attracted American attention. For this reason, in 1929, the *American Machinist* published a complete technical description of Bauersfeld's optical invention in a series of five articles.[38] Though preceding Fuller's invention by more than a quarter century, Fuller's claim to his invention could be argued legally from the point of his singular success in imbuing newness and significance in an otherwise overlooked idea.

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[36]Ibid., pp.27-28.
[37]J. Krausse, "The Miracle of Jena," p.82.
[38]See issues of *American Machinist*, 8/8/29, pp.227-237; 9/12/29, pp.433-440; pp.625-628; pp.737-740; pp.897-898.

2.2.3.3. Graham Bell's Tetrahedral Structures

Bauersfeld's prior art was not the only issue Fuller had to contend with as he argued the originality of his own inventive approach. As the interests in space-frame construction and structural morphology grew, public scrutiny extended to and subsumed the geodesic structures under a broader category of structure types called space structures. It was at this point that a specific category of Fuller' planar geodesic structure, the octet-truss (comprising of octahedral and tetrahedral assemblage of struts), was related to the structural precedents of Alexander Graham Bell [Fig.2.22d cf. Fig.2.24a, b & c]. Fuller's trademark experimentation with the tetrahedron was then seen as a derivative of the tetrahedral cells that Bell had employed in his experimental kites and engineering constructions. Between 1899 and 1907, Bell experimented on tetrahedra, tetrahedral kites and towers in his Beinn Bhreagh (Canada) laboratory; these were subsequently developed further by A. Campbell Wood and associates.[39]

Fuller was not alone in failing to acknowledge Bell's pioneering works in structure until the late fifties. Konrad Wachsmann, too, despite enlivening architectural interests in Bell's 80-foot experimental tetrahedral tower (ca. August 1907) in his own treatise, *The Turning Point of Building: Structure and Design* (1961), omitted any earlier reference to taking cues from the works of Bell and his protégé, Frederick Baldwin. Assembled from tetrahedral modules, the Bell-Baldwin tripod structure consisted of three seventy-two foot legs and weighed less than five tons.[40] Wachsmann was fascinated by the remarkable engineering achievement of the tower, particularly its use of tubular steel and standardized universal, three-dimensional connections. He had also intended to create an alternative history of modern building by highlighting the works of "outsiders" like as Paxton, Bell and Monier (inventor of reinforced concrete).

Fuller recounted that during a luncheon in late '75 at the National Geographic Society, Gilbert Grovsner, the Editor-in-chief of *National Geographic*, also the grandson of A.G. Bell, offered him his first opportunity to view Bell's sketchbooks of 1900-1910. These included a series of drawings and notes showing Bell's exploration on flight, using "box kites." Characterizing the work as "pulling a cobweb through the sky at the velocity of a hurricane," Fuller described the exploratory process of the drawings in careful detail, almost as if they were his own:

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[39] "Alexander Graham Bell Museum: Tribute to Genius," *National Geographic Magazine*, Vol. CX. No.2, Aug. 1956, pp.227-256.
[40] See R.V. Bruce, *Alexander Graham Bell, and the Conquest of Solitude*, Boston: Little Brown & Co., 1973, p.431, 444.

(There were) drawings of diagonal tensional chords to structurally stabilize the kites' six rectangular frames....
(I)n October (1901), Bell made speculative sketches ... of a triangular instead of a square sectioned kite. He had three parallel main struts of wood together with smaller wood strut triangles which formed a long triangular section tube or prism shaped box. He flew this experimentally with the light cloth bandaged around its ends. Then in October 1901, he began to make more drawings of triangulated structures. *Then suddenly we see his evolving the omni-triangulated octahedron-tetrahedron truss complex*. By November 1901, he had evolved completely clear drawings of such an octahedron-tetrahedron truss for framing a great triangular kite which he planned to fabricate.
I realized that, I too, had been fortunate enough to travel the same theoretically conceptual and experimentally realistic route in the development of structures so strong and light...[41] (Itl., my emphasis).

Bell's kite experiment was premised upon the possibility of making a lighter-than-air craft, that is, a lighter flying wind-supported prototype that would be less hazardous. Thus, he constituted his study "by flying the machine as a kite" to establish the basis of its equilibrium and stability in the air.[42] In quiet defense of his own creative route, Fuller offered in the prologue of Dorothy Eber's *Genius At Work, Images of Alexander Graham Bell*, a quaint explanation of how he had arrived at the tetrahedron. It was, he explained, a consequence of his "innately mis-shappened (sic) eye lenses."[43] Further, while Bell was driven by his interest in making a stronger wing for his experimental kites, Fuller claimed that he had started from the close-packing of four spheres, stemming from his earlier tactile "semi-dried peas & toothpick experiment." Thus, coincidentally, both he and Bell "discovered nature":

(Nature) isn't something you invent.
I didn't learn about Bell until after the geodesic dome, and the geodesic comes quite a long time after what I call the synergetic mathematics - the way the spheres of the unit radius close-pack ...
Not having visualized the rectilinearity about me, I used only my tactile sense. My finger muscles found that only the triangle had a natural shape-holding capability. I therefore felt my way into producing an octahedron-tetrahedron truss assembly, I of course, knew naught of such names.[44]

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[41]R.B. Fuller, "Alexander Graham Bell's Discovery of the Octet Truss," BFI-MSS 76.04.02, p.2.
[42]J.H. Parkins, *Bell and Baldwin. Their development of Aerodomes and Hydrodomes At Baddeck-Nova Scotia*, Toronto: University of Toronto Press, 1964, p.5 (See especially Part I, "Before 1907. Alexander Graham Bell and His Early Experiments with Kites," pp.3-18). Parkins explained that in 1901 Bell arrived at the tetrahedral cell as a design strategy to avoid the limits posed by the low strength of available metals and the weight of propelling engine. He replaced the distorted rectangular cell of Laurence Hargrave (ca. 1892) by deforming the rectangular faces of the triangular prism into tetrahedral construction, and combining many small structures in a compact assembly.
Bell was trying to disprove Prof. Simon Newcombe's then classic proposition (in "Is the Airship Coming," *MCClure's Magazine*, Sept. 1901) that surface area and volume/weight are affected in square and cubic proportions respectively by any given change in scale of a flying machine (See Robert V. Bruce, "Castle in the Air," *Alexander Graham Bell, and the Conquest of Solitude*, pp.430-454).
[43]R.B. Fuller, "Alexander Graham Bell's Discovery of the Octet Truss," BFI-MSS 76.04.02, p.1.
[44]Dorothy Eber, "An Interview with RBF," *Genius at Work, Images of Alexander Graham Bell*, N.Y.: Viking Press, 1982, pp.9-11.

Despite the quaint restraint in this explanation, it is difficult to dismiss the likelihood of Fuller's familiarity with Bell's work. After all, one of Fuller's early collaborators retorted, "he came from the same part of the world that Graham Bell did."[45] Even if Bell's structures were an influence, it is difficult to establish the extent; it was probably limited, at least with respect to geodesic invention. The more convincing argument is to examine the differences in the way geometry was deployed in the works of both men.

Graham Bell explored the geometry of tetrahedra primarily for their performative rather than spatial possibilities. In other words, he was more concerned with the strength of structures under dynamic loading conditions than their spanning capacity. For this reason, Robert V. Bruce suggested that the Bell-Baldwin tetrahedral structure used as a tower probably obscured its structural potential as a spanning element. While Fuller recognized the singular stability of the tetrahedron, his preference for it over the orthogonal structures was symbolic. In this respect, Arthur Loeb explained that Fuller's preference transformed the crystallographer's problem of modeling; his tetrahedral system offered an explanation for the location of ions without recourse to the increasingly complicated ball-and-rod models, built on the presumption of a cubic (orthogonal) unit.[46] For Fuller, orthogonality was a conceptual system despite its success in fulfilling a wide range of pragmatic structural tasks. It was culturally installed, and thus was a pale simulacrum of reality based on energy. Ironically, of course, towards the end of Fuller's life, tetrahedronality moved from the observable, physical and modelable towards conceptuality. Amy Edmondson, a researcher of Fulleriana geometry, explained that while the tetrahedron was nominally physical in the method, it was finally a "conceptual entity" without size and time.[47]

2.2.3.4. Robert Le Ricolais's Prior Art

In the professional circles, Z. S. Makowski had suggested at the 1966 International Conference on Space Structures that the brilliant French structural experimentalist, Robert Le Ricolais, beginning as early as 1940, drew attention to the geodesic type of spherical surfaces used in the skeleton structures of sea fauna, various Radiolaria and algae[48] [Fig.2.27g & h]. Makowski asserted that Le Ricolais was the first person to conceive the geodesic subdivision of

[45]Notes from Author's Interview with Duncan Stuart, Raleigh-N.C., 4/26/95.
[46]Notes from Author's Interview with A. Loeb, Cambridge-MA., 4/21/95.
[47]A. Edmondson, *A Fuller Explanation: the Synergetic Geometry of R. Buckminster Fuller*, Boston: Birkhauser, 1987, p 28. Henceforth as *A Fuller Explanation*.
[48]Z.S. Makowski, et.al., "Space Structures" in *Space structures : a study of methods and developments in three-dimensional construction*, Edinburgh: Blackwell Scientific, 1967, p.2.

the sphere, and had "published" the findings.[49] Further, Makowski claimed that he had visited Le Ricolais' studio in Paris and had seen numerous models of geodesic structures which were built in the thirties. Makowski's claim however remains unsubstantiated. Even René Motro, a French structural morphologist who curated Le Ricolais' work and had known the man personally, offered no such claims. While Makowski described Le Ricolais rather condescendingly as a "designer," Motro observed that Le Ricolais was theoretical with "no guiding lines," and used a "mathematical approach without validation."[50]

Le Ricolais, Makowski offered, was set back by two things – the technical difficulties encountered in making a hub in wood for multiple struts, and his generally low profile and poor publicity skills in advancing his work. He was, in Makowski's words, "modest and did not look after his own interests." Nevertheless, through the enormous "public relation" success of Fuller's project, Makowski recounted that Le Ricolais once exclaimed, "Fuller advanced my work!"[51]

Like Fuller, Le Ricolais conducted his structural experimentations outside the eyes and reviews of professional circles. Le Ricolais's painterly training drew him towards the structural integrity of the micro-organisms, particularly the Radiolaria, illustrated in the scientific expedition records of *HMS Challenger* (ca.1887). The version that Le Ricolais employed was probably one of the many editions of *Kunstformen der natur* by Ernst Haeckel, the German monist known for his speculative theory of the universality of substance.[52] Most of his later structural explorations, however, consisted of concrete ellipsoid sections using intertwined reinforcements. In the fifties, when Le Ricolais moved to America, he directly launched personal attacks on Fuller's geodesic invention.

T. C. Howard, Fuller's collaborator at Synergetics Inc. (Fuller's professional practice in Raleigh, North Carolina), recounted that Robert Le Ricolais introduced the office to Haeckel's drawings of the Radiolaria.[53] Another collaborator, James Fitzgibbon, at Synergetics Inc., likewise enthusiastically announced to Fuller his discovery of the *Volvox* and *Radiolaria*:

> Get a volume of Photozoology & have a look. They are plankton forms, Pseudopodia and are terrific. Energy geo-forms that hit you right in the eye, triangulated domes and spheres, tetras, octas, the space frame, etc.. *Le Richolais*(sic) *put us on to them*, he had based some of his first space frame investigations on observations of these forms[54] (Itl., my emphasis).

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[49]Notes from Author's Interview with Z.S. Makowski, Singapore, 11/14/97.
[50]Notes from Author's Interview with René Motro, Singapore, 11/14/97.
[51]Notes from Author's Interview with Z.S. Makowski, Singapore, 11/14/97.
[52]See Ernst H.P.A. Haeckel, *Kunstformen der nat--*, Leipzig und Wien, Verlag, 1899; reprinted in English as *Art Forms in Nature*, New York, Dover Publications [1974].
[53]Notes from Author's Interview with T.C. Howard, Raleigh-N.C., 4/26/95.
[54]Ltr. ca. May 1952 J.W. Fitzgibbon to RBF in BFI-CR139.

Whether or not it was out of professional jealousy, Le Ricolais was generally cynical about Fuller's original claim, as Howard recounted:

> (Ricolais) said, 'Fuller, how could he patent anything? Mother nature did everything that you are doing eons ago ... so all you have to do is to look at the record of *HMS Challenger*. Skip right up to the Library of Congress, get a filmstrip and look at it. Quit screwing with Fuller ... he doesn't know what he is talking about.'[55]

By inference, Le Ricolais's remarks underpinned geodesic as an "organic architecture" which drew directly from the exceptional rigidity and lightness of structures built by Nature. Thus, in alluding to these geometries as natural principles, he implied that Fuller could not claim geodesic patterns as an original invention. Rather than recognizing or acknowledging any direct formal-analogical precedent in these natural patterns, Fuller's response during these earlier years was a nonchalant one:

> There is no question of *their value here in corroborating the logic of energetic geometry*[56] (Itl., my emphasis).

2.2.3.5. Natural Patterns as "Prior Art"

Fuller, too, had observed that the fecundity and variety of natural organisms were proof of the richness in permutations of elemental parts. His awareness came primarily through the works of D'Arcy Thompson.[57] As early as 1949, D'Arcy Thompson's monumental treatise, *On Growth and Form*, was a prime reference on his reading list to promote "total thinking" for a "comprehensive designer." It was one of a few books, he qualified, that treated their subjects in "as comprehensive a manner as historical data permits and in the light of latest advantage of scientific activity"[58]

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[55]Notes from Author's Interview with T.C. Howard, Raleigh-N.C., 4/26/95. See also Robert Le Ricolais, "Buckminster Fuller," *L'Architecture d'aujourd'hui*, 1953, Vol.50-51, pp.122-124.
[56]Ltr. 5/23/52 RBF to J.W. Fitzgibbon in BFI-CR139.
[57]D'Arcy Wentworth Thompson (1860-1948) undertook his ambitious neo-Pythagorean project to set biology on a mathematical foundation around 1917. Hardison explained that more than a mere application of mathematics to life, Thompson's project was a statement that nature is "the materialization of mathematics." Thompson himself claimed this quantification of life:

> My sole purpose is to correlate with mathematical statement and physical law certain of the simpler outward of phenomena of organic growth and structure or form (quoted in Hardison 's *Disappearing Through the Skylight*, New York: Viking Penguin, 1989, p.34).

[58] Ltr. 9/19/49 RBF to B. Kelly in BFI-CR136.

D'Arcy Thompson's influence on Fuller is clear.[59] However, it is more difficult to establish if he was familiar with or had seen Ernst Haeckel's illustrations of the morphologies of biological organisms. Even if he did, the Radiolaria would not, in all likelihood, have captivated his imagination. For him, the "geodesic" pattern of the Radiolaria would have been a mere coincidence of images. Rather, it is more accurate to argue that his predilection was more towards Thompson's grandiose work, namely, to put biology, its morphology and typology of organisms, on a mathematical basis. For this reason, the prefix "Bio" which Fuller had initially used to qualify his own geometrical explorations, Energetic Geometry (*EG*), was probably intended to suggest a more encompassing framework to subsume the physical knowledge concerning biological organisms.

In the early years, Fuller professed that he was not "duplicating" the effort of others, and that what he had disclosed was unique because of its new "slant on the forms and information that men knew a great deal about."[60] In a public lecture in 1950, he openly acknowledged that he was familiar with:

> the exploration of Greek mathematicians and cosmogonists, with the regular Platonic solids and the secondary solids of Pythagoras, with the geometrical space concepts of Da Vinci and Kepler, of D'Arcy Thompson's *Growth and Form*, with (Irving) Langmuir's *Oct-Tet* explorations, (with) the geometrical crystallography, with typology, with __, *Anschauliche Geometrie* , with the geometry of chemistry of Linus Pauling, with geometry of quartz and wave mechanics, with geometry of chromosomes, genes in biological cell ___ .... I have been quite well aware that many others might have come through the same door...[61]

However, increasing comparisons of his works, in later years, with this "prior art" of nature, and the precedents of Bauersfeld and Bell, aggravated public suspicions over his creative enterprise. They became affronts to the research-processes that he had nurtured throughout his

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[59] See Fuller's reading list assembled for his studio in colleges, the "Live Book Squad (The mobile 'shelf' (footlocker) of R.B. Fuller of September, 1949)" and 1955 revised version; both contain citations of D'Arcy Thompson's work.

[60] R.B. Fuller, "Transcription of Energetic Geometry Lecture at Cooper Union," 3 April 1950, in BFI-EJA Blue, pp.2-3.

[61] Ibid. Irving Langmuir (1881-1957), one of the twentieth century's outstanding chemists, is popularly known for two of his inventions, the high-vacuum electron tube and the gas-filled incandescent lamp. In total he received sixty-three patents and was awarded the 1932 Nobel Prize for Chemistry.

Irving Langmuir's researches were conducted at General Electric Company's laboratory in Schenectady-New York. The "Oct-tet" explorations that Fuller alluded to was probably Langmuir's work on atomic theory in surface chemistry, which dealt with chemical bonding forces, the orientation of molecules at liquid or solid surfaces, etc. This led to plasma physics, and it provided the first theoretical end experimental analysis of its properties.

The book, *Anschauliche Geometrie*, Fuller referred to was probably by D. Hilbert & S. Cohn-Vossen (Dover edn. 1944 [1932]; and the version of Pauling's work that Fuller drew upon was *General Chemistry* [W.H. Freeman edn. 1947]).

life. Fuller aggressively challenged them, as they began to impinge on his personal integrity. He argued against this "prior art" of nature by highlighting the paradigmatic difference between his inventive approach and the patterns provided by nature. Indeed it is accurate that the counter-arguments he advanced in *Synergetics* contained subtleties missed by his critics. Thus read Entries #203.09 and #640.01 in Synergetics 2 and Synergetics respectively:

> The development of synergetics did not commence with the study of these structures of nature (Radiolaria, etc.), seeking to understand their logic. The picture of the Radiolaria has been available for 100 years, but I did not happen to see it until I had produced the geodesic structures that derive from the discovery of their fundamental mathematical principles. In other words, *I did not copy nature's structural pattern.* I did not make arbitrary arrangements for superficial reasons. *I began to explore structure and develop it in pure mathematical principles out of which the patterns emerged in pure principle & developed themselves in pure principles.* I then applied them to practical tasks[62] (Itl., my emphasis).

> Radiolaria collapses when taken out of water. Flies' eye do not provide human-dwelling precedents or man-occupiable, environment-valving structures.[63]

In deference to and in defense of Fuller, one could propose that inventions are impossible without nature as a working basis. Applied ideas that draw upon and are permitted by nature, whether directly or metaphorically, nevertheless, are inventions because they entail human intervention and purpose. Fuller's geodesic structure, though derived from principles of nature, is not, as he correctly pointed out, identical to the examples of nature like the Radiolaria. Rather, the geodesic structure claim as an invention entailed not just a novelty, but a successful demonstration of a surprise behavior and performance of physical principles previously not available.

Fuller's own working relationship with his collaborators during the early years of the geodesic experimentations added frays on this issue of the originality of his inventions in particular, and of his personality in general. While Fuller could amicably explain away the coincidence of his ideas with the more established inventors who preceded him, he was generally neither able to accommodate his younger collaborators' claims of their original contributions towards his work nor apportion credit due to them within the context of his larger enterprise.

Fuller attempted to annul the criticisms against him in broad intellectual terms. Under what appeared as undisguised humility, he often stated his selfless project:

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[62]R.B. Fuller, *Synergetics 2. Explorations in the Geometry of Thinking*, New York, Macmillan, 1979, p.25. Henceforth as *Synergetics 2.*
[63]R.B. Fuller, *Synergetics. Explorations in the Geometry of Thinking*, New York, Macmillan, 1975, p.349. Henceforth as *Synergetics.*

> What often seems to the individual to be an invention, and seems also to be an invention to everyone he knows, time and time again turns out to have been previously discovered when patent applications are filed and the search for prior patents begins ... This simultaneity of inventing manifests a forward-rolling wave of logical exploration of which the trends are generated by the omni-integrating discoveries and subsequent inventions of new ways to employ the discoveries at an accelerating rate, which is continually changing the metaphysical environment of exploratory and inventive stimulation....
> Such events (of coincidence) increased my confidence in the resourcefulness and integrity of human thought purely pursued and based on personal experience.[64]

However, such idealistic presentations quickly became tiresome under the real-life pressures of the dome enterprise, which entailed commitment of time and resources. Naturally and understatedly, Fuller's relationships with his collaborators were turbulent. The public spectacle of claim and counter-claim over the authorship of the "tensegrity" structure between Fuller and Kenneth Snelson, his one-time retainer, exemplified such a point[65] [Fig.2.28a].

2.2.3.6. The Fuller-Snelson Episode -- A Pattern of Personal Character.

The contested object in the Fuller-Snelson episode is over the beginnings of the tensegrity structure. It is a structure which, even by today's engineering practices, is considered a novelty. Tensegrity, a word-invention of Fuller, is derived from the contraction of two words, tension and integrity. The fundamental working of a tensegrity structure is based on an almost magical proposition that structural elements can be deployed in a pattern of tension forces, separated only by islands of compressive elements. Fuller explicated the concept of tensegrity in this way:

> Tensegrity describes a structural-relationship principle in which structural shape is guaranteed by the finitely closed, comprehensively continuous, tensional behaviors of the system and not by the discontinuous and exclusively local compressional member behaviors. Tensegrity provides the ability to yield increasingly without ultimately breaking or coming asunder.[66]

His patented version of "Tensile-Integrity Structures," Patent No. 3,063,521, filed in 1959, granted in November 13, 1962 consists of three struts grouped around the three axes of the octahedron held by tension wires along six of its twelve edges.[67]

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[64]Entry #250.50, "Coincidental Nature of Discoveries," *Synergetics 2*, p.72.
[65]For the most recent discussion over the origins of tensegrity, see "Origins of Tensegrity: Views of Emmerich, Fuller and Snelson" in *International Journal of Space Structures*, Vol.11, No.1 & 2, 1996, pp.27-55.
[66]Entry #700.011 in *Synergetics.*
[67]For detail description of the process which Fuller's patent lawyer described as "visible only to the mind's eye" see D. Robertson's *The Mind's Eye of Buckminster Fuller*, New York: Vantage Press, 1974, pp.60-61. Henceforth as "*The Mind's Eye.*"

The tensegrity structure is, in Fuller's parlance, a "discontinuous compression-continuous tension" structure (DCCT) in contrast to traditional structuring which he generalized as "continuous compression and discontinuous tension." This structure was meant to demonstrate a wider and more ambitious claim. With the prospect of making a structure of "continuous tension" where compression elements are reduced to "islands in a sea of tension," Fuller imagined a new generation of domical environments that would be stronger as they grew larger. This was the counter-intuitive suggestion that impelled his fantastic "Cloud Nine" projects consisting of miles wide domes and tetrahedral cities. In tandem with his variations on the geodesic inventions, Fuller created a variety of tensegrity structures[68] to advance this grand ambition but their respective details are tangential to the concerns of this dissertation [Fig.2.23].

2.2.3.6.1. The Stake of the Tensegrity Debate

Tensegrity as a principle, Fuller argued, needed no validation. It is a fundamental principle in nature's structuring. In the early fifties, he argued that it was nature's way of using tension forces to cohere islands of compression over relatively large spans or microscopically, like the planets in the solar system or atoms respectively:

> Nature has compression operating in little remotely positioned islands, as high energy concentrations ... while cohering the whole universal system ... by comprehensive tension.... The Universe is a tensegrity.[69]

The tensegrity debate is significant to Fuller because he had mobilized it to establish the uniqueness of the conceptual beginning in his structural inventions as well as to illustrate a continuity in the entire corpus of his works. This was especially pronounced as the stakes of his geodesic invention widened, and the need to defend the originality of his life-work grew. For example, Robert Marks, in his retrospective account of Fuller's works, explained how tensegrity "intensified the structural integrity of the geodesic" besides giving it "highly flexible surfaces."[70] Another casual observer characterized "tensile integrity" as a "pattern integrity" that forms the "basis" of geodesic structure.[71] Fuller himself repeatedly advanced this reading of tensegrity principle in relation to his geodesic structures, especially calling the latter a "special case" manifestation of the former. However, there is nothing immanent in the geodesic experimentation that would lead from or lead to tensegrity. Conceptually and technically, they

[68]For a list of tensegrity structures developed by Fuller between 1949 and 1960, see R.W. Marks' *The Dymaxion World*, pp.156-63.
[69]World Design Science Decade (WDSD), Doc. II, p.29. See also Fuller's letters to D. Stuart.
[70]R.W. Marks, *The Dymaxion World*, p.57.
[71]L.S. Sieden, *Buckminster Fuller's Universe*, p.102.

ensued from separate paradigms, despite sharing a common field and geometrical basis. Tensegrity as a theory of geodesic structures is, for all intents and purposes, totally fabricated and employed by Fuller to advance an appearance of cohesiveness to his life-work.[72]

2.2.3.6.2. Snelson's Testimony

Kenneth Snelson's public efforts to seek a legitimate recognition of his structural invention came, according to him, after a rift between him and Fuller during the retrospective exhibition of Fuller's work, *Three Structures*, at the Museum of Modern Art-New York (MoMA) in November 1959[73][Fig.2.28c]. Leading from this event, Snelson filed the claims for his invention on 14 March 1960. The claims under U.S. Patent #3,169,611 entitled "Continuous Tension, Discontinuous Compression Structures" was granted in February 1965.

By Snelson's reckoning, the frequency of credit that Fuller duly attributed to him declined after the pivotal presentation of the geodesic experimentations in the *Architectural Forum*, August 1951. He recounted:

> When I posed the question some years later why he (Fuller) accredited me, as he said, in his public lectures and never in print, he replied, 'Ken, old man, you can afford to remain anonymous for a while.'[74]

Over the next fourteen years, however, as his own reputation as an innovative sculptor mounted, Snelson embarked on a protracted and aggressive effort to stake his original contribution in tensegrity invention. In the process, he also painted an unflattering picture of Fuller as megalomaniacal, narcissistic and dishonest.[75]

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[72]Duncan Stuart, one of Fuller's earliest collaborator (a self-trained artist, later Professor of Architecture at NCSC), who shared the early years working with Fuller on the geodesic structure and the tensegrity mast, saw both these structures as paradigmatically different:

> No ... I don't think it (tensegrity structure) did or it can be related to it (geodesic structure) ... (Fuller) built the so-called a tensegrity tower, and the theoretical idea was that (in) the tensegrity tower ... the long continuously connected members were tension members, the compression members would not touch each other (Notes from Author's Interview with Duncan Stuart, Raleigh-N.C., 4/26/95).

[73]Kenneth Snelson, "Snelson on the Tensegrity Invention," *International Journal of Space Structures*, pp.43-48.

[74]Ltr. ca. Nov. 1990 K Snelson to R. Motro (Kirby Urner's "Kenneth Snelson Gallery," *Synergetics on the Web* @ http://www.teleport.com/pdx4d/snelson.html).

Margaret Fitzgibbon pointed out that Fuller would only address someone an "old man" or "skipper" when he was clearly agitated by signs of impropriety and disrespect. Fuller held closely to a dictum from his Navy days -- there could only be one captain on his boat (Author's Notes from Interview with M. Fitzgibbon, St. Louis-Mo., 9/15/94).

[75]K. Simon & K. Goodman, Transcript of Interview with Kenneth Snelson (for a PBS documentary "Thinking Out loud"), New York, ca.1995, p.4

The exchanges between the two men over the authorship of the tensegrity structure were given a formal history in the *Snelson-Motro* letter.[76] This was the climax of Snelson's public exposé of Fuller's excesses with regard to authorship of the tensegrity structure. In 1979, Snelson began to directly characterize Fuller as "purposefully dishonest." The charge of deception stemmed from his claim that Fuller's students, presumably working under Shoji S...lao, had pirated his "arcuate-lip cable connector" joints in order to imitate his sculptures, and to make them "indistinguishable":

> (Y)ou have employed various means for the purpose of deceiving people that this structure was your idea - and that I sort of fooled with it. You even resorted to renaming your earlier work 'tensegrity' to obfuscate the fact that I showed you in 1949 an entirely new principle -- a structure which you had not imagined was possible.[77]

As a sculptor, Snelson had been trying to escape from under the shadow of Fuller. For example, while seeing it fit to record that he studied painting with Fernand Leger in Paris, he was silent about his short apprenticeship with Fuller. Publicly, Snelson styled himself as an "intellectual vagabond and artist," but showed difficulty in articulating the identity of his work. Yet, when the work was criticized as neither art nor sculpture, he curiously defended, "I don't care whether it's sculpture or not; I'm interested in structure."[78]

Snelson's encounter with Fuller began in the summer of 1948. He went on a GI-bill, from University of Oregon to Black Mountain College (BMC) to study painting with Josef Albers. Asked by Albers to assist Fuller to set up his studio, Snelson recounted that not only did he become one of many "electrified 'Fullerites'" but he also graduated as Fuller's exemplary

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[76]See Ltr. (ca. Nov.1990) K. Snelson to R. Motro and his own "Not in My Lifetime. (Snelson's autobiography)," unpubl. MS., Kirby Urner's "Kenneth Snelson Gallery," *Synergetics on the Web* @ http://www.teleport.com/pdx4d/snelson.html.

Motro explained that Snelson's letter emerged during his collaborative work with Snelson on a special issue of the Bulletin of the *International Association for Shell and Spatial Structures* (IASS, November 1990) on tensegrity. Motro had seen Snelson's needle tower but confessed that at that point, he did not know much of Fuller's experimentations with tensegrity. However, he felt that some kind of recognition should be accorded to Snelson (Notes from Author's Interview with René Motro, Singapore, 11/14/97).

[77]Ltr. 12/31/79 K. Snelson to RBF in BFI-MSS 80.02.02, also known as "Kenneth Snelson Letter."

Following the MoMA Exhibition, there was a subsequent blow-up between both men during the Spoleto Festival in 1967. Shoji Sadao, Fuller's partner, had proposed that the castings at the ends of the tube for the Festival's structure would be similar to the ones employed by Snelson in his sculptures. Thereupon, he advised Fuller that Snelson be given the proprietary rights on the joints, even though he did not hold any patents on them. These suggestions agitated Fuller to a point that he demanded that the project be abandoned. Fuller also staked his claims on the tensegrity issue further, reminding Sadao that the "wire wheel is the first tensegrity" (See Ltr. 3/17/67 S. Sadao to RBF in BFI-CR299).

[78]"Artist Designs 30-Legged Giant for Utility Exhibition at Fair," *The New York Times*, 28 Jan. 1964. The ground-breaking bid for public attention was the $20,000 "modern structural design" commissioned by the Electric Power and Light Co. exhibit at the New York World's Fair.

"summer protégé" and "resounding board."[79] Snelson would, however, emerge clearly embittered several years later from what he called his "Fullerian trance."[80] As he tried to establish his authorship of the tensegrity structure, he gradually developed a jaded and cynical view of Fuller's achievements. For example, he retrospectively proposed that Fuller's concern with "design products for living" was a tired Bauhaus theme, one which Fuller did not recognize. Fuller's stage manners with "hands behind his head (as though squeezing out ideas)" as if simulating an "inventive process," he added, was pure theatrics.[81]

Snelson, of course, was not alone in rendering these less-than-flattering impression of Fuller which implicitly undermined his character and cast doubts on the integrity of his ideas and mission. However, he was more malevolent than the other critics. Peter Blake had similarly characterized Fuller's messianic intensity in "selling his snake oil to growing hordes of believers totally mesmerized by his cosmic visions." Blake's remarks were based on a short impression of Fuller's stay at ID-Chicago; but more significantly, his views were colored by his sympathetic reception of Wachsmann's "narrow and highly disciplined objectives."[82]

Among Fuller's collaborators, Bill Wainwright, who also worked with Wachsmann, called the two men, "spell-binders, kind of snake-oil salesmen, " though neither of them "did anything that they didn't think would make the world better."[83] In the same vein, T.C. Howard credited Fuller's "true talents" to the likes of "P.T. Barnum" under whom many worked, but only Fuller got the credit."[84] Finally, D. Stuart recounted his impression of Fuller's lecture at Black Mountain College (ca. 1949):

> (T)he first time, I (was) absolutely fascinated ... I think it started three o'clock in the afternoon and ... broke up around four o'clock in the morning, without a halt. All of us left quite exhausted, but very exhilarated by a most interesting experience ... (H)e is a *real snake-oil salesman* ....
> Bucky ... lacks all that rigor in his talk ... but ... (he was) sort of magically and transcendentally persuasive. And ... (he) had been around long enough that he knew the art of persuading ... and I guess we were willing to be persuaded[85] (Itl., my emphasis).

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[79]K. Simon & K. Goodman, Transcript of Interview with Kenneth Snelson (for a PBS documentary "Thinking Out loud"), New York, ca.1995.
[80]Ibid.
[81]Ibid.
[82]P. Blake, *No Place Like Utopia*, New York: Alfred A. Knopf, 1973, p.95.
[83]Notes from Author's Interview with William Wainwright, Boston-MA., 4/19/95.
[84]Notes from Author's Interview with T.C. Howard, Raleigh-N.C., 4/26/95.
[85]Notes from Author's Interview with Duncan Stuart, Raleigh-N.C., 4/26/95.

Snelson's primary claim to initiating the creative process leading to tensegrity was the rudimentary, but significant act in moving two pieces of the sculptural-structural experiment from hinged parts to wooden "X-column structure" piece on string [Fig.2.28b]:

> I am sure that the string wouldn't have been there if it hadn't been for Bucky ... (but it) was certainly more closer to Alexander Calder at the time than to Buckminster Fuller....
> I finally got to the point where I tied off everything that could move and when I tied off everything that could move, solid parts floated, independent of other solid parts except that they were suspended by strings, tension members, and here was this miraculous looking structure that evolved from it, which was two hard separate parts connected only by tension parts .... I went back (to BMC the next summer) with my little plywood model by then, of this floating compression structures and *Bucky was extremely fascinated with it. I was extremely relieved because it was art*[86] (Itl., my emphasis).

It is evident from this statement that Snelson did not fathom the larger theoretical underpinnings and ramifications of his own act. Snelson also explained to Motro that he had rejected the tetrahedral configuration of internal members in favor of the X-column module for compression members because they "permitted growth along all three axes (in) a true space-filling system, rather than only along a single linear axis." Further, though he was reluctant to give Fuller his wooden X-column structure pieces, in June 1949, he "felt relieved that (Fuller) wasn't angry that (he) had employed geometry (Fuller's geometry) in making art"[87] [Fig.2.32a].

Fuller reiterated Snelson's limited objectives by casting his fascination with the "novelty and aesthetic beauty" of the other geometrical models that he brought with him in his trailer. Further, Fuller recounted that Snelson was "almost afraid" to show his "sculpture," since Snelson was aware of his grandiose projects to uncover "nature's geometrical coordination" and to create "occupiable(sic) structures."[88] Further, according to Fuller, Snelson merely modeled in physical form an idea that he had intuitively long held possible. Thus, Snelson was, in Fuller's words, a "technical-expert refiner," who merely demonstrated a "spontaneous articulation of the solution" in the blueprint of his idea.

Fuller had clearly valued Snelson's contribution. At one stage, he recommended Snelson for a research position at North Carolina State College (NCSC) alongside his other collaborators, J. Fitzgibbon and D. Stuart. He even appeared less guarded with his own research findings. He was generous to a point of making available to Snelson, his "perplexed student," the tools of his

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[86] K. Simon & K. Goodman, Transcript of Interview with Kenneth Snelson (for a PBS documentary "Thinking Out loud"), New York, ca.1995, p.4.
[87] Ltr. (ca. Nov.1990) K. Snelson to R. Motro; see also "Emmerich's Response," *International Journal of Space Structures*, Vol.11, No.1 & 2, 1996, p.49.
[88] Ltr. 3/1/80 RBF to K. Snelson.

research. This included a U.S. Naval Math pamphlet with Energetic Geometry and film negatives of his Dymaxion paraphernalia.[89] He had, on many occasions, guarded these items cautiously. He also continued to caution and advise Snelson against his fixation with the cube in his structural explorations.[90]

By Snelson's account, he had obliged Fuller's request for the model the following summer. Thereafter, Snelson accused that Fuller appropriated the conceptual model as his own through an "absorption process," first by inventing the word "tensegrity" and then speaking of the structure as "his."[91] Besides calling this distorted sense of proprietary and damning plagiarism a "blatant theft," he also insinuated that this pattern of dishonest appropriation was pathological.[92] He further lampooned Fuller's treatise on geodesic experimentations, "Project-Noah's Ark#2." Fuller as "Noah" in his "Ark (of) ideas," Snelson concluded, was an:

> idea collector ... (but) it didn't much matter where...(or)whose ideas they were, but *they became his ideas the moment he recognized them*, especially people who worked around him....
> (He) ignore(d) in his history...the works of others ... (since) he felt proprietorship about any good idea, and *his penchant for patenting ideas... is part of a pathology*[93] (Itl. my emphasis).

Snelson accurately pointed out that Fuller generally assumed himself to be the "hub of the wheel" in his enterprises.[94] His primary excesses stemmed from his general inability to adequately credit the contributions of his collaborators, despite his often-enunciated concern for commonweal and cooperative spirit. This is perhaps the most problematic aspect of Fuller's character, vis-a-vis his enterprises; but it was not a pathological pattern forged out of malice. Rather, it was a personal weakness. It was formed by his own hyper-sensitivity and deep uncertainty over his own self-achievement. This inferiority complex is seemingly paradoxical, though not uncommon, for an over-achiever like Fuller.

Recognizing that vagaries and vanities are part of the human condition, Kirby Urner, an active promoter of Fuller's ideas, nevertheless implied his sympathy towards Snelson's position. He too saw Fuller's attitude towards Snelson and the tensegrity issue as a "symptomatic part of a

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[89]Ltr. 9/1/48 K. Snelson to RBF in BFI-EJA-Green.
[90]Ltr. 9/18/48 RBF to K. Snelson in BFI-EJA-Green.
[91]K. Simon & K. Goodman, Transcript of Interview with Kenneth Snelson (for a PBS documentary "Thinking Out loud"), New York, ca.1995.
[92]K. Snelson, "Not in My Lifetime (Snelson's autobiography)."
[93]K. Simon & K. Goodman, Transcript of Interview with Kenneth Snelson (for a PBS documentary "Thinking Out loud"), New York, ca.1995, p.6. See also Ltr. ca. Nov. 1990 K Snelson to R. Motro.
[94]Mary Emma Harris, *The Arts at Black Mountain College*, Cambridge-Mass.: MIT Press, 1987.

life-long pattern that revealed a flaw in Fuller's character."[95] On the other hand, Ed Applewhite, although acknowledging Snelson's contribution, skillfully sidestepped the issue of authorship. Firstly, he paraphrased Fuller by suggesting that tensegrity was a rediscovery "of ancient tenets, a physical confirmation of timeless beliefs." Secondly, tensegrity was a product of "zeitgeist," exceeding both Fuller's genius and Snelson's technical break :

> (The tensegrity) principle became clearly elaborated and modeled only after Kenneth Snelson, a sculptor and student of Fuller at Black Mountain College, intuited the possibility for compression to be entirely discontinuous while realizing a closed structural system.... Yet tensegrity has been (appropriately) initiated within the same time frame as general system theory, each in part describing the other and both signaling a quantum leap in our collective worldview.[96]

This quandary over the issue of ownership of idea and artifact was hardly a new one. Such conflicts had been previously demonstrated on several other occasions. These included Fuller's one-piece bathroom project at John B. Pierce Foundation; his reaction against Fisher's General Houses project and finally DDM-Fuller House. In these previous works, the issue was, likewise not just over who originated or authored the creative idea. It was also over the issue of control, the act of naming, the definition of origin, and the jostling between the contending significance of object and idea.

Snelson argued that the tensegrity structure was invention because the physical object emerged from his self-experiment. But following from Snelson's working model of the tensegrity concept, Fuller claimed that he moved quickly from two to six, then twelve to twenty-four strutted "discontinuous compression, continuous tension"(DCCT) structures.[97] By this, he implied that he was well in control of and understood the productive principles of tensegrity. Fuller proposed that Snelson merely saw a new sculptural possibility and missed the subliminal implications, among which was a metaphor for how the universe itself is constructed[98] [Fig.2.32b].

Fuller explained that he kept his end of a promise in acknowledging Snelson's contribution to "his" project. Nevertheless, he also felt compelled to firmly establish his own influence on Snelson:

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[95]Kirby Urner, "Synergetics on the Web," http://www.teleport.com/~pdx4d/snelson.html.
[96]E.J. Applewhite, "Synergetics-EJA Material," n.d. BFI-MS.
[97]Ltr. 12/31/79 RBF to K. Snelson, BFI-MSS 80.02.02
[98]Ltr. 3/1/80 RBF to K. Snelson (cc. to Arthur Drexler) in BFI-EJA Green. This 29-page letter is Fuller's primary retort to Snelson's Letter of 12/31/79.

> In all my public lectures I tell of *your original demonstration* of discontinuous -- pressure - (com-pressure) and continuous tension structural advantage ... The event was one of those 'It happened' events ... *If you had demonstrated this structure to an art audience it would not have rung the bell that it rang in me, who had been seeking this structure in Energetic Geometry. That you were excited by the latter, E.G., into spontaneous articulation of the solution, also demonstrates the importance of good faith of colleagues of this frontier.* The name of Ken Snelson will come to be known as a true pioneer of the realized good life and good will[99] (Itl., my emphasis; RBF's underline).

On the surface, the Fuller-Snelson episode is a classic contestation of ego in the long-standing master-student relationship. With Snelson, especially, the defense over the authorship of tensegrity became increasingly protracted. Fuller's actions, and the excesses of which Snelson accused him, were edged on, in no small way, by Snelson's own aggressive stance in establishing his stake. Not only was Snelson perceived as disrespectful, his actions also clearly spurred Fuller into a more defensive mode.

Fuller had initiated the process for the tensegrity patent about three months before the *Three Structures Exhibition* at MoMA in November 1959.[100] The rift between Snelson and Fuller that involved Arthur Drexler probably happened earlier in September 1959.[101] No doubt the public embarrassment and doubts created over the authorship of the tetrahedral tensegrity mast, in the presence of Drexler, a long-time supporter of Fuller's works, edged him to take a more aggressive stance in pursuing the patent at this point.[102] Fuller then countered that the tetrahedral tensegrity mast was a replica of the one he had designed and had shown to Snelson in 1949 at BMC after Snelson's own "octahedronal sculpture."[103]

Given that Fuller had established prior art for spherical tensegrity (the multi-polarized forms) since 1953 and that, in 1959, he was on the verge of getting the "aspension dome" (another variety of his tensegrity dome) prototyped, Snelson's threat was more psychological than real. Snelson did not explain why it took Fuller over ten years to file his tensegrity claims in August 1959, if indeed he was insecure about his prior art. Clearly, Snelson was also

[99] Ltr. (copy, typed by K. Snelson) 12/22/49 K. Snelson to RBF in BFI-MSS 80.02.02, (See also letter in H.N. Fox's essay on "Kenneth Snelson," an Exhibition organized by Douglas G. Schultz, p.23).
[100] See Telegram ca. July 1959 RBF to T.C. Howard in BFI-CR203, which sought clarification on the" Metropolitan (Museum of Art-New York) tensegrity sphere"; also Ltr. 7/29/59 D. Robertson to RBF in BFI-CR203.
[101] See "Snelson on the Tensegrity Invention," pp.46ff.
[102] T.C. Howard who was assisting Shoji Sadao on the MoMA thirty-feet high discontinuous tower, recounted Snelson's anger towards the tensegrity mast, then fabricated at the Edison-Price workshop:

> Kenny came, got drunk ... (and said) 'Goddamn it. That's my design. What are you doing with it here? *Not even a good design anyway. I have got a better way of doing it.*' That was when he actually, cocked up a way to do this single-strut ... that came up from being mad (Notes from Author's Interview with T.C. Howard, Raleigh-N.C., 4/26/95; Itl., my emphasis).

[103] Ltr. 3/1/80 RBF to K. Snelson, p.6.

emboldened by the headway that he had made in securing a vitrine to exhibit his "continuous tension, discontinuous compression" structures alongside Fuller's *Three Structure* exhibition.

Thrown into the fray over the debate of the origins of tensegrity, David Georges Emmerich (ob. 1996), a French engineer who had also systematically experimented with self-tensioning structures since 1958, felt that Snelson was a "catalyst."[104] Emmerich reached this conclusion despite his personal tiff with Fuller over a tensegrity mast of one of his "ex-disciples" that was displayed at UIA-Paris in 1965. René Motro, another French structural morphologist, on the other hand, argued from his close reading of Snelson's patent that "the birth of the idea seems to be the result of Snelson's work."[105] Motro reasserted the position advanced by Snelson that Fuller merely created the word "tensegrity" and that the "birth" of the simplest tensegrity of three struts and nine cables which concretized Fuller's idea of tensegrity should be attributed to Snelson.[106]

2.2.3.6.3. The Significance of the Tensegrity Debate

Fuller's extended response to Snelson's "peeve" and "self-concern" over the issue of the authorship of tensegrity was more than a mere defense of his personal integrity.[107] When Fuller offered his credentials and tedious preparations towards the discovery of tensegrity, he was acting strategically. In Fuller's public presentation of tensegrity, it was, to use an Einsteinian parlance, a generalized principle. Arguing that Snelson merely "demonstrated" a "special case" to him, Fuller thus tried to diffuse Snelson's contribution:

> Inventors cannot invent nor obtain patents on eternal principles -- cosmic laws of the Universe. Principles can only be discovered or -- being eternal -- be rediscovered by humans. Special case uses of generalized principles can be invented by humans. The comprehensive structural principle of Universe is exclusively tensegrity. It was this cosmic structuring fact that caused me to invent the term 'tensegrity.'[108]

Under the broad scope of tensegrity, geodesic structuring would eventually be subsumed as a special case demonstration. Thus, a geodesic structure is an "only-sculpturally-conceived octahedronal special case discontinuous-compression-continuous-tension realization."[109]

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[104] D.G. Emmerich, "Emmerich's Responses," *International Journal of Space Structures*, Vol.11 No.1 &2, 1996, p.49.
[105] R. Motro, "Structural Morphology of Tensegrity Systems" *International Journal of Space Structures*, Vol.11 No.1 &2, 1996, pp.233-239.
[106] Notes from Author's Interview with René Motro, Singapore, 11/14/97.
[107] Ltr. 3/1/80 RBF to K. Snelson in BFI-EJA Green, p.7.
[108] Ibid.
[109] Entry #703.03 in *Synergetics*, pp.371-373.

Whether or not these subtleties are visible to the observer, tensegrity represented, for Fuller, the ultimate model of efficiency, a standard without any parallel model of culture. Thus, the significance in securing "proprietorship" of tensegrity was over the strategic control of the template of a universal principle. Nowhere is this significance more pronounced than Fuller's own contexualization of the significance of tensegrity which he offered:

> What I said to you then was that you had a special case demonstration of a generalized principle for which I had been seeking ... *The generalized principle ... would logically integrate my energetic-synergetic geometry (and its hierarchy of volumetric rationalizations, and of discontinuous compression continuous tension which had been used in the Dymaxion House since 1927 but in a polarized manner.* No one else in the world but I could have seen the significance I saw in what you showed me....
> I am confident that the only individual alive in 1949 who could have seen what I saw was myself. I am absolutely confident that you did not[110] (Itl., my emphasis).

For this reason, Fuller had to rework and reconstruct all of his previous structural works as precursors of tensegrity, and simultaneously as harbingers of geodesic structuring. Under such retrospective construction of the history of his own works, the 1927 4D-Dymaxion House [Fig.1.05c] was a "wire-wheel type, discontinuous compression - continuous tension system" while the 1944 DDM-Fuller House contained the emblematic mast that acted as "an islanded compression member in a discontinuous compression, only tensionally-continuous structure."[111]

[110] Ltr. 3/1/80 RBF to K. Snelson in BFI-EJA Green, pp.3-5.
[111] Ibid., p.12.

2.2.3.7. In support of Fuller

More inclined to overlook the excesses of Fuller, like those described by Snelson, were the new sympathizers who came to value Fuller's work in the early and mid-sixties. Among them were Arthur Loeb, Hugh Kenner and Delta Willis. Clearly valuing the conceptualizer, Arthur Loeb explained his reason for his support for Fuller:

> (I)f Snelson discovered it, I am sure Fuller pushed him to the edge of it. He trained him all these things ... so how can you separate the function of the teacher from the function of the student. True, Fuller should have given credit to Snelson ... but you see, Snelson should not claim he only discovered it because he was pushed to that.[112]

Similarly, Hugh Kenner overlooked the failure of Fuller to attribute credits to antecedent works that might have contributed to his inventions. He defended Fuller by posing his argument in a rhetorical question:

> It has always been possible for people to make them (tetrahedrons, geodesics, and tensegrity) without understanding them. Triangulating a sphere, and understanding the virtues of the structure you get by triangulating a sphere are quite different things ...*Can a man have invented a thing, if he cannot explain it?*[113] (Iti., my emphasis)

Implicit in Kenner's argument is the significance of understanding over mere making. Thus the challengers merely stumbled upon their respective novelties, left "no successor" in the wake of their discovery and "was attended by no explanations."[114]

In a similar vein, Delta Willis suggested that the Zeiss dome patent was limited by its narrow technical objectives. The primary consideration of the patent, Willis contended, was in thin-shell application. For this reason, after the Jena dome, none of the subsequent Zeiss domes were geodesic:

> The patent apparently did not detail a unique formula for the framework, but a method for the fabrication of domes and other curved surfaces of reinforced concrete.[115]

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[112]Notes from Author's Interview with A. Loeb, Cambridge-MA., 4/21/95.
[113]Hugh Kenner, *Bucky - A Guided Tour of Buckminster Fu''er*, New York: William Morrow & Co. Inc.1973, p.264. Henceforth as *Bucky - A Guided Tour.*
[114]Ibid.
[115]Delta Willis, *The Sand Dollar and the Slide Rule*, N.Y.: Addison Wesley, 1995, p.141 (Especially, Ch.6, "Tensegrity," pp.118-148). Willis tried to establish the roots of Fuller's work in the morphological project of D'Arcy Thompson. She argued that Fuller's packing of spheres and Thompson's "closest packing of cells" studies are unified by the themes of economy and flexibility.

In light of these prior arts, the central questions now looming over Fuller's geodesic dome invention pertains to its originality as an object and as a process. Despite the defense rallied in support of Fuller and his own denials of the charges of plagiarism and improper appropriation of intellectual property, the integrity of his character and the originality of his inventions have been opened to question. As a result, in one rendition of the history of space-frame, Fuller has been reduced to the status of promoter alongside Le Ricolais and Wachsmann; while Ernst Haeckel, Walter Bauersfeld and Dywidag were given the credit of visualizing the geodesic pattern and employing it in the building structure, respectively. Fuller's further contribution was his "great success" in advancing space frame as a construction scheme.[116] Even some of Fuller's collaborators, over the years, became skeptical of the originality of Fuller's geodesic inventions and other of his artifacts. T.C. Howard, for example, recounted how Fuller, despite denying knowledge of the Zeiss dome was yet able to recognize that its design impetus was based on "the best way to do reinforcing bars."[117]

Was Fuller aware of these precedents? If not, how did he personally arrive at the principles of geodesic structuring? Finally, did Fuller merely rediscover an existing geometry and redeploy this to new and efficient use?

To address these questions, one needs to examine how Fuller constituted the "problem" of geodesic structure differently from the experimenters before him, and to identify what his inventive step was. The answers are not straightforward; they are related to and are complicated directly by Fuller's own public presentation and promotion of his project.

2.3. The Private Process of Invention

2.3.1. Framework for the Explication of Fuller's Inventive Process

In assessing the effects of corporatization of research and development on the practices of the lone American inventor, Max Lerner lamented that the "days (were) over for watching the flight of birds."[118] Yet, Fuller's self-history of his creative practices are replete with countless exemplars of the wonder of innocent starting points - the bubbles churned up by the propeller, the

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[116]D.G. Emmerich, "From Gravitation Toward Levitation," *International Journal of Space Structure* Vol.11, No. 1 & 2, p.9.
[117]Notes from Author's Interview with T.C. Howard, Raleigh-N.C., 4/26/95.
[118]Max Lerner, *America As a Civilization. Life and Thought in the United States Today,* N.Y.: Simon and Schuster, 1957, p.231. Also refer to Ch. IV "The Culture of Science and the Machine," pp.207-264.

jelly-fish, the basketry-weave, etc. [Fig.5.05]. These dramatic examples, besides setting him apart from the institutional practices of science, also enhanced his dramatization of the power of enchantment in common things and sights. The implicit message offered is that specialized disciplines had blocked these enchantments; the explicit one established the legitimacy of his science practice, ensuing from the didactic examples of nature. Despite the commonplace examples that Fuller drew, he was deadly serious about the prospects of his work.

In 1951, *The Architectural Forum* published one of the first complete disclosures of Fuller's geodesic structure:

> The geodesic dome is a combination of the virtues of the tetrahedron and the sphere. The sphere's virtues: it encloses the most space with the least surface, and is the best container - the strongest against internal pressures. The tetrahedron's: it encloses the least volume with the most surface, and is the stiffest form against external pressures ...
> In order to approach the sphere, Fuller compounded tetrahedra into an octahedron, then into an icosahedron....
> Then, in a sense, he exploded the icosahedron onto the surface of a sphere enclosing it. This divided the surface of the sphere into a number of spherical triangles, or triangles with three bowed legs....
> Fuller took the chords to these great circles arcs, removed some, added more members, and came out with a three-way grid, all of whose vertices lie on the surface of a sphere. So he has a trussed structure which quite closely approaches the shape of a sphere - close enough for half of it to be called a dome. The dome gets its name from the arcs, which are called geodesic....
> Fuller's achievement is in the regular patterns he has created by using the great circle chords selectively and adding to them until he has a complete skeletal system of the shape he wants, whose bone lengths are all within a 10% variation, for easy mass production.[119]

The implied processes in the above account idealized the geodesic invention as an object created purely from a geometrical investigation. It overlooked the continuity of some of his practical and symbolic concerns, thereby grossly simplifying and impoverishing the process of his geometrical explorations.

In other written accounts, public discourses and private conversations, Fuller offered no singular path for the genesis of the geodesic dome. This is quite natural, if not entirely appropriate, for a man who believed in and publicly professed the seamlessness of his experiences.[120] Such diverse renditions, one could also propose, were constantly shaped by

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[119] "Geodesic Dome," *The Architectural Forum*, August 1951, pp.148-9.

[120] Joseph Clinton, an associate of Fuller from his days at SIU-Carbondale, recounted that Fuller initially offered beginnings of geodesics in the great-circle studies and the Wichita House project. Later, the reason was offered in his mathematical investigations and geometry; finally, the impetus was his social project for "just how human beings live among each other" (Author's Notes from Interview with Joseph Clinton, Santa Barbara-Calif., 10/22/94).

external circumstances. For example, the projection of the practical and symbolic uses of the dome, the context of patronage, the type and size of domes or the manufacturing techniques, all exerted their respective influences on the geodesic research agenda as well as their presentations.

Some of these circumstances were actively sought by Fuller; others were externally engendered, and sometimes inadvertently by the publicity which he created around the prospects of his invention. It is against this multifarious backdrop that Fuller's geodesic research agenda and his dome enterprises should be examined. Only then can a more accurate understanding be obtained as the geodesic dome transformed from a scientific investigation into a mere instrument, and finally into a symbolic object. During these transformations, the geodesic dome passed through professional, public, scientific and military imaginations.

Fuller's inventive process in the geodesic research agenda should be explicated in two related sets of considerations. The first set of considerations is practical, which produces the programmatic agenda. Its concerns arise from and is related to the repro-shelter project which Fuller dealt with since the 4D-Dymaxion House project. The second is theoretical and metaphysical, which lead to the methodological issues. It pertains to his ambitious concern in devising a geometry of symbolic and practical economy that was related to his interests in energetics; a framework for viewing reality based on energy.

2.3.1.1. Practical considerations from Experiential Knowledge

To diffuse the presentational hype in the inventive approach, one could examine how several of Fuller's pivotal practical experiences and apprenticeships have provided the programmatic elements that set the framework for his subsequent geometrical explorations. In other words, these elements are proposed as actively forming rather than augmenting his research agenda.

2.3.1.1.1. <u>The Apprenticeships at Phelps Dodge, *Fortune* and BEW</u>

Between the three-wheel car project, the Dymaxion Transportation Unit (DTU) at Bridgeport-Connecticut and the DDM-Fuller House enterprises, Fuller was employed in several industrial, research and governmental positions. He used these experiences to fortify the progressive development of *EG*. Firstly, there were two years of work at Phelps Dodge research department (1936-38), during which he developed an understanding of working in metal, primarily through the one-piece all-copper bathroom [Fig.2.33]. This ensued from and was emboldened by his strategic study of the industrial economics of copper, especially with regard to its logistics of supply, demand and recycle. Privately, Fuller cast his experience in a lofty tone: under some of the world's best metallurgists, he went "deeply into the within-atom and inter-atomic discontinuity of structuring."[121]

Secondly, during the two years at *Fortune* (1938-40), Fuller acquired more than journalistic research skills. Those years provided him remarkable opportunities to conduct reconnaissance into the workings and technologies of America's foremost industries. His research in several feature pieces of the magazine, especially *Fortune*'s tenth anniversary edition, illustrates the scope of his knowledge most clearly. However, here too, he proposed that the journalistic investigations brought him to a close study of "boundary layer physics." This included the "atomic structuring of lubricants" where "nothing was touching anything else anywhere" -- in other words, an almost frictionless world.[122] Finally, as the head mechanical engineer at BEW, he pontificated on "geometry of nature's own coordinate system, and for a multi-dimensional geometrical elucidation of naturally discontinuous compression continuous tension structuring" among America's and England's greatest scientists."[123]

By Fuller's account, the ideas of *EG* was first proposed publicly to a highly specialized audience at informal lunch meetings of the Cosmos Club in Washington D.C., between 1942-44[124] [Fig.2.31]. John Wolfenden,[125] Fuller explained, instigated his publication of two-hundred copies of *EG* to be distributed to scientists. In all likelihood, it was also Fuller's own impulse to protect his ideas that directed him to seek copyright, a process which he had undertaken previously with *4-D Timelock*.[126] Known as "Dymaxion Comprehensive System. Introducing Energetic Geometry," the self-published 1944 tract, then obscure, nevertheless found its way into a local technical publication, *The Northwestern Engineers*. In it, Fuller proposed *EG* as a model for "live reality, expressed in its own terms" rather than one formed by the view of a static world:

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[121]Ltr. 3/1/80 RBF to K. Snelson in BFI-EJA Green, p.2.
[122]Ibid., p.2.
[123]Ibid., p.4.
[124]Fuller only became a member of the Cosmos Club in 1973 until his death in 1983 (Ltr. 12/9/98 Lura Young [Librarian, Cosmos Club] to Y.C. Wong).
[125]Wolfenden was an Oxford chemistry professor before bestowed a Lordship. As Head of the British Scientific Mission to Washington, he also subsequently assumed the position of Head scientist of the British team on the Manhattan project.
[126]Ltr. 3/21/44 RBF to C. Morley. See the citation of this letter in R.B. Fuller & Louis Morley Cochrane, "A Sense of Significance," BFI-MSS 76.12.01, p.189. One of the early recipients was Christopher Morley, an early mentor and financial supporter of his *DDU* project. The document of limited circulation was also distributed amongst a number of Fuller's "associates in the scientific population of wartime Washington."

> Energetic Geometry establishes the scheme and mechanical ratios within the new comprehensive system but not the application of those mechanics to any special fields... The comprehensive system is 'the general clearing house of measurements,' establishing equivalence.[127]

By this preamble, Fuller had envisioned his project as a broad system of quantitative measure of all reality, physical and non-physical. This unified mensuration for all manifestations of reality would entail time, temperature, magnetism, current, etc. Put in another way, Fuller offered it as system of knowledge "without reference to any well-known discipline."[128] While he was previously more concerned with language as a unifier, this renewed interest in quantitative measure ensued from his role in and capacity as head mechanical engineer at the Engineering Division-Board of Economic Warfare (later Foreign Economic Administration).[129] *EG* was effectively formalized as a full-scale project during these years of engagement.

2.3.1.1.2. Familiarity with Brilliant Engineers

Fuller also left little doubt that his acuity for advanced structures had been sharpened by his contact with influential structural designers of his time; and also first-hand experiences of those structures. Immediately, there was Starling Burgess, the creator of sloops and the J-boats for the America Cup and his collaborator in the DTU-project, who Fuller unabashedly called "my engineer." Other luminaries Fuller cited included Glen Martin, the designer of U.S. bombers and

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[127]R.B. Fuller, "Dymaxion Comprehensive System. Introducing Energetic Geometry," *The Northwestern Engineer*, (January 1944) in BFI-EJA Blue, p.1. The MS., dated 3/13/44, contains 14-pages. Fuller's "Dymaxion Comprehensive System" contains five tables & three charts (B, C & 4) which should be read alongside the tract. The details of the components are as follows:

Table 1: Functional Properties of Digits (INDIG)- there are only 16 functioning numbers
Table 2: (untitled) Multiplication tables of INDIG from 2 though 9
Table 3: Spherical Collection of One-layer
Table 4: Spherical Collections in Pyramids and Tetrahedron
Table 5: Spherical Collections in Dymaxion Comprehensive
Chart B (untitled) Hierarchy of VE, Octa and Tetra
Chart C Universal Section of Energetic Geometry
Chart 4 Reciprocal Motion of 9 Internal Sphere Propagates Wave by Diagonal Elongation.

Henceforth, as "Dymaxion Comprehensive System."

[128]R.B. Fuller, "Transcription of Energetic Geometry Lecture at Cooper Union," 3 April 1950, in BFI-EJA Blue, p.8.

[129]Fuller treated his *EG* project as a multi-disciplinary enterprise, evidenced from the reading list he provided Duncan Stuart. The list included: D'arcy Thompson, *On Growth and Form*; P.A.M. Dirac, *Quantum mechanics*; D. Hilbert & S. Cohn-vossen, *Anschauliche geometrie*; A.D. Michael, *Matrix and tensor calculus*; Tobias Danzig, *Number, the Language of Science*; Linus Pauling, *General Chemistry*; O.R. Frisch, *Meet the Atoms*; L.A. Maccoll, *Geometric aspects of relativistic dynamics*; F.C. Phillips, *An introduction to crystallography*; M.C. Conell, *Application of Absolute Differential Calculus*; P.W. Bridgeman, *The Philosophy of Modern Physics, and Operational procedures*; Matila Ghyka, *The geometry of art and life*; Jakob Mandelker, *The Principles of new energy mechanics*; Hume-Rotheny, "Symposium on teleological organisms of the new academy of sciences, electrons, atoms, metals and alloys." (Ltr. ca.1950 D. Stuart to B. & D. Stuart in BFI-EJA Green)

Sikorsky flying boat; Ted Welles, Chief Engineer of Beechcraft; and Don Douglas Sr., the creator of the DC3 airplane series.

More directly related to his 4D-Dymaxion project was his long-standing interest in rigid airships. Viewed then as the only viable trans-oceanic transport of passengers, mail & express, the rigid airship, Fuller figured in his *4D-Timelock* sketches, would enable many facets of his world-around house-service.

Fuller had followed closely the works of Aereon Corpn. (Philadelphia-PA), then conducting work on Aereon III[130] rigid airships [Fig.1.03]. His choice of airship design as a leitmotif for geodesic is obvious. Airships are light, portable and are only tenuously connected to the land. Besides, rigid airship technology was a high-tech enterprise. Airship technology consolidated five wide areas of skills and manufacture. These included expertise of general design and computation, civil engineering application to girder construction and invention of manufacture of light-metal alloys, internal combustion engine, pneumatics experience of balloon-making and the manufacture of hydrogen gas, and materials of gas cells and strong fabrics for outer hull covering.[131] Separately, Konrad Wachsmann also identified that nineteenth century structural engineering ideas were systematically refined in the airship and flying machine technologies. Space-frame construction, three-dimensional bracing system, mass production of complicated parts, prefabrication of structural elements and complicated nodes were simplified into a crystalline form.[132]

Under these considerations, one could understand Fuller's pride in claiming that while en route to Chicago (ca. 1935), Dr. Arnstein (the former chief of Zeppelin Dirigible works, brought in by the U.S. Navy to be the Chief Engineer of Goodyear Dirigible after WWI) had asked to "see him at the great zeppelin hangar to discuss structural design problems (for the hangar)":

> (Arnstein) felt that my discontinuous compression continuous tension system of framing (in the Dymaxion House, as seen in the movies, Fox Movie Tone?) would be much lighter and stronger than his rigid truss framing. (After the geodesics) he was certain that if the dirigible were again developed that I had a greatly improved means of structuring them.[133]

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[130] See pamphlets and material on rigid airship technology in BFI-CR242.
[131] Henry Cord Meyer, *Airshipmen, Business Men and Politics 1890-1940*, Washington: Smithsonian Institution Press, 1991, p.80 (Especially Ch3., pp.80-120: "Building Rigid Airships: Three Communities and their Changing Fortunes").
[132] Konrad Wachsmann, *The Turning Point of Building Structure and Design*, N.Y.: Reinhold Publ. Corp., 1961, p.44.
[133] Ltr. 3/1/80 RBF to K. Snelson in BFI-EJA Green, p.5.

A more direct connection between geodesic structure and airplane design was provided by Fuller. Referring to the World War II Wellington Bomber by the legendary designer, Barnes Wallis,[134] Fuller explained that the most impressive aspect of the aircraft was its fuselage. It was, he described, a "geodesic spiral-counter-spiral framing whose diamond interstices ... triangulated by the fuselage skin of 5-ply 1/8 inch birch plywood."[135] In all likelihood, Fuller had also followed Wallis' earlier engineering study on airships, in particular; his work on the R100 Airships (1920-34) with interior network structures of tiny triangles[136] [Fig.2.27f]. The network of struts as a lattice of holes, Wallis explained, was based on "geodetic principles" allowing for a "homogeneous distribution of stress."[137] Despite the geodesic prefigurations in these structures, Fuller suggested that they were merely "masters at using the mathematical coordinate system already in use"; and that they were not "looking for nature's own omni-rational coordinate."[138]

There is nothing to disprove the more detailed and retrospective claims that Fuller made of his apprenticeships or his familiarity with the structural explorations of the brilliant engineers he enumerated. The significant claims of these apprenticeships directly revealed his familiarity with material science of metals and with advanced high-strength lightweight structural investigations. Implicitly, these associations were highlighted to underpin the sound scientific basis of his claims in *EG*. His familiarity with the works of engineers was not so much to diffuse the originality of his own approach. Rather, they were inserted to establish the provenance of sound and practical ideas that had shaped his experimentations. In few words, his works, though fantastic were not fantasy.

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[134]Fuller subsequently met Wallis and participated alongside him in a series of panel discussions in England. The meeting probably happened in mid-July 1967, when he and J. McHale organized a *Design Science Decade* student-event in London as an alternative to IXth UIA Congress at Prague (See Ltr. 4/4/67 RBF to L.J. Fricker (Department of Architecture, Univ. of Edinburgh) in BFI-CR300).
[135]Ltr. 3/1/80 RBF to K. Snelson in BFI-EJA Green, p.5.
[136]In Fuller's preparatory notes for *4D Timelock*, "References" ca. April 1928 in BFI-CR35, is a list of readings he considered noteworthy. This included C.D. Burney's "England to US by Airship R-100" (*Aero Digest*, Mar. 1928), which is an account of Barnes Wallis's airship.
[137]D. Willis, *The Sand Dollar and the Slide Rule*, p.143.
[138]Ltr. 3/1/80 RBF to K. Snelson in BFI-EJA Green, p.6.

2.3.1.1.3. Practical Considerations of and Lessons from the DDM-Fuller House

Fuller's reductionist agenda on shelter from 4D-Dymaxion to the DDM-Fuller House phase also made the general pursuit of geometry logical. It encapsulated his interests in area, volume, weight and their reciprocal relationships in determining geometrical efficiency. While *EG* highlighted the objects of Fuller's research agenda, one could suggest that there were also practical considerations which edged him towards this type of investigation. However, given that the relationship between the cube-octahedron and great-circle geometry was known as early as 1938, and given that he was desperately looking for an opportunity to apply this idea, why was the great circle geometry not deployed as a structure earlier -- either in the DDU or in his first repro-shelter project, the DDM-Fuller House?

The DDU was a make-do artifice constrained by Butler grain-bin technology. There was no obvious need to retool an existing technology that had worked rather perfectly. Therefore, its potential to lead into a geodesic innovation, at that point in Fuller's repro-shelter project, was remote. Nevertheless, T.C. Howard offered that Fuller's insight into the geodesic structuring emerged from his DDU-project at Butler:

> I often suspect that his real insight into how well a dome form and perform ... was when he was playing around with the old silos that he built way back ... (T)he Butler metal form silos had domical tops. I think he began to develop a feel for what he might do with that form ... and he got into the Wichita house, previous to that, the so-called Dymaxion studies. *They were pseudo-domical, and* (Fuller)*started to realize that to do a true shell was easier said than done* ... even a hen has a lot of trouble doing a nice egg.[139]

The precision aircraft technology at Beech Aircraft used to prototype the Fuller House, on the other hand, promised solutions to the issues that Fuller was attempting to muster -- packing, demountability and weight. Years later, for example, Fuller reminisced about its technological superiority in reducing weight for his repro-shelter project:

> The aircraft industry, using their technology, came out at three tons. Boy! I was right on! My theoretical 1927 figure was precise; it came out three tons in 1944.[140]

Yet, given these technological potentials of Beech Aircraft, Fuller did not take the inventive step towards geodesic structuring. Instead, Fuller provided an interesting

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[139]Notes from Author's Interview with T.C. Howard, Raleigh-N.C., 4/26/95.
[140]"The Way We Live; Reflections and Projections," *Architectural Digest*, June 1977, p.28.

reconstruction of his experience he gained which led him towards the process of the geodesic dome:

> I've greatly advanced from the Beech Aircraft House. There I had a mast support, and the mast had to have stays so it wouldn't tip over. But I found the stays were bordersome(sic) in the inside space, so I made the mast itself fatter, a 'cage' mast that you can get inside of. In other words, *it became the stays and the mast in one*. It became a dome[141](Itl., my emphasis).

This explanation of a disappearing structural mast, as it explodes into the structural cage of the dome, is elegant. However, given the other evidence sketched out earlier, it is questionable as the inventive step. Indeed, from the 4D-Dymaxion to the DDM-Fuller House, the mast was cumbersome during construction and created inflexibility in interior planning. However, the mast did not completely disappear from geodesic technology. It remained a significant, albeit temporary staging component, in many geodesic dome construction processes. However, it is plausible that this quest for a self-scaffolding structure of high space-weight efficiency played a role in advancing his geodesic research agenda.

The Fuller House project definitely produced a real-life and heightened awareness of what severe concentration of bulk meant for transportation requirements. In his classic tract on the project, "Designing a New Industry," Fuller explained that to effectively realize a "house in motion," there was a need for a careful consideration of its weight to volume ratio. This was to be achieved only in the design of assemblage parts: fewer and lighter parts, efficiency and coordination of assemblage on the site; and quality control of the highest dimensional accuracy in the parts to be assembled.[142]

This last reason directly accounted for his return to his cartographic project. Here was a ready-made object with which he had sufficient familiarity. It was based on a sound, precise and reasonably worked-out geometry of gnomic projections. By reversing the geometrical projection process used in the map invention, that is, from polyhedron to the sphere instead of the sphere to polyhedron, Fuller advanced the inventive step fundamentally. The first great circle geodesic model Fuller made in 1944, for that matter, was merely a test of the precision of his projection method. His interest was to translate the connection-intersection points of a polyhedron onto spherical surface aligned along great circle lines rather than with the structural strength of the dome.

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[141]Ibid., p.26.
[142]R.B. Fuller, "Designing a New Industry" [A Composite of a series of Talks c. Jan. 26 '46], p.36.

Fuller House remained a repro-shelter project despite its far-reaching technical implications. One could suggest that the motivation for advancing a generic structural invention that could have wider applications was infinitely more appealing. Fuller intended this, when he summarized the larger horizon of the dome project as a "universal and integral structural system." It would be, he proposed, capable of:

> sustained enclosure and controlled isolation of conditions favorable to man's activities ranging from single-family dwellings to major industries housed on the moon.[143]

Programmatically, there was also a fundamental redefinition of the research agenda on repro-shelter after Wichita. As argued in Chapter One, the 4D-Dymaxion House was premised on a careful integration of the building shell and mechanics. The contexts of DDU and DDM-Fuller House projects formed by Butler's manufacturing interests and Beech Aircraft's production processes. Their respective contexts necessitated the practical distinction between the shell and the mechanics. These technical considerations were realistic. Perhaps after the DDM-Fuller House and his protracted 4D-Dymaxion projects, Fuller gradually became cognizant of the limitations of his own technical resources.

With a new type of structure, however, Fuller believed that he could create an enclosure system that exceeded those limitations. The new shell, as an "environmental valve" would merge structure and mechanics. The new invention would be a one-stop structural-enclosure system, an engineering panacea that would accommodate all scales of human activities from dwelling to industries. This was what Fuller intended when he explained that the new structure was:

> capable of supporting appropriate mechanisms for valving all locally impinging random or periodic energy environment receipts into preferred patterns complementary to man and machine processes[144]

The fundamental paradigmatic shift in Fuller's research program was achieved by transforming the narrow technical considerations of the repro-shelter into a broader one shaped by energetic concerns. The new structure-enclosure as an "energy valve," to use Fuller's nomenclature, would be an energy machine. The inherent domical shape, Fuller argued, not only enabled a lightweight high-performance structure, but it also recirculated the energy level within and optimized the energy exchanges with the outside.

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[143] R.B. Fuller, "Domes - Their Long History and Recent Development," *The Buckminster Fuller Reader*, James Meller (ed.), London: Jonathan Cape Ltd., 1970, p.166. Henceforth as "Domes - Their Long History."
[144] Ibid.

The idea of the structure as an energy valve is best illustrated in his description of a 60-foot dome project that he offered to Mrs. Eleanor Cannon, a benefactor living in Woodstock-New York in October 1949. Besides explaining the radical structuring efficiency of the dome for her "ranch dreams," Fuller also highlighted its internal "environmental valving" which he claimed was almost independent of the external environment. He characterized the dome as a "space-isolator(sic)" similar to an electric light bulb or an electronic valve.[145] Further, Fuller explained, it would fulfill the desire of a new type of planetary domicile:

> The sky-vantage geometry will carry an outline tracery of the world continents (the hemispherical portion thereof coinciding) oriented from the hemisphere's center, as they are oriented from the earth's center, these two centers being so nearly coincidental in astronomical space that any star or planet viewed from the hemisphere center, as in zenith over any continental point will in reality be so in zenith at that moment.[146]

This conflation of the three-dimensional map project and the search for a near perfect energy valve in the domicile formed the new programmatic elements of Fuller's research agenda after Wichita. The first consideration led Fuller to return to his cartographic project. The second concern, related to the first, led him to imagine a state or boundary condition where the qualities of inside and outside was identified only in relation to energy exchange. The ideal state would be the dissolution of any distinction of spatial enclosure. In this respect, the instructive metaphor employed by Fuller was the model representing the moment of energy equilibrium. The end-state of that equilibrium manifesting the most perfect and efficient geometry is the sphere. The continuum of equal vectors, formed by closest packing of spheres, or a "spherical zonal system," Fuller proposed, was an almost seamless matrix in which macro and micro reality, between visible and non-visible, interact.[147] Also called the "isotropic vector matrix"(*IVM*), the pivotal constituent object, he proposed, was configured in the geometry of a cube-octahedron. Fuller called it a "Vector Equilibrium,"(*VE*). Collectively, these were the subject matter explored in *EG*.

2.3.1.2. Theoretical and Metaphysical Considerations

The methodological issues, exemplified in *EG*, are difficult to explicate, although its investigations are seemingly geometrical. In later years, as Fuller moved from the demonstration of natural principles through his artifacts directly to the "scientific" articulation of those

[145]Ltr. 10/1/49 RBF to Mrs. Cannon (Woodstock, N.Y.) in BFI-CR134, p.1.
[146]Ibid., p.3. Perhaps more than any other statement, this collapse of the domicile, dome and geoscope provided the seamless evidence of geodesic beginnings and connections to his Dymaxion globe project.
[147]R.B. Fuller, "Architecture Out of the Laboratory," *Student Publication* (University of Michigan, College of Architecture and Design), Vol.1 No.1, 1955, p.12.

principles, he also transformed his role from an inventor to a natural philosopher. It is his parallel re-presentation of the purpose of *EG* that created a primary obstacle to the assessment of its relation to the geodesic invention. For this reason, any analysis of *EG* to assess its value to the geodesic structure invention entails a decoupling of Fuller's eventual presentation of *EG* as science-project from its more immediate purpose, around 1944.

The foremost task in establishing how *EG* constitutes an inventive step is not to examine its veracity as a science project. Without devaluing the depth of Fuller's project, his activities could be more accurately described as tinkering. This is a fundamental shift in mind-set any scholar wishing to analyze Fuller's creative process must be prepared to take. The analysis is thus advanced to identify where in *EG* are the creative links, tangible and temporal, between the geometrical explorations and geodesic invention.

2.3.1.2.1. The Significance of *EG* in Fuller's Presentation.

Working through the thickets of Fuller's constructions and perusing the prolific production of notes and sketches in Fuller's archives made during this period (1944-48), one could venture that *EG* had some kind of role in the invention.[148] Fuller was cognizant of the symbolic value in dramatizing the "final" stages of works leading to the new structure. For this reason, *EG* was offered as the loom that unraveled the geodesic structure. Indeed, not only were these preliminary works made in conjunction with the first ideas of the geodesic structures, they were also consistently considered as a cluster of problems related to his investigations on the spheres and the *VE*.

Fuller continuously reformed and exaggerated the significance of *EG* as a science. There are two cynical angles to view these claims. One could view it as a publicity gimmick; a presentation tool to legitimize Fuller's practice, that is, to set a theoretical spin and order to his

[148] Most of the working items on *EG* are contained in two locations in the Fuller archives: EJA (E.J. Applewhite) Green and Blue Trunks. Organized by Applewhite over the course of writing of *Synergetics*, the trunks contain significant primary material written by Fuller between Nov. 1947 and Feb. 1948. These included topics with idiosyncratic nomenclatures, which form the main-stay of Fuller's self-constructed science. For example: interior and exterior tetra-octa; ABCD particle relationships; 25 great-circles work data (mostly from late Feb. 1948); comprehensive geometry of 12 great-circles; kinetic phases of Dymaxion Comprehensive system; internal angles of centers of developed gravity at various phases; significance of interrupted compression and continuous scenario space and its successful modeling; 51 or 91 great-circle data; all particles data; dimensional data at 2nd dimension (4 great-circle) and 3rd dimension (6 great-circle); data on dimensions of axial rotation, great-circles at the equator; A-particle dimensions at various magnitudes; sequence of Dymax shells ending in Digits 92; symmetrical decentralization of centers of gravity, open and closed face rotation phases of Dymax; isotope count coincidence at 6-ball radius Dymax.

erstwhile amateur geometrical dabbling. Another is to see how it is used to "sell" geodesic works in the broader cultural realm or to create a broader perspective for Fuller to bypass, generalize and incorporate other people's ideas. Despite these re-presentations and excesses, there is no doubt that aspects of its geometrical explorations were pivotal for two inventive steps, first in the development of a new cartographic method, and second in the geodesic structure. The fundamental significance of EG in Fuller's inventive steps is heuristic.

By treating science as a metaphor and geometrical findings as metonymic, he fundamentally shifted the structural issues he was exploring and facing to the domain of energized micro-structures and projectiles:

> I became interested a number of years ago in an attempt to generalize 'structures' out of three separate sciences first out of crystallography and chemical structures as explored by Linus Pauling, secondly out of topology and thirdly out of physiology.[149]

Fuller solved problem by formulating a parallel one in another domain. His fascination with bubble and its pregnant significance illustrate this point. Bubbles as spheres represented discreteness and hence they can be counted. In fact, Fuller saw regular polyhedra as rationally related in some volumetric unit. He treated the tetrahedron as the basic unit volume. From this starting point, the octahedron (with a unit edge equal to that tetrahedron) has four times the volume, the cube (with diagonal length of same length as the edge of the tetrahedron) has three times the volume, the Dymaxion has twenty times the volume.[150] By speculating on the transformability of spheres, Fuller shifted their discreteness from the abstract domain of Euclidean geometry to nature. *EG* assisted in his conceptual leap by allowing him to imagine that energy could be structured geometrically, and vice versa. In Fuller's rendition of vector geometry, the vividness of time, movement and direction are represented par excellence.

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[149] "Transcript -- Meeting of the Forest Products Research Society-Grand Rapids, Mich.," 5/7/54 in BFI-CR158.
[150] R.B. Fuller, "Transcription of Energetic Geometry Lecture at Cooper Union," 17 April 1950, in BFI-EJA Blue, p.1.

2.3.1.2.2. Contexts for Choosing Energy as an Operating Reality

> In 1917 I thought (Newtonian phraseology) was silly because, as a sailor, I am dealing in universe all times. My point of reference are in universe, I am on a heaving ship, my ship is rotting under me and I am coming apart myself and everything, as far as I could see was in a continuous state of agitation; there was no thingness about it. The only single aspect within which I could resolve it was the word energy.[151]
> Is it not possible that we might discover a satisfactory live reality, expressed in its own terms, instead of continually increasing the dilemma of th concept of a static world that no longer stands still (?)....
> If energy's own unique speed were adopted as the norm, would we not discover ourselves to be constantly near the norm, rather than dispersing chaotically from it?[152]

It is easy to identify that the basic impulse of *EG* was built upon Fuller's general predisposition towards energy as a primary reality and a corresponding skepticism of the reality of a solid world. For Fuller, the physical world is a carcass of the static Euclidean geometry.

While EG was fully articulated in the 1944 tract, its intuitive beginnings were earlier in the 4D-Dymaxion phase of Fuller's life-work. These intuitions, initially as sensibilities, challenged the nominal perception of the object-thing or thingness. For example, Fuller's description of a seemingly prosaic element such as a line, is revealing:

> Let us indicate truthful by a hypothesis that the shortest distance between two points is a straight line - However I may not draw a perfect line, as there will ever be a flaw in the temporal graph. But because I may not --temporal graph (sic) a perfect line may I yet because my intellect has such an abstract concept - by controlling self - my temporal fingers - my machine may I draw a truer and truer line. *And at that moment that I finally make a perfect line - there is no moment or line or two temporal points of radionic element of specific longevity ...(H)ow may I indicate the abstract prosaic straight line. Harmonically by dividing it into harmonic units of color, smell, texture, etc. without digressing from the straight line*[153] (Itl., my emphasis).

To replace the axiomatic solid, Fuller had earlier proposed in *4D-Timelock* a "radionic" model of waves to model energy. He claimed that the "radius dimension alone is essential to description of all energetic phenomena."[154] Fuller's preoccupation with representing his built works enmeshed in geometry of action and energy was unique. But it was also shaped by circumstances formed by a larger cultural and social context.

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[151] R.B. Fuller, "Transcription of Energetic Geometry Lecture at NCSC, Raleigh, N.C.," ca. November 1950, in BFI-EJA Green, p.9.
[152] R.B. Fuller, "Dymaxion Comprehensive System," p.6.
[153] R.B. Fuller, Notes, ca. May 1931 in BFI-CR38. Excerpt of a three-page note which Fuller wrote while working at Pierce Research Foundation in Buffalo-New York.
[154] R.B. Fuller, "Dymaxion Comprehensive System," especially Table 4.

A Metaphor of Energy that is Culturally Sited

When Fuller challenged the Euclidean "tyranny of the static base line,"[155] or arguing that "the affairs of (Man)" could no longer "be graphed within a static frame,"[156] he was merely joining a chorus of critics. Challenges to the axiomatic notions of solidness and staticism were not new. Increasingly, in science, the phenomenon of force between isolated points and the growing recognition through instrumentational measure, of thermal, electrical, electrostatic, electromagnetic properties of material undermined Newtonian particulate theories.

Energy as a Philosophical Monad and Fuller's Inclination in Technocracy

H. Mumford Jones described the fifty year period in American history, from the post-bellum to the eve of WW I, as the Age of Energy.[157] By the thirties, energy had become a foremost reality, a modern motif and imperative in America. It opened a new universe of discourse and was accepted as second nature. In everyday life, large-scale productions were dependent on energy resources and the machine. Thus, for a civilization urged on by mobility, the sciences of energy represented a reasonable and valued pursuit.

Energy as a leitmotif, as shown in Chapter One, was underpinned by Fuller's technocratic inclinations. This is fundamental in understanding the ideological impetus for *EG*. Energy was, to him, the raison d'être of human civilization. It was the true identity of material life, its lowest common denominator and its primary operative element. The energetic unit, as a natural unit to measure human progress, was attractive to Fuller because he believed that it was unmediated by the vanities of cultural conventions. For this reason, energy was a primary basis of Fuller's speculative and deterministic world history, which he worked on intermittently from 1938 to 1949. Touted as the "northwest spiraling" of human civilization, Fuller proposed that the phenomenon of human geography was a direct function of temperature variations.[158] Not only do coldness or the absence of heat determine large social patterns, but it also affected the inventiveness of humans. By cold areas, Fuller was referring to areas with large differentials in temperature.

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[155]Ibid
[156]Ibid., p.4.
[157]H.M. Jones, *The Age of Energy, Varieties of American Experience 1865-1915*, N.Y. Viking Press, 1973.
[158]R.B. Fuller's "Ballistics of Civilization," ca.1940, BFI-MSS 40.01.01. See also R.B. Fuller, *Critical Path*, pp.3-4.

Energy Discourse – in Thermodynamics and the New Physics

EG was also a product of Fuller's speculative projections and his popular rendition of the New Physics. For example, he extrapolated Avogadro's observations on gases to "all conditions of energy."[159] In this sense, *EG* itself was strategically sited at the nexus of the most potent metaphors available at the turn of the twentieth century, namely, relativity and thermodynamics. To understand Fuller's fascination with the New Physics and his metaphorical use of it, it is worthwhile to consider how he imagined his connection to and fascination with his science-hero, Albert Einstein. For a start, Fuller believed that his *EG* was complementary to Einstein's opus.[160] It was, in his own jargon, an "articulated 'Open Sesame' to a comprehensive system of sublime commensurability, synoptic mathematical properties inherent in an energetic universe."[161] Fuller's explanation of his science project to Albert Einstein was self-consciously reflective and overtly pedantic. He offered *EG* as a unified science, along the line of Einstein's own project:

> All chemico-physical-biological components and behavior necessities *seem originally invested*. Any and all of the radiant, thermal, compressive-expansive, convergent-divergent, rotational, orbital, precessional, reciprocal, valencial, polar, refractive, gravitational factors, etc., may be uniquely identified, separated, subdivided or compounded empirically in infinite extension and *seemingly without sacrifice of commensurability of any state*.[162](Itl., my emphasis)

At a cursory level, both Fuller's personal and the nation's fascination with and attraction to Einstein were no less due to his achievements in unlocking the secrets of nature's greatest energies. The interest was also shaped by desires in the social realm. Two outstanding aspects of the New Physics, namely, relativity and quantum mechanics, enabled modern intellectuals to come to terms with issues of personal limitation or the freedom to act and to control matters of

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[159]Entry, #410.04 in *Synergetics*, p.109.

[160]In popular accounts (See A. Hatch, *At Home in the Universe*, p.142), however, Fuller's role is often aggrandized by drawing credits from Einstein's stature. He is often cited as showing the legendary scientist how his scientific contributions to cosmogony and astrophysics were equally significant for everyday life. Fuller's one-upmanship is also illustrated in this marginalia (in his copy of Sir James Jeans' *Physical Science*, p.217, BFI-Library):

> This recalls Mr. Einstein's statement to me after he had read and approved my ref(erence) to him in "9 Chains." (S)aid A.E. to B.F. 'Young Man, you amaze me - I cannot conceive of anything I have done ever having practical application.'
>
> That was Dec. 1937 – $E = mc^2$ had practical applications at Hiroshima 8 years later and all world practically will henceforth. B.F. developed from Einstein's impractical $E = mc^2$.

[161]In Spring '48, an opportunity arose for Fuller to present his theory to Einstein. The invitation, in the form of an anonymous postcard, dated 1/5/48 probably came from John Wiley publishers, via Ernso Strauss (Institute of Advanced Study, Princeton Univ., Asst. to Albert Einstein). Responding to "The Great Date," as Fuller characterized the propitious meeting, he penned a two-page reply.

[162]Ltr. (draft #1) 1/17/48 RBF to A. Einstein in BFI-EJA Blue, p.1. A longer nine-page draft (second?), also dated 1/17/48 BFI-EJA Blue, provides a detailed description of *EG*.

destiny.[163] They produced a renewed hope as they eroded the determinism of "traditional materialism" through supporting and legitimizing "humanistic yearnings of free will."[164] For example, Miller explained that contemporary popular accounts of an "Einsteinian universe" constituted an optimistic social paradigm, where "the habit of scientific truthfulness" and egalitarianism prevailed:

> Einstein's world suggests less government, less organization, less activity, and with more emphasis on the individual, the family, the community and brotherly love.[165]

It was under such idealism that Fuller's interest in Einstein shaped the construction of his own science project and research. Einstein and the New Physics also significantly influenced Fuller's construction of his science on several levels that are seldom examined.[166]

Significance of Einstein and the New Physics to Fuller's *EG*

The first influence was the indirect effect of Einstein's proposed cosmology, which he expounded in a popular essay, "Religion and Science," published in the *New York Times Sunday Magazine* in November 1930. Fuller admitted it freed from anthropomorphism his own thoughts about religion and science. In this essay, Einstein proposed that science rose above fear and moral to become "the cosmic religion sense" with neither dogmas nor anthropomorphic God. Reconstituting Einstein's theory of religion into rational and operative terms, Fuller saw that "longing" as opposed to fear was a state purged of ego; and thus it represented the fountainhead of knowledge.[167] With no ego, Fuller argued, the psychological state was set for an exploratory

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[163]The special theory of relativity collectively included the theoretical speculations of Einstein and the Michelson-Morley experiments. Quantum mechanics, exemplified in Hertz's work, radioactivity and atomic spectra produced the "indeterminacy" or "uncertainty principle."
[164]R. Olson, "The New Physics of the Twentieth Century," *Science as Metaphor*, Belmont-Calif.: Wadsworth Publishing Company Inc., 1971, pp.269-270.
[165]E. Miller, *The Einsteinian Culture and Communication*, Portland, Oreg.: Miller Publ. Co., 1967, pp.11-13.
[166]While Fuller was acquainted with Einstein's scientific work, it is not clear to what degree and detail. Fuller probably read the popular rendition and interpretations of Einstein's work by James Jeans and Arthur Eddington. As early as 1928, Fuller noted the relationship of his time-concept in *4D* essay and Einstein's work:

> After I had worked out my own time laws of relativity ... I decided to study the books of and by Albert Einstein ....
>
> I find that I check with him quite closely materially and abstractly, both as cause and effect, and even to the relative importance of formula.
>
> *Truths must be mechanically interpreted wherever applicable*. Time and Relativity are essential components of construction design and harmonious composition. *The abstract starting point must be consistently adhered to in the complete subjection of materialism to the will of the unselfish or spiritual man* (Ltr. 6/8/28 RBF to J.M. Hewlett in BFI-CF.46; Itl., my emphasis).

[167]R.B. Fuller, *Nine Chains*, pp.358-9.

approach based on "some sort of a priori guiding energy extant." In a metaphysical leap, Fuller constructed the eternal presence that a human mind gained as it enjoined the universe.

Fuller's constructed science, following on the heels of the New Physics, was a personal effort in closing the gap between the subjective and objective worlds. No longer was the scientific point of view deterministic. Along this line, Fuller, like many others, fell into the pervasive scientistic appropriation (in social thoughts and aesthetic practices) of the Einsteinian idea, namely; the rendition of relativity in the conduct of human lives. Though Fuller did not fall into the extreme relativistic mode which characterized many popular reception of Einstein, his challenge to the "Newtonian system of coordinates" as the penultimate reference of "absolute accuracy" nevertheless constituted a scientistic tendency. Ideologically, this relativism supported his own reading of human experiences, namely, a re-centering of the mechanistic world by installing a human-centered universe. In this manner, Fuller perpetuated similar aesthetic readings, like those of the modern American poet William Carlos Williams, in which the measurements of esthetics, science, morality or religion became a direct function of man.[168] This is the deep irony of Einstein's de-anthropomorphism & the New Physics that he had partly ushered in -- the relativity of the frames of observation now placed precise demands on the observer with respect to measurements.[169] Its critical edge was the unraveling of the a priori knowledge system of the Greeks built around an objective nature outside the realm of human sensations. For Fuller, this meant that the new demands "retransferred" measurements to man and his "subjective measurements."[170] The Einsteinian paradigm had no place for sloppiness. It demanded great precision in measurements, and perhaps underlined a context for why Fuller was obsessive in crafting his communications, as if to leave no space for misinterpretation.

Second, Fuller used the Einsteinian paradigm to symbolically polemicize against materiality in general and the "traditional materialism" associated with the Newtonian paradigm in particular. Fuller's narrative of energy as a primary determinant in civilization drew from

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[168]Lisa M. Steinman, *Made in America (Science, Technology and American Modernist Poets)*, New Haven: Yale University Press, 1987, p.65. Steinman explained that Eddington and Heisenberg (both of whom Fuller often quoted) respectively professed that "the footprint" discovered by science was man's own and that "(man) constitute what (man) observe." Contrary to popular understanding of relativity as a shift from objective to a subjectivity; Olson, argued that relativity is precisely objective because of its dependence on "experienced fact and free from personal bias" (See R. Olson, "The New Physics of the Twentieth Century," p.270).

[169]Osserman noted that the "Special Theory of Relativity" of 1905, though abandoned the notion of simultaneity for both practical and theoretical reason, still demanded great precision in measurements:

> Any sloppiness regarding Einstein's theory lies in the attempt to carry over the theory to the political, social and moral domains (R. Osserman, *Poetry of the Universe [A Mathematical Exploration of the Cosmos]*, N.Y.: Anchors, 1995, p.128).

[170]Fuller's marginalia in his copy of Sir James Jeans' *Physical Science*, BFI-Library, p.294.

Einstein's explication of the dynamic relationship between material and energy.[171] Earlier in the thirties, Fuller's own search for the natural definition of wealth, even without the assistance of the Einsteinian paradigm, was channeled towards undermining the materiality of the Newtonian world. With Einstein, Fuller explained, a new definition of wealth replaced the "Newtonian static tonnage."[172]

By the mid-fifties, a third implication of Einsteinian physics was explicitly embraced in Fuller's *EG*. This pertained to a reinterpretation of space as an energized field, extending the concept of his "compassed" space-time in the *4D-Timelock* exposition. One could see *EG*, the geometry in action or energized geometry, as analogical to Einstein's space-time couplet in which gravity is curvature in geometry.[173] Fuller explained that in this transformation, there was no such phenomenon as "space." Rather, there was a field of events.

> These (field of events) are configuration of events and experiences. These events and experiences are non-simultaneous. *This static concept of space infers a simultaneity of events which requirement is not met by nature.* I recognize the experiences which stimulate people into careless reference to 'space' but I myself do not permit the use of the word 'space' in my vocabulary except as the name for an illusion[174] (Itl., my emphasis).

In this explication, Fuller engaged a natural and explicitly objective rather than subjective approach to the treatment of space. The allusion to and metaphorical translation of the Einsteinian concept of space was meant to evoke a dynamic and transforming space. It also sidestepped any connotation of "space" defined and associated culturally, socially or architecturally. Such idealism was not the trappings of Fuller alone. Among others, Ludwig von Bertalanffy, a pioneer in systems thinking and an acquaintance of Fuller, for instance, argued that the theory of relativity gradually eliminated linguistic and cultural bias in the process of "de-anthropomorphization" and "perspectivism."[175]

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[171]Bachelard explained how the Newtonian's definition of mass was a "measure of the opposition of force to move it"; but with relativity, mass became a "mathematical structure," that is, what had been concrete is now notional. See G. Bachelard, *The New Scientific Spirit*, Arthur Goldhammer (trans.), Boston: Beacon Press 1984, pp.48-49.

Fuller's tirade against Newton is not misplaced. Merchant, for instance, argued that notwithstanding the cultural implications of the New Physics, "western commonsense reality is the world of classical physics (of Newton and Liebniz)" (See Carolyn Merchant, *The Death of Nature (Women, Ecology and the Scientific Revolution)*, San Francisco: Harper & Row Publishers, 1980, p.275).

[172]Ltr. 3/30/63 RBF to Gerald Piel in BFI-CR247.

[173]R. Osserman, *Poetry of the Universe*, p.136.

[174]Ltr. 10/26/61 RBF to M.J. Alexander in BFI-CR224: the letter was written on the occasion of Association of Interior Design Conference in Los Angeles.

[175]See Helmut Schoek and James W. Wiggins, eds., *Scientism and Values*, p.204;also Ludwig von Bertalanffy's "An Essay on the Relativity of Categories," *Philosophy of Science*, XXII, 1953, pp.243-263.

Despite claiming his project as science, albeit undertaken as an amateur, Fuller ironically abided by Edisonian pragmatics. He argued that his science project would gain authority only by the condition that its "components and products of abstractions so calculated coincide with reality."[176] *EG* was to be a purposeful undertaking:

> (I) find it hard to conceive of exploring Energetic Geometry through all these __ without the fundamental interest in the significance relative to advantage for man.[177]

EG would finally be a "means of empirical demonstration of the principles of atomic phenomena to the untutored mind."[178] *EG*, he suggested, given its "inherent facility," should be a forefront research tool for the exploration and utilization of nuclear fission.[179] The didactic project, though lost in the rhetoric in later years, was not far-fetched immediately, in 1946, to Americans who recently had witnessed the atomic devastation of Nagasaki and Hiroshima.

2.3.1.2.3. The Problems Posed by the Presentations of *EG*

However, Fuller's skillful use of science and scientific principles as metaphor comes with a severe price, especially when empirical evidence increasingly emboldened its speculations. On one hand, it exacerbated general difficulties in assessing *EG* as a science; on the other hand, it diffused any precise moment or logical routes in the inventive process. Using principles as metaphors always creates a confusion of paradox as a discovery. Tony Rothman, for example, pointed out that metaphorical operations are often confused as truth productions and claims of uncovering "new truth."[180] For this reason, the significance of *EG*, at least to Fuller's research enterprise, should not be bounded by scientific strictures.

EG had assumed a host of multifarious meanings in the course of Fuller's life-long presentations. The name-changes of his science project alone, one could propose, are reflective of his varied but linked ambitions. Initially, this was about establishing proprietary right. Then it was for legitimizing his enterprise, and finally for immortalizing his mere inventions as realms of knowledge. Of the last of these ambitions, Fuller recognized that the single greatest coup he

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176 "Fuller Research Foundation Background and Purpose," BFI-MSS 46.08.01, pp.5-6. In this quest for a pragmatic science, Fuller was not quaint. For a discussion of the pragmatism in America's explication of the New Physics, see James Gleick, *Genius: Richard Feynman and Modern Physics*, London: Little, Brown, 1992.
177 R.B. Fuller, "Transcription of Energetic Geometry Lecture at Cooper Union," April 26 1950, in BFI-EJA Blue, p.1.
178 "Fuller Research Foundation Background and Purpose," p.6.
179 Ibid.
180 T. Rothman, "The Evolution of Entropy," *Science a la Mode, Physical Fashions and Fictions*, p.76.

could accomplish is the eventual identification of his inventions as transcendental leitmotifs for the operation of the universe:

> Discoveries are uniquely regenerative to the explorer and are most powerful on those rare occasions when a generalized principle is discovered...
> It is the realization that the newly discovered principle will provide spontaneous, common sense logic engendering universal cooperation[181]

***EG* – Making an Outsider's Science**

When an invention crosses over into the realm of discovery, the work moves from the realm of private ownership into public trusteeship. Yet, his search of a name for this "discovery" was symptomatic of his quest for control and public identification. From its "beginnings"(1944-7), *EG* was also rendered as "Dymaxion Comprehensive System"(ca.1944).[182] It became Dymaxion Bio-energetic Geometry (1948), then Dymaxion Synergetic Geometry, Synergetic-Energetic Geometry (1954) and finally, Synergetics (1961). One could argue that initially, *EG* was neutral enough as a label for public funding of his "pure science research." The failure to secure public funds probably convinced Fuller that it should remain his private enterprise, in a "private trusteeship" so to speak, until such a time when he was ready to "relinquish" it to the public realm. This was the impetus behind the change of name to "Dymaxion Bio-energetic Geometry," with his trademark Dymaxion.

The choice to drop the prefix "Bio" perhaps came from Fuller's own assessment that his project would bridge the physical and the affairs of man. A one-page handwritten document is the only extant description, in Fuller's jargon, of his bio-energetic concept. It was to be an:

> (i)ntroduction of the individual, and the utterly interactive association of individuals, to the exact mechanics of social navigation (by cosmoginal [sic] reference) within the infinitely variable synchronous permeability of Nature; demonstrating controlled reorientations, morphology and magnitude valving amongst the respective integrities of preoccupying aspects of several firmamental dimensions and their 'absolute' phases, functions and tendencies.[183]

Generally *EG*, Robertson paraphrased later, was a work that bridged "across all of the chasms in man's compartmented world."[184]

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[181]R.B. Fuller, Entry #250.01, *Synergetics*, p.67.
[182]"Dymaxion Comprehensive System," (ca. 1944) dedicated to Mr. LeSourd (Fuller's Physics teacher at Milton Academy).
[183]R.B. Fuller, "Dymaxion Bio-Energetic Geometry" in BFI-EJA Green, undated, ca. Nov.'47 -Feb.'48
[184]D. Robertson, *The Mind's Eye*, p.29.

It is likely that the successful demonstration of geodesic principles as structures in the Woods-Hole and the Ford Rotunda domes (1952-53) edged Fuller to relinquish his personal identification with *EG* [Fig.2.21b& Fig.3.64a-c]. It now became a demonstration of a theory to "valve" the physical energy latent in the universe. As the geodesic structure rapidly demonstrated that its structural performance exceeded its elemental components, Fuller gradually dropped "Energetic" in favor of "Synergetic."

"Energetic," Fuller broadly explained, was an analytical route that depended on "differentiation" of the structural parts while the new descriptor "synergetic," on the other hand, was demonstrative of "integration." Marks paraphrased the distinction in this way:

> Energetic studies of nature differentiate out or isolate unique local functionings. Synergetic studies seek to organize and comprehend the complex co-operative patterning that exists, a priori in nature.[185]

The first name "Energetic Geometry," narrowly concerned with the physical, in this way, became expansive by assuming the new couplet. The conversion to "Synergetic Geometry" and finally to "Synergetics" allowed for a complete transformation of a personal exploration to an impersonal opus, just as *4D* underwent a name change to Dymaxion. In the final flowering, *Synergetics* was posed as a measuring and coordinating device for "all information regarding (human) experiences" geometrically and topologically.[186] It would, as a "a single language," Fuller claimed, accommodate all sorts of "proclivities, phases and disciplines" and "recognize and accommodate" all existing laws.[187] In other words, the project was offered as one grand empire of knowledge, a tool of divination and a meta-language.

In the conversion of *EG* to Synergetics, Fuller's final emblematic monad, the quintessential tetrahedron would stand for the "minimum structural system for the universe," colonizing the structure of thinking and the object of thought.[188] On this occasion, Kuhn, an

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[185] R.W. Marks, *The Dymaxion World*, pp.134-35.
[186] R.B. Fuller, *Synergetics2*, p.25.
[187] Ibid., pp.25-7.
[188] Reflecting on his role in realizing Fuller's theoretical opus, E.J. Applewhite noted the difficulties encountered in the grand project:

> Synergetics is a book without genre ... The dilemma of the book is that it attempts to combine science and poetry and philosophy in a single work...
>
> (T)he whole structure of Fuller's cosmos is a poetic one of vast harmony and subtlety. If the book is nothing else, it is one of the most complex literary and *pattern metaphors of the age*. It is a rare and wonderful *vision of geometry of conceptuality: how to start from a new place* -- independent of Euclid, Descartes, and Liebniz, independent of size, independent of time (E.J. Applewhite, *Cosmic Fishing: An Account of Writing Synergetics with Buckminster Fuller*, N.Y.: Macmillan Publ. Co., 1977, p.143; Id., my emphasis).

enthusiastic commentator, augmenting Fuller's claims, emphatically suggested that with *Synergetics*, a tool for deciphering nature and the man Fuller had been simultaneously forged:

> Synergy(sic) is not only Fuller's slide rule for interpreting the universe; it is the reader's slide rule for interpreting Fuller.[189]

Despite the affinity of *EG* to the energy metaphor, Stuart explained that Fuller's primary preoccupation was closer to Thompson's mechanistic model of nature. Its investigations dealt with linear and volumetric scales and surface area relationships.[190] The Einsteinian energy-mass equivalent in the physics of energetics, on the other hand, is a macro-view of how the world organizes itself, "going from the very minute world of the atom up to the whole of the galaxy in scale."[191] However, in viewing the order of energy as a geometrical configuration and reexamining the relationships of the two prevalent forces associated with the built world, namely; tension and compression, Fuller's work paradigmatically departed from Thompson's.

***EG* as Explained by Fuller and his Supporters**

Extant writings on the geodesic invention, primarily fueled by Fuller's own presentations attributed a pivotal role played by his self-constructed science-project, Energetic Geometry (*EG*).[192] J. McHale, one of the most ardent promoters of Fuller's ideas in the mid-fifties through the late sixties, so much as suggested that the geodesic dome would be impossible without *EG*. McHale fundamentally endorsed the uniqueness of Fuller's contribution in making a direct connection between spherical polyhedra and a new system of spherical gridding:

> It was unknown mathematically, before energetic/synergetic geometry that the modular frequency of a symmetrical subdivision of a spherical or linear tetrahedrons-octahedrons or icosahedrons provides spring points for geodesic 3-way grid intersections.[193]

Likewise, Don Robertson, Fuller's patent lawyer, explained, in the memoirs of his professional transactions with Fuller, *The Mind's Eye of Buckminster Fuller* (1974), the significance of the new grounds created by *EG*, or the "Dymaxion Comprehensive System," as he called it:

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[189]W. Kuhns, *The Post-Industrial Prophets*, p.226.
[190]Notes from Author's Interview with Duncan Stuart, Raleigh-N.C., 4/26/95.
[191]Ibid.
[192]For examples, see J. McHale's "Richard Buckminster Fuller," *Architectural Design* (July 1961), R. Pooley & Ron Ward (eds.)" The Energetic-Synergetic Geometry of R. Buckminster Fuller and its Application to Geodesic Structures," Design Department, SIU Carbondale-Ill., October 1962.
[193]J. McHale, *R. Buckminster Fuller*, p.45.

As the latter date precedes the December 1951, filing date for the first patent in geodesics.... it will be seen that the fundamentals of the geometry were discovered before any of these particular inventions came into the Patent Office. *Thus, it is that the fabric of the inventor's comprehensive approach to geometry will be found to be inextricably woven into the compatible fabric of the several inventions*[194] (Id., my emphasis).

Further, Robertson proposed that the primary conceptual breakthrough of Fuller's geometrical exploration, *EG*, was the discovery of the tetrahedron as its "first identifiable 'system.'" From this "minimum system," he argued the geodesic structure became a product of "further development" from the system "tetrahedroning."[195]

Naturally, such retrospections should be treated with caution. While there is no reason to dismiss the fidelity of these accounts, it would be prudent to assume that they were inevitably threaded with self-interests. For Robertson, the motivation would be to protect the integrity of his professional service and Fuller's proprietary claims. For McHale, it was to brace the general sympathy that he had for the futuristic approach of Fuller's work. Fuller's explanations, proffered in the course of his subsequent public presentations, were more expansive.

Hyped EG

Fuller began consolidating and presenting the meaning of *EG* in the wake of the first public demonstration of his geodesic works. For example, in a broadside, "Schedule of Projects and Publication by R. Buckminster Fuller" issued on the occasion of a public lecture in April 1950 to the Division of Social Philosophy-Cooper Union (New York), Fuller offered the following genesis of *EG*:

1.1 1927, as 4D Coordinate Planning system
1.2 1931-32, As basis of Teleologic economics, *SHELTER* Magazine, 1931-32
1.3 1933, Coincidental energy centers of car
1.4 1936-44, as basis of new map projection
1.5 1940-43, EG as a new comprehensive System of mensuration
1.6 1943-44, as publication monograph (science luncheons, Cosmo Club-Washington DC)
1.7 1944, as logistic reference frame for the Fuller House, Wichita
1.8 1943-44, Presentation to Yale Club Diner, Special lecture to the LIFE editors.
1.9 1945-50, College circuit[196]

In 1960, he began to describe how en route to his discovery of the "coordinates of the nature" in *EG* , he found a practical use for these principles in the geodesic structure. Paraphrased in another way, the geodesic invention was a mere piece of empirical evidence

[194]D. Robertson, *The Mind's Eye*, preface.
[195]Ibid., p.29.
[196]See copy of broadside in BFI-CR134.

needed to corroborate the speculations of *EG*. After a quarter of a century of artifactual demonstrations, Fuller summarized the process of science project to a journalist, Henri Pradier in the following way.[197] What started as a limited project to reform the production of shelters or to put it on a "scientific" basis, Fuller explained, had transformed into a more general one of uncovering scientific principles.[198] In another but no less dramatic rendition, Fuller reconstituted his empirical and pragmatic projects into a more boldly articulated and theoretical one:

> The Dymaxion House was simply a translation of the idea which emerged when I began to set my thinking in order. I did not set (out) to design a house. I set out for environment control. I might have come out with a pair of flying slippers.[199]

The re-presentation of the Dymaxion House as a science project was undertaken as early as 1938, with the publication of his collection of aphoristic essays, *Nine Chains to the Moon*, though in less fantastic and dramatic terms. The allusion of his repro-shelter as an application of scientific principles, was publicly articulated in this way:

> The Dymaxion House was *simply an attitude and interpretive principle*, - a principle of doing the most with the least in consideration of a mobilizing, integrating society necessitous of *breaking its exploitable bondage through science*. That the principle could be mechanically interpreted and that this was done for preemptive patent purposes did not infer that its research arrangements and mechanical and structural interpretations required by patent law as 'typical' were frozen against time evolving reinterpretation and adaptation[200] (Itl., my emphasis).

There is, of course, a gulf of differences in intent and purpose between a scientific pursuit and the activities of inventing. It is more compelling to suggest that Fuller's representation was driven by a desire to establish an aura of legitimacy for his practices. Such a motivation was also behind the installation of his geometrical tinkering as *EG* in the first place. However, the exaggerated purpose of *EG* does not in anyway diffuse its relevance to the creative route in the invention.

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[197]In 1960, Pradier proposed a UNESCO-book project, "Debut and Maxims of Life of the scientists of the Whole World." From the illustrious list of scientists (including Bertrand Russell, Einstein, Norbert Weiner, Fred Hoyle, Carl Jung, Arthur Compton, Max Planck, Robert Millikan, Linus Pauling, Oppenheimer) who Pradier claimed had responded to his solicitation, the inclusion of Fuller attested to his popular profile in the "science world" (See Ltr. 5/31/60 RBF to Henri Pradier in BFI-CR211).

[198]Ltr. 5/31/60 RBF to Henri Pradier in BFI-CR211.

[199]R.W. Marks, "The Dymaxion World of Buckminster Fuller," MS. Notes in BFI-HEv20, p.13. As the list of Fuller's artifices grew, so did the variations on his presentation of his "science-project":

> I did not set to design a house that hung from a pole, new type of autos and maps or domes. I started with the Universe, I could have ended up designing a pair of flying slippers ("Junior Scholastic Magazine," April 18 1962, MS. notes in BFI-CR228).

[200]R.B. Fuller, *Nine Chains*, p.340.

A Culmination of an EG Exploration

Much of the ground work for the first geodesic structure was accomplished before the summer of 1949, after what he described as "feverish days of work at Forest Hill." However, Fuller chose to publicly dramatize his "final" manuscript on geodesic art, assembled in the fall of 1950, as "Project -Noah's Ark #2."[201]

By the name "Project -Noah's Ark #2," Fuller intended, as he had done previously with *4D-Timelock*, to present his work as a kind of revealed knowledge. In this case, the name was directly associated with the biblical deluge, and implied a second creation. It was also to be read as a tool of salvation for an ominous apocalypse, thus exceeding the pragmatic "figurative buoyancy" suggested by Ward.[202] This new artifactual offering also reiterated the theological symbolism of the 4D-project, which he previously built upon the primal essence of light.

2.3.1.2.4. "Project-Noah's Ark#2"

The journal-manuscript was probably assembled at a date later than indicated on its signed cover (Summer 1950)[203][Fig.2.29a-c]. A few months earlier, Robertson probably assessed a preliminary version of this manuscript-journal, and concluded that it contained evidence of the significant conceptual grounds that *EG* was directly breaking with the geodesic application.[204] Both these groups of documents differ from the drawings presented as "Geodesic Structures: 'Noah's Ark II' 1950" by James Ward in *The Artifacts of R. Buckminster Fuller*.[205] Ward's compilation of drawings are not only unrelated to the geodesic explorations, but they are also wrongly gathered as a group [See Appendix I, for author's annotation of a list of drawings pertinent to the early experimentations on geodesic structuring]. Ward seriously erred in characterizing his grouping of unnumbered drawings as "templates" for the eventual unfolding of the dome projects.

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[201] See a signed copy of "Project -Noah's Ark #2 (Discovering New Man [sic] Advantage)," in BFI-MSS Noah's Ark 50.06.02. Henceforth as "Project -Noah's Ark #2."
[202] J. Ward, *The Artifacts of R. Buckminster Fuller.*, Vol.3, N.Y.: Garland Publishing Inc., p.31. Henceforth as *The Artifacts*.
[203] Eight page of sketches (unnumbered) within the folio were dated 8/27/51.
[204] Ltr. 7/19/50 Don Robertson to RBF in BFI-CR133.
[205] J. Ward, *The Artifacts*, pp.31-36.

Two Creative Features in the Great-Circle Geodesic

"Project-Noah's Ark#2" was consolidated after a series of structural experimentations at ID-Chicago and BMC; probably towards the end of September 1950. It contains two components, unrelated in time and content: twenty-three pages of text and twenty-five pages of diagrams. Subtitled "Discovering New Man Advantage," the forty-eight page manuscript is the definitive document which enunciates Fuller's three-way gridding. Nineteen pages of diagrams in this manuscript were regrouped in Ward's compendium under "Great Circle Mapping. Device Booklet. Late 1940s."[206] Of the remaining original six drawings, only two appeared in a separate location in Ward's compendium.[207]

There are two significant features in this journal-manuscript. They worked out the implications of the two programmatic elements in the research agenda enumerated earlier. Collectively, they established the uniqueness of Fuller's approach which led to the geodesic invention. Firstly, the connection to the mapping process which he developed in 1944, and second, his observations of the relationships between great circle geometry and the transformability of a sphere.

The first feature establishes the conceptual continuity in Fuller's creative process by directly linking the earlier map-making activity to the first great-circle geodesic structure. It reversed the process of his cartographic invention -- instead of translating a sphere into a regular polyhedron, it translated a polyhedron into a sphere. For this reason, Fuller's first great-circle geodesic structure was based on the cube-octahedron rather than an icosahedron, since the first map was made from facets of equilateral triangles and squares of a cube-octahedron.

The second feature was a homely contraption that demonstrated the relationships between great circle and transformability of a sphere [Fig.2.10a]. This contraption consisted of an equilateral triangle made of spring-steel straps with equally-spaced holes to contain steel rods and rubber-bands. Though it was primarily used to demonstrate radial projection from an imagined center, it had another serendipitous effect. The model demonstrated the physical workings of a multi-polar three-way grid. The model had flexible connections at its vertices. As it moved from one pole to the other, it transformed in stages, from a spherical triangle into a circle and back again into spherical triangle. This apparent pulsating quality, accompanied by attendant changes

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[206] J. Ward, *The Artifacts*, pp.11-17.
[207] J. Ward, *The Artifacts*, p.45.

in the radii led to the expansion and contraction of the spherical surface [Fig.2.10b & c]. With this "intuitively initiated empirical exploration," Fuller projected:

> This model then demonstrates the principle of transformation employed by nature in her prolific and facile structuring of contracting and expanding bubbles whose limits are only imposed by the original constants on the one hand of the aggregate of tensile structuring, of liquid components, – and on the other hand, - by the specific number of molecules to be enclosed compressively (in gaseous phase). The variable limits if association are determined by the net excess of time energy involvement if the latter compressive gaseous functions over the energy inherent in the cohesive limits of the tensed functioning of the liquid molecules.[208]

A larger significance loomed ahead of this pulsating effect. Fuller explained that it was identical to the effect of energy propagation:

> And in as much as our model is a physical complex experience and we seem to have been developing therefrom an exact agreement with wire transmitted radio transmitted communication signals, it will be seen that structural pattern, which is what our model demonstrates is *an identical phenomenon to wave and energy a (quanta) mechanics*, and therefore a new engineering era is opened up ... (by)(THE 3 WAY-GREAT CIRCLE GRID DISCOVERY)[209] (Itl., my emphasis)

The scientific speculation Fuller made of his analogical model might not warrant serious examination. Nevertheless, its fundamental value was a heuristic one. It assisted Fuller to visualize the transformability of energy as structure, and to make a direct connection between the mapping of sphere and regular polyhedra. These two features reinforced his view of structure as an energetic order, or in his words, an "energetic recirculating system." These characteristics immediately allayed doubts that his conceptual models were derived from the rational-biological model of D'Arcy Thompson.

Most significantly, the two sources account for how Fuller came to the issue of tesselating the sphere by viewing its rational sub-divisions as energy paths of great-circles, and that their patterns of criss-crossing were "energetically" related to the sphere in a series of regular, geometrical transformations. How Fuller arrived at these geometrical relationships is the subject of the following section.

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[208]J. Ward, *The Artifacts*, p.9.
[209]R.B. Fuller, "Project -Noah's Ark #2,"p.8.

The Actual Role of EG in Geodesic Structure Research

The map project highlighted a similarity, if not common expertise, that Fuller and Bauersfeld shared. Their respective experiences, during both World Wars, with the new world of moving targets, trajectories and speed directed both men to the geodesic geometry, albeit along different lines of investigation. These areas of ballistics and navigation were literally heightened by new views from the airplane. The searches were directed towards an elegant mapping and an economic description of trajectories. Krausse, for instance, illustrated how the knowledge accrued in weapons manufacture significantly shaped Bauersfeld's geometrical invention:

> Optics came to occupy a complementary position alongside ballistics," especially the air-war & the need for dynamic sighting devices (correct angle could be obtained without calculations)– the airplane turning the four dimensional time-space continuum into a reality.... In the 4-D space-time continuum, aiming by eye was no longer sufficient.[210]

However, unlike Bauersfeld projection project, Fuller's map-project was affected by his symbolic visualization of the world as an energy route. In a 1943 manuscript, "Motion Economics and Contact Economy," written while Fuller was in the employment of the BEW, he termed the Mercator projection, a map of the "pre-industrial era." This was an "era of controlled energy as motion of action, or heat of reaction," or "conceptually a world of several widely separated continents."[211] More sympathetic towards the ancient ovaloid maps, Fuller noted that their round concept was also symptomatic of the spherical dynamics of all the universe beyond and about man's small visible world. His own map invention, he proposed, befitted the new era of energy; as it emulated a "united geometrically realistic manner symptomatic of the great-circle which it prototyped it beyond the rim."[212]

Navy, Navigation and Ballistics -- and Great Circles

One could suggest that his familiarity with vectors and great circle geometry were shaped by his experiences in the Navy with navigation and ballistics. Both these practices are about energized bodies of ships or shells, and their trajectories in fluid and air respectively. As categories of fluid mechanics and force transmission, these experiences, one could say, prefigured a general predisposition for fluids, fields and aggregates over solids and individual particulates as

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[210] J. Krausse, "The Miracle of Jena," p.81.
[211] R.B. Fuller, "Motion Economics and Contact Economy," in BFI-MSS May 1943, p.56. Henceforth as "Motion Economics."
[212] Ibid., p.55.

representations of reality. They predisposed him towards the "fantastic simplicity" of great-circles and energy vectors.

The great circle arcs represent the shortest lines between points on the surface of a sphere and the great circle segment chords represent the shortest distance between two surface points on the surface of a sphere. The sphere, Fuller recognized, implicitly exhibited strength with economy of material. By extension, the great circles are geometrical representations of penultimate efficiency. But while the great-circle establishes the base element and the cartographic root of geodesic geometry, the random patterns of criss-crossing of great circles are inadequate; their combinations in some logical and efficient pattern were needed to enable the creative step towards the geodesic structure.

The pulsating contraption provided Fuller with the first palpable clue of the connection between great circle and the most stable minimal polygon, the triangle. The great circle arcs represented the structural transformative limit of an outward surface tensing by internal pressures; while the great circle segment chords represent the limit structural optimum for axii of compression resisting columns opposing external pressure by surface spreading.[213] In other words, spherical triangles do not merely provide rigidity to the great circles; rather, they were related in some logical geometrical patterns. Thus the great circle geometry was, for Fuller, a geometry that would "match (the) mobility and flexibility of nature," a "geometry of every phase of motion" -- a "geometry of nature - geometry of energetic universe."[214] Fuller established that relationship in the *VE*.

VE in the First "Dymaxion Map"

> I could see that the great circle geometric gridding of my map was leading to pre-glimpsed, omni-triangulated geodesic structuring.[215]

Before *VE* was evoked as a "zero-model" of energy and deployed as the first great circle geodesic structure, it was deployed earlier under a different context and name. The dating of *VE* is based primarily on Fuller's first published tract on *EG* in 1944. However, six years earlier in 1938 its geometry was deployed in a new type of map constituted from a polyhedral globe. Such a map, possibly the first and extant version of with great circle gridding based on the cube-

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[213] R.B. Fuller, "Problem of Industrial Logistics and Design Strategy," *Pennsylvania Triangle*, 1952 p.6.
[214] R.B. Fuller, "Transcription of Energetic Geometry Lecture at Cooper Union," April 3 1950, in BFI-EJA Blue, p.7.
[215] Ltr. 3/1/80 RBF to K. Snelson in BFI-EJA Green, p.13.

octahedron, was given to David Park, Emeritus Professor of Physics (Williams College), when he was a teenager[216] [Fig.2.35]. It shows four great circle lattices, each intersecting the other so as to subdivide each circle into six symmetrical arcs of sixty-degrees. The map was constituted from a cube-octahedron approximating on a globe-form; and thus it could be decomposed into its six squares and ten triangular components. David Park recalled that the primary concern of the map, as explained to him by Fuller, was to "plot routes for long-distance air travel."[217]

In 1944, Fuller offered his Dymaxion Map project as a new method of projection of spherical data onto plane surfaces.[218] The immediate goal of the new map, he proposed, was "to convince the U.S. population, both civilian and military, of the need for new geographical knowledge"[219] [Fig.2.14b & d]. A second version of the map, which Fuller called, "Dymaxion Projection Sky-Ocean World Map" was published in *LIFE*, March 1943; the final version, filed with the U.S. Patent Office in February 1944, received a patent in January 1946 [Fig.2.14b]. The invention in U.S. Patent #2,393,676 was issued for a cartographical method based on a cube-octahedron, or "Dymaxion" as Fuller christened it.

To understand how the geometry of the *VE* was related to the great circle geometry, it is instructive to examine the way Fuller viewed vectors. Conceptually, a vector tames and orders the amorphous and uncertain energy. The vector is also an attractive and economical form of representation. Whether used in setting a ship's course or predicting the path of a projectile, it contains information about speed and direction. For Fuller, it unified all aspects of the physical world as it stood for "all the qualities of weight, longevity and temperature (he had) sought."[220] In ballistics and navigation, vectors inhabit the great-circle lines, enlivening them with space and time. These routes of least effort for the particulates of energy momentarily integrated his earlier couplet of motion and time. For this reason, Fuller characterized great-circle lines or geodesic lines as "time patterns," and the only real patterns that would enable one "to see time (as) a visible quality."[221] Elsewhere, calling vectors as integrative time-space elements, *EG* is thus a

[216]See back-cover, *ANY 17*, "Forget Fuller."
[217]Email-Ltr. 6/21/98 D. Park to Y.C. Wong (Author's Collection).
[218]Hamilton proposed that *EG* as a search for a spatial coordinate system started with the *4D* charts. This led to the topological problem of spherical to polyhedral transformation which began in the maps (See R. Hamilton, "Notes on Structuring," MS. in BFI-HEv7).
[219]"Fuller Research Foundation Background and Purpose," p.2.
[220]Stuart suggested that from the experiences in ballistics and navigation during the "later days of World War I," Fuller had gained actual knowledge of the reality of collisions, that is a recognition that objects do not pass through one another. This observation led to an investigation in "omni-directional series of forces, with the tetrahedron as 'the first building block in the edifice'" (Ltr. ca. 1950 D. Stuart to B. and D. (Stuart) in BFI-EJA Green, p.2).
[221]R.B. Fuller, "Transcription of Energetic Geometry Lecture at NCSC, Raleigh, N.C.," ca. November 1950, in BFI-EJA Green, pp.11-12.

theoretical study of energy as geometry of vectors and time; and geodesic works are thus demonstrative "energy actions."[222]

Despite the continuous shifting targets in navigation and ballistics, the reference point of any observer on a ship continues to reinforce his centeredness. For this reason, Fuller was able to couple the centredness of this primary frame of reference with his earlier version of a radionic model in *4D Timelock*. This coupling reinforced his preoccupation with and interest in the nucleus of the cube-octahedron, which he termed "center of my (*EG*) system." In the ensuing metonymic process, he sketched the primary leitmotif of *EG*:

> In terms of my experience I have observed I can only start with myself as center and get my experience in terms of my time radially and circumferentially ... When I do that it is no trouble at all to come to new common centers. This system (of isotropic vectors) that I found of 12 around one grew to have more radial and more circumferentials.[223]

The universe as a field of isotropic vectors would, in Fuller's construction, exemplify energy spatialized in an ordered manner. Physical structures, as a sub-set of this universe, for the same reason, would be viewed as a special case of spatialized energy. As energy and space are inseparable, Fuller concluded that spatial and surface representations are diagrams of energy events. In this sense, *EG* was, Rosenberg quite accurately summarized, "geometry (of and) in action."[224] For Fuller, the demonstrative model of the live nature, was the "jitterbug" [Fig.2.04a].

Zero-model of Nature, *VE* and "Jitterbug"

David Park recalled that Fuller used the term "jitterbug" to describe his globe constituted from the cube-octahedron.[225] Fuller himself explained to L. Cochrane that the pumping "jitter-bug" model emerged before the *VE*. He recounted that between 1936-38, while working at Phelps-Dodge, he had tried to patent the "jitter-bug," but was advised that he could not patent a natural principle; rather, he was advised to use the his map as a demonstration of its unique application.[226]

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[222] R.B. Fuller, "Transcription of Energetic Geometry Lecture at Cooper Union," April 24 1950, in BFI-EJA Blue, p.2.
[223] R.B. Fuller, "Transcription of Energetic Geometry Lecture at NCSC, Raleigh, N.C.," ca. November 1950, in BFI-EJA Green, p.22.
[224] Sam Rosenberg, "The Man in the White Suit," BFI-MSS. by Others in BFI-CR64, p.2.
[225] Email-Ltr. 6/21/98 D. Park to Y.C. Wong (Author's Collection).
[226] R.B. Fuller, "A Sense of Significance," BFI-MSS 76.12.01, p.44.

Despite the immediate, albeit novel map application, the presentation of *VE*, as part of a larger research enterprise, was transformed by 1944. The "jitterbug" assumed Fuller's functional definition of a figurative demonstration of a living *VE*. The language to describe its working was primarily metaphorical. Geometry was used interchangeably with structure, and structure with energy circuits. Fuller's description of the octa-tetra couplet, the constituents of *VE* illustrated such metaphorical operations:

> In my interpretation of the tetrahedronal and octahedronal aggregation, the monometric legs of the common equilateral triangle *represents* uniform vectors. All vertexes *represents* force foci. One half of each vector is then a radius of uniform tangential spheres centered on these vertexes(sic). Natural symmetry and asymmetrical aggregations of these spheres appear to coincide with the numbers, positioning and behavior of atomic population.
> In my explorations the polyhedron formed by the central angles of the tetrahedron and the outside angles of the octahedron have been found to possess unitary values and to be employable as basic fields of force and as *fundamental switch yard* of convergent and divergent radiation. (Itl., my emphasis)[227]

To illustrate the "life" or the elements of time and movement in the "jitterbug," Fuller often demonstrated its physical transformability from a cube-octahedron to tetrahedron. Calling the process a "pumping action," the model allowed Fuller to account for wave phenomena as energy transfer. This was what Fuller meant by the "inherent movement of energetic geometry." It was, D. Stuart paraphrased, a demonstration of the "dynamic universe in motion," and an explanation of the "mechanics of the dynamic universe."[228]

Fuller's "jitterbug" is premised on the ideal sphere that is self-referential, in terms of contraction, wave propagation and oscillation. In perhaps the clearest explication of the relationship of the "jitterbug" to the energetic state of matter (conceived as a constellation of spheres), Fuller proposed:

> It might come to a point where we could look at energy as contained gases or crystal ... as crystals within a tetrahedron, the greatest compression; as liquid possibly at the octahedronal stage; as gaseous at the spherical (icosahedral stage).[229]

The "jitterbug" was thus a demonstration of an activated "static Dymaxion" transforming into an icosahedron by "pumping" action at its nucleus which, in turn, translates into rotation of the edges and the vertices [Fig.2.04b]. Fuller also called it a "wave mechanic model."[230]

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[227]Ltr. 7/2/46 RBF to R. Patterson (General Electric, Schenectady-N.Y.) in BFI-HEv6.
[228]Ltr. ca. Nov. 1950 D. Stuart to B. & D. Stuart in BFI-EJA Green, p.4.
[229]Transcript of Lecture from Wire-recordings at ID-Chicago, 11/13/48, p.8.
[230]R.B. Fuller, "Loose Notes" in BFI-EJA Blue.

The 1944 *EG* tract basically worked out a more systematic geometrical relationship of this model of energy, albeit a speculative one. The pivotal object in Fuller's speculative inquiry was nature's "zero model." Because Fuller assumed that all reality is energetic, he speculated that at the state of energy equilibrium, vectors are somehow isotropic.

Fuller had developed an awareness through his map project of the relationship between the geometric projection and great-circle aggregations formed by imploding spherical data inwards onto a cube-octahedron. However, Fuller concluded that the*VE* took the form of a cube-octahedron through a series of simple but astute studies of the closest packing of spheres. This probably happened between 1938-44.

Fuller was naturally attracted to the sphere; it has obvious practical and symbolic advantages. It represents the least surface-greatest volume configuration of all known regular geometrical solids. Elementally, it is also the extreme limit in the formal threshold of polyhedra, beyond which the sphere form dissipates. In the closest packing of sphere study, each sphere represents discreteness, that is, countability. This rendition of energy as a discrete entity was shaped by Fuller's reading of Avogadro's Law for gases. Edmondson, however, observed that the sphere had a paradoxical quality, namely "its shapelessness (in its omnisymmetry) enables (one) to explore the shape or space."[231]

Before the sphere, Fuller had observed the relationship of shape to force in plant cells. The sphere, he concluded, was the most adaptable in inter-transformability:

> In compression, a tangential agglomeration of spheroids is structurally the most satisfactory cellular arrangement since cellular elongations under compression tend to wedge and spit asunder their agglomerations. In tension, however, fibrous crystalline surfaced elongations of the globular cells are most frictionally cohesive.[232]

More directly and in a practical way, Fuller's interest in spheres had beginnings in the experiments with tube and cable for his 4D-Dymaxion House projects. For example, he had experimented with concentric hexagonals of steel wire and two-dimensional tessellation equilateral duralumin "bladder" in the floor structures of the Dymaxion House. The cable stays were bundled "elements in solid fibre-pack state"[233] [Fig.1.16e]. Later, in the DDM-Fuller

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[231]A. Edmondon, *A Fuller Explanation*, p.101.
[232]R.B. Fuller, *Nine Chains*, p.190.
[233]R.B. Fuller, "Universal Architecture Essay No.1," p.69.

House, the mast was made of bundled tubes from high-strength alloy steel. These structural examples represented an infinite system of structure in one direction and one plane.

The formal predisposition to the sphere also had religio-symbolic overtones. In the previous chapter, point-emanated waves and sphericity were the primary leitmotifs of "Lightful Houses." Fuller proposed that they represented "the omnipulsative physical Universe," and their "omnisymmetry" was symbolic of unrestrictive movement. So dominant was this motif that even hydraulics was explained as "structurally-balanced compression functions by elements in spheroidal liquid state."[234] Fuller elaborated the significance of the sphere further by suggesting that it contained "the progression of new dimensions of the expanding universe." This vitality and capacity to graph "multiplicity in time" tied the objects from the lowest to the highest :

> The rounded wheel, which at first was solid and later became compression and finally tension spoked (sic), and the "HALO" in decorative art as the unit symbol of energy or power God 'radiantly' expansive above man, is empirical testimony of long existing knowledge of a radiant tie dimension.[235]

Fuller subsequently secularized this symbolic sphericity as an "omni-directional halo." Even in this rendition, the ideological-symbolic identification remained, and it was presented as a paradigmatic, cosmic space: "One space. A cosmic democracy."[236]

Connection of Closest Sphere Packing Study to *VE* and *IVM* and the Jitterbug

> (The) sphere shrinks to a tetrahedron.[237]

While a matrix of equal vectors is most directly represented as tessellation of circles in two-dimensions; the closest packing of equal-sized spheres, represents vectors in space. Starting with an incremental addition of spheres around a nucleus-sphere, Fuller found that twelve spheres were required to encapsulate this sphere totally. Fuller's primary interest was in the contact points and relational geometry engendered in the arrangement. While he was aware of the residual octahedral spaces between adjacent spheres, he was not concerned per se with space-fillers which included cube and rhombohedron, and rhombododecahedron. Rather, with spheres alone as the primary constituents, he argued that their closest packing, whether in layers or

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[234] "Universal Architecture, Essay I," p.69.
[235] R.B. Fuller, *Nine Chains*, p.127.
[236] *Synergetics*, p.109.
[237] R.B. Fuller, "Transcription of Energetic Geometry Lecture at Cooper Union," April 3 1950, in BFI-EJA Blue, p.8.

"omni-directionally," represented a palpable and natural whole-number system which included volume relationships and "powering" dimensions.[238]

The contact points of the twelve spheres produce a cube-octahedron, a regular polyhedron with equal edges forming fourteen faces of six squares and eight triangles [Fig.2.09a-b]. Fuller concluded that this was the base pattern of isotropic vectors, *VE,* which reproduced infinitely, to form the "isotropic vector matrix" (IVM), where "everywhere (has) the same energy conditions." However, not knowing the cube-octahedron by that name, and convinced that he had chanced upon the geometrical model of nature at stasis, Fuller christened this model as Nature's *Dymaxion*. It was, he claimed "a finite system in universal geometry," and that spherical studies implicitly proved the instability of the 92-nd element on the Periodic Chart.[239]

In this act of ego, of naming his speculative model of Nature as *Dymaxion*, Fuller shifted the narrative of his repro-shelter to that of an energy machine. The evidence of this is obtained in notational form in one of Fuller's many marginalia:

> Energy Exchange. Dymaxion House = Autonomous energy exchange machine.[240]

The *VE* was supposedly a momentary and frozen whole picture of a configuration of natural energy tracks in equilibrium. Each point contains six positive and six negative vectors symmetrically arrayed around itself.[241] The symbolic significance of this "scenario" universe, Fuller explained, is as a "multi-optioned omni-orderly scheme of behavioral reference," a "most economic pattern of evolvement."[242] As a meta-model of energy relationships, *IVM* would subsume Einsteinian and Newtonian paradigms for radiation and gravitation respectively.[243] Such an ambition was evident in Fuller's claim that the transformations of his "Dymaxion" concurred with electrical and electromagnetic phenomena.[244]

VE and *IVM* were intended to be models of energy and time. In such a scheme, points are provisionally accepted as concentrated energy events; lines are vectors or trajectories of energy; and surfaces and spaces are the orbits and optimal configurations of these trajectories. The

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[238] See Entries #960.00 and #990.00, *Synergetics*, pp.533ff &pp.602ff respectively.
[239] R.B. Fuller, "Energetic Geometry," *Earth Inc.*, p.17.
[240] Fuller's marginalia in his copy of James Jeans' *Physical Science*, BFI-Library, pp.270-271.
[241] Entry #537.11, *Synergetics*, p.297.
[242] Entry #540.03, Ibid., p.304.
[243] Entry #960.10, Ibid., p.556.
[244] Fuller's marginalia in his copy of Sir James Jeans' *Physical Science*, BFI-Library, p.304.

frequencies, shapes and sizes of these trajectories are related by a comprehensive geometrical system revolving around the zero-model.

In *Synergetics*, the final Fulleriana science, *VE* would become its "true cornerstone,"[245] the "Grand Central Station in the Energy System of Nature."[246] For Snelson, however, the "zero model" definition of *VE* was an after-thought since Fuller found no living examples. He offered Fuller's explanation skeptically :

> The Dymaxion is elusive for the very reason that it represents nature at the dead center of all dynamic interactions. And because nature is always in motion- never arrested at dead center- we will never find any Dymaxions about, except those we ourselves construct-out of balsa wood or cardboard.[247]

With the central nucleus-sphere of the cube-octahedron assemblage removed, the *VE* is transformed into a jitterbug. It enables the polyhedron to oscillate towards the minimal polyhedron, the tetrahedron. In the frozen frames of this transformation, the cube-octahedron gradually appears to shrink to a tetrahedron. More importantly, Fuller saw the *VE* constituted from components of tetrahedra, with each tetrahedron representing the model of most direct and minimal energy network[248] [Fig.2.09b]. However, these details and developments are tangential to the inventive process of the geodesic structure.

The tetrahedron held the special position in this end-point topological transformation because it has the least volume and the most surface. In between, it passes through the icosahedral and octahedral state. The inter-transformability of this polyhedron convinced Fuller

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[245]The zero-model of equilibrium is summarized in Entry# 430.03:

> The vector equilibrium is an omnidirectional equilibrium of forces in which the magnitude of its explosive potentials is exactly matched by the strength of its external cohering bonds (*Synergetics*, pp.151-164; See also Entry #430.00-440.00ff).

[246]H. Kenner, *Bucky - A Guided Tour*, p.83.

[247]K. Snelson, "Not in My Lifetime."

[248]From these geometrical decompositions, Fuller would eventually forge his meta-science project, in *Synergetics*, of building block of the universe.

The lowest possible constituent "unit-volume," or "A & B quanta modules" are tetrahedra without symmetries, a student of Fulleriana *Synergetics*, argued that they contain the "geometrical data needed to reconstruct the whole system"(A. Edmondson, *A Fuller Explanation*, p.189.) Particularly, as a "mite," (a contraction of minimum tetrahedron), which consisted of two A- and one B-quanta modules, Fuller claimed that a "prime minimum system," the "cosmically minimal" all space-filler, is formed (See Entry #950.10, *Synergetics*, p.533).

Arthur Loeb provided a protracted explanation of these constituents, and further identified four instead of two particles. (See Arthur Loeb, "Contributions to Synergetics" in *Synergetics*, p.847ff.) For Fuller, the "quanta modules" were the geometrical equivalent of the biological genes. With A-quanta as "energy conserver," and B-quanta as "energy disturber," they also, Fuller postulated, "hint(ed) at the correspondence with the behaviors of neutrons and protons":

> A- and B- quanta modules - provide a satisfactory way for both physical and metaphysical, generalized cosmic accounting of all human experiences. Everything comes out rationally (Entry #950.34, *Synergetics*, p.535).

that the cube-octahedron represented the equilibrium configuration of an energy event, the "zero phase of energy." Since there is no absolute equilibrium, the *VE* represented the end-point of equilibrium, thus a zero model of "neutral resonance."[249] The underlying assumption Fuller employed in this modeling process is metonymic. The "smallest, maneuverable but complex system" has the full capacity to demonstrate and duplicate the behavior of larger systems.[250]

***VE* and Great-circle Geodesic**

Edmondson suggested that the close-packed spheres study was "at the root of Fuller's great-circle studies."[251] The geometry of *VE* immediately provides twelve contact points around the nuclear sphere -- six on one plane, six others in two sets of threes, on the adjacent sides, which when connected produce a family of twenty-five great circles. This process seems a rather convoluted way of making a spherical cube octahedron. But in recognizing that there is a relationship between the vertices of the spherical polyhedron and the great circle groupings, Fuller was able to extend these patterns to other regular polyhedra. In this way, Fuller was able to model the spherical icosahedron as a grouping of thirty-one great circles.

Fuller calls the spherical polyherdra of great circles that he created as "energetic models." They were, he believed, palpable demonstrations of how "stress flow(s)"[252]; just as he had suggestively characterized that it was the "tendency of energy as electron to associate with (the) exterior (of) spheres."[253] More vividly, Fuller characterized the energy circuit in this manner:

> Suppose we are energy and trying to go through all space in some kind of energetic system ... Find shortest distance through space is through points of contact ... One sphere to another ... 12 points of contact one sphere to another.[254]

In another way, Fuller proposed that his "25 dimensional studies" demonstrated "one condition of energy where it seems to stay on the surfaces (and) relates to the poles, (and) to

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[249]Edmondson termed this more directly as a model of "universal death" as a model in "meta-time" in the " absolute perfection of timelessness" (A. Edmondson, *A Fuller Explanation*, pp.98-99). Under Entry #921.02, Fuller explained the potential energy of "vector equilibrium packages" as "the centers of energy rebirth," to be actuated by time:

> The only dimension is time, the time dimension being the radial dimension outward from or inward toward any regenerative center, which may always be anywhere, yet characterized by always being at the center of system regeneration (*Synergetics*, p.508).

[250]R.C. Pooley & R. Ward, "The Energetic-Synergetic Geometry of R. Buckminster Fuller and Its Application to Geodesic Structures," SIU, Carbondale-Ill., 1962, p.2.
[251]A. Edmondson, *A Fuller Explanation*, p.228.
[252]R.B. Fuller, "Transcription of Energetic Geometry Lecture at Cooper Union," April 24 1950, in BFI-EJA Blue, p.9.
[253]Ibid., p.5.
[254]Ibid., p.6.

axes" and it was the limit of "explosive/free radiation effect."[255] Fuller explained that the great-circle aggregations were developed "relative to the spheres as the natural sectionalizing into planes that become diaphragm between the masses." These aggregations were "wandering of energy on the surface (that) have to go through the points of tangency as the shortest distance."[256] Further, he argued that the discreteness of energy required their representation as circles, in the wholeness of waves. Thus, the great-circle lines connecting the "vertices" of the spherical polyhedra were conceptually the pulsating traces of energy (energetics) of the compacted energy below. As projections, these traces contained the topological information of the polyhedron below. In other words, these traces collectively represent the "life" of the polyhedron on the surface.

Stuart described how Fuller began to work out the geometrical relationships between the great-circle aggregations of the spherical cube-octahedron and their central angles through a series of "foldable geodesics"[257] [Fig.2.09a-b]. This probably took the form of an assembly of circular cardboard disks [Fig.2.02]. Since early February 1948, he noted the significance of the method:

> (T)his general assembly sectionalizes total surface entirely into great circle triangles.[258]

In April 1948, he recorded his "swelling hunch" that in his "great circle folding" he had located with a comprehensive system to relate spherical geodesics, or in his words, an "absolute of geodetics (of geodesics) of families of families of force."[259] This was a system of accounting, based on great-circle aggregations, that would explain the transformative progression of the cube-octahedron to an icosahedron to an octahedron to a tetrahedron. His ability to develop the thirty-one great-circle aggregations corresponding to a spherical icosahedron convinced him of a potent method of making spherical geodesics. Later, he explained the concurrence of this folding experiment with structural investigations in crystallography:

> I found that all seven of those great circles assembled could be produced by folding whole circular cardboard disks which had been pre-creased to produce the appropriate set of central angles as derived by spherical trigonometry ... These seven sets of great circles comprise all the planes of symmetry of all crystallography.[260]

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[255]Transcript of Lecture from Wire-recordings at ID-Chicago, 11/13/48 in BFI-EJA Blue, p.7; see also Entry #986.470, "Geodesic Modular subdivsioning" in *Synergetics II*.
[256]Transcript of Lecture from Wire-recordings at ID-Chicago, 11/13/48 in BFI-EJA Blue, p.6.
[257]Ltr. ca. 1950 D. Stuart to B. & D. Stuart in BFI-EJA Green, p.10. See Entry #986.501 in *Synergetics II* for the elaboration of great-circle foldable discs.
[258]R.B. Fuller, Loose Notes in BFI-EJA Blue, 2/20/48.
[259]R.B. Fuller, Loose Notes in BFI-EJA Blue, 4/28/48.
[260]Ltr. 3/1/80 RBF to K. Snelson, p.16.

At this point with these data on central angles, Fuller made his first two-dimensional schema of the great circle aggregates -- one consisting of a basic triangle of the twenty-five great-circle geodesic [Fig.2.03]. This was followed by sketches of the great-circle chordal truss, which he termed an "atomic buckalow," a pre-cursor of the eventual great-circle geodesic gridding [Fig.2.05a]. Marks observed that this fundamental geometric pattern of great circles which Fuller "methodically compounded in all directions around one sphere" were master patterns that demonstrated "generalized constancy with respect to any nuclear patterning of the universe."[261]

Putting aside, for the moment, any harsh assessment of *EG* as a product of Fuller's presentation and exaggerated construction, the science project, nevertheless, was a very productive and unique tool. No doubt it was derivative and a science from a process of "make-do" -- an eclectic mix of the craft of geometer, numerology, scientistic rendition of the New Physics and thermodynamics. *EG* established two significant routes leading to geodesic invention -- one provided a metaphor of geometry as energy and structure; the other, ensuing from the first, redirected Fuller's research agenda from merely dealing with the physical aspect of the shelter. If there is any tangible uniqueness in Fuller's approach to the geodesic problem, the methods and objects of *EG* offer the most direct evidences.

In the "Dymaxion" map project, one could argue that Fuller's interests in practical geometry preceded his subsequent theoretical propositions in *EG*. Superficially, one could characterize Fuller's inventive step in geodesic structure as merely entailing a reversal of projective principles he had previously employed. However, it is this expanded agenda -- these acts of theorizing geometry as structure, and structure as energy that forged the bridge towards geodesic structuring.

On the other hand, Bauersfeld arrived at the geodesic solution from a purely projective project, converting the icosahedron into a spherical equivalent. He was operating within the limits of the Archimedean paradigm, namely, the classical solid geometry. Fuller's speculative and symbolic "zero model" of nature predisposed him towards seeing the edges and vertices of the cube-octahedron as orbits of great-circles. He particularly interpreted great-circles as energy orbits. His general reluctance to relinquish the cube-octahedron attested to this fixation. Thus *EG* , in interpreting geodesic patterning as active orbits of energy along the path of least travel,

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[261]R.W. Marks, *The Dymaxion World*, p.136.

rather than as lines joining vertices of a gnomic projection of light paths from a center, provided Fuller the significant break.

2.4. Public Process of the Invention – Prototyping the Domes, Implementing & Presenting the Research Project

2.4.1. Prototyping the Great-circle Geodesic at Black Mountain College (BMC) & Institute of Design-Chicago

With the first model of the 25-great circle geodesic completed at Forest Hill, Fuller undertook his first experimentation in geodesic structuring at BMC in July 1948. This was a project done in earnest. Prior to the start of this phase of his work, Fuller confessed to his close friend, Alfred Mansbach, that he had a keen interest to bring his "Dymaxion Energetic Geometry" from "comprehensive tasks through to working model form."[262] In Fuller's account, he had spent many hours of self-study on Energetic Geometry at Forest Hill from January through June 1948.[263] When he arrived at Black Mountain College(BMC) in Asheville, North Carolina, he was adequately primed for launching the first summer session in the history of the College.

Fuller's summer school workshop, forming part of the Summer Institute of BMC, lasted eight weeks. It revolved around themes he simultaneously developed in his thirty-six hours of lectures on *Dymaxion Architecture*, which included "Geodesic Structures and Philosophy." Various values that had been assigned retrospectively to this moment in Fuller's geodesic enterprise, either as start of a new science project or a historical aberration.[264] It was the general consensus that Fuller's summer program was one of enchantment.[265] Josef Albers prompted his return the following summer in hope to secure his "archive," presumably of the legendary models, and also the prospect of Fuller's assistance in securing "a few patron saints" besides "friendly intellectuals" like Gaty of Beech Aircraft Corporation.[266] The engagement initiated the first leg of Fuller's legendary, life-long college lecture circuit.

[262]Ltr. 2/9/48 RBF to Alfred H Mansbach (Cleveland, OH) in BFI-CR125.
[263]Refer to extant of "Loose Notes," variously dated form 1/1/48 through 5/27/48 in BFI-EJA Blue.
[264]Edmondson, an understudy of Fuller in the late seventies, proposed that Fuller's BMC experiments were prompted by his quest to model the invisible (See "The Deresonated Tensegrity Dome" in *Synergetica-Journal of Synergetics*, Vol.1 #4, Nov. 1986, p.2). More recently, distressed by the general apathy and public amnesia of both Fuller's work & BMC, Brower lamented that BMC and Fuller had been characterized as "two freaks of history that crossed paths" (Steven Brower, "Letter From Black Mountain College,"*ANY16*, pp.16.6).
[265]Ltr. 9/20/48 Josef Albers (Rector, BMC) to RBF in BFI-CR127.
[266]Ltr. 11/6/48 J. Albers to RBF in BFI-CR127.

Fuller's teaching engagement at BMC was not accidental, even if it was, in appearance, a fortuitous opportunity occasioned by a last minute cancellation of Betrand Goldberg's plan to run the BMC architectural course.[267] Goldberg was acquainted with Fuller through his associate Leland Atwood, an architect who had actively supported Fuller's 4D-Dymaxion project in the thirties.[268] Snelson, unaware of this long-standing connection, belittled Fuller's appointment as a "summer substitute for a legitimate architect."[269] Duberman, writing a history of BMC, similarly cast the entire "Summer Institute" project as a "peripheral" college and suggested that they were often contrary to its pattern of education:

> Summer institutes have, historically seemed to misrepresent Black Mountain - just as they gave the artists who participated in them a somewhat false image of what the quality of life in the community was like.[270]

Contrary to what had been proposed, Fuller's approach was constitutionally closer to the educational disposition of the College and the educational pedagogy of two of its primary trustees, Theodore and Barbara Dreier. Theodore Dreier spelt out the philosophy of BMC, and explained how Fuller fitted into it; namely, its opposition to "methods of mass education," its professed creative teamwork and its stress on "active participation." Dreier concluded:

> Needless to say we do not stress 'appreciation' as is done in most colleges but rather active participation ... Theory and practice were closely linked together ... Since the war we have not been able to get our work in architecture started again except during summer.
> Buckminster Fuller is exactly the sort of person whom we are looking for and a good many of us here are hoping that we can persuade him to come back ...
> We are more concerned with what people can do with what they know than how much they know.[271]

Like Fuller's illustrious non-conformity, the Dreiers came from a family tradition steeped in idealism and social commitment. Immediately, there was a fit between Fuller's pedagogy and BMC's "anti-academic spirit." Fuller's experimentalism also fitted into what Harris

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[267]Ltr. 7/3/48 to J. Albers to RBF in BFI-CR126; the letter routed via B. Goldberg provided details of the arrangement and terms of compensation for the proposed first summer session. The other summer staff included the artist William DeKooning and another architect from MIT, John Ely Burchard.

Goldberg had studied at Bauhaus-Berlin (1932-33) under Mies and later at Armour Institute of Technology. From the late thirties through the late forties, Goldberg was actively involved in prefabricated houses, housing and industrial units and hence the kinship of his professional interests to Fuller's life-long cultivation was not far-fetched. Fuller as Goldberg's replacement was, thus, natural (See Entry for "Betrand Goldberg" in *Contemporary Architects*, pp.293-295).

[268]See a number of drawings in *4D Timelock* attributed to L. Atwood.

[269]M.E. Harris, *The Arts at Black Mountain College*, p.146.

[270]M. Duberman, *An Exploration in Community. Black Mountain*, p.291.

[271]Ltr. 7/28/48 Theodore Dreier to Robert Reis (copy to R.B. Fuller) in BFI-CR124.

characterized as Albers and Reis's "pragmatic anti-eclectic, forward-looking view of technology and industrialization."[272] In other words, as art practices and education on the margin, BMC fitted Fuller like a hand in a glove and vice versa. Between an individual search for knowledge and the translation of that knowledge into a larger social project of industrialized housing service for "all the people of the world," Fuller's enterprise suited BMC's variety of Bauhaus social ideology, namely, as welfare towards society.[273]

2.4.1.1. The EG Models at BMC

By popular accounts, Fuller arrived at BMC with a trailer-full of geometric models preparing to embark on the next phase of his great-circle structuring project. These were models from the *EG*-study that he had conducted at Forest Hill over the previous six months. Among the geometrical paraphernalia was the magical "jitterbug" which Elaine de Kooning described as "an ingeniously-fashioned icosahedron."[274] The more significant object, however, was his mock-up for a thirty-one great-circle geodesic structuring [Fig.2.01].

It is not exactly clear when Fuller developed the thirty-one great-circle spherical analog for the icosahedron, even though by March 1948, he had established, using his jitterbug, its inter-transformative relationship to the cube-octahedron. However, it is highly unlikely that this was executed in 1947, as suggested by Ward's dating of a thirty-one great-circles drawing [Fig.2.05b]. In all likelihood, it was wrongly backdated by Fuller, and it is an inked-version (and presented upside-down) of another similar drawing[Fig.2.05c], perhaps the original, dated May 1, 1948.

One month before arriving at BMC, Fuller had already conceived of the great-circle geodesic structure as a "private sky" for dwelling [Fig.2.06]. He reminded himself of the significance of this great-circle routing as a structure and its implications in production:

> Due to the shortest distance girdling by great circles of metal in tension, sky becomes explosion 'proof' i.e. buildings blow outwards in explosion or cyclone or hurricane centers as

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[272] M.E. Harris, Ibid, p.14.

[273] Arthur Penn suggested that the general freedom of BMC augmented its community by and large "on the periphery of society." Its ethos was about "survival" and a place created for personal epiphany. Penn suggested that Fuller:

> joined a lot of other people who couldn't get a job either in the academic world, for a variety of reasons. It ... could be an epiphany for somebody, a way of really breaking loose from the circumstances, and having an experience that could start you on the rest of your life. And that was the remarkable thing about the place, and an awful lot of people, I think had that experience. Bucky certainly did (A. Penn, WNET (PBS Online) "American Masters series: Buckminster Fuller - Thinking Out Loud" http://www.pbs.org/wnet/bucky.cgi [NEH-NEA]).

[274] M.E. Harris, *The Arts at Black Mountain College*, p.146.

sudden low pressure engulfment(sic) causes now relatively high pressures inside structure to stress outwardly materials and construction of low tensile capacity....
As electrical charges always stay on outside great circle circuits of spheres - inhabitants of 'Sky' will be completely protected against electronic phenomena - lightning, etc. strikes steel buildings and ships frequently without knowledge of inhabitants. Multi million volt electrostatic generators - spheres of copper are inhabited harmlessly by workers due to this phenomena.
May 'print' aluminum strip great circle not only with intersection holes colored to code them to identical color holes in 'trending' strips for in place weaving - but may also imprint dishing(sic) to stiffen strut action between vertex, assuming outward set curve as normal and thus inducing use of high tensile properties while retaining resiliency of structure.[275]

Fuller elaborated his "private sky" in a series of concentric hemispherical shells [Fig.2.07] each to be assembled from thirty diamonds of a half-icosahedron. However, in September, at BMC, Fuller managed only to complete his first public demonstration of a great-circle geodesic structuring based on the great-circle geometry.[276] Dubbed the "supine dome," a project he "predicted to fall down," the forty-eight foot diameter hemisphere was made from thirty 76-foot strips of high-tensile aluminum Venetian blinds held together by aircraft bolts at precisely punched-cut holes. The dome failed due to buckling, and Marks recorded that Fuller quickly remedied the collapsed dome by fortifying the individual chords with a "prismatically arranged addition of two more Venetian blind strips"[277] [Fig.2.34]. Fuller assessed the significance of the "suppine dome" in this way:

> (W)e finished enough to show ... that the discontinuous compression, continuous tension system did take its designed spherical shape ... (and) that we had a delicate non-lethal method ... (to) safely learn that our new doming-over principle was valid ... *We could thus discover the critical point in the comprehensive structure between rigidity and collapse*.[278] (Itl., my emphasis)

Concurrently, Fuller claimed that he also assembled a thirteen-foot high mast, his first DCCT-mast from the ubiquitous material of the summer -- three strips of two inch-wide Venetian blind held together with Scotch-tape in a "back to back" configuration with the concave surfaces outwards, forming a tetrahedral cross-section. Two triangular "flying stabilizers," also made of

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[275]R.B. Fuller, Loose Notes, dated 6/15/48 in BFI-EJA Blue.
[276]A. Hatch, *At Home in the Universe*, p.191.
[277]R.W. Marks, *The Dymaxion World*, p.178. In Duberman's account of the "supine dome", based on his interview with Fuller in June 1969, Fuller's dome project at BMC in the Summer'48 was his third; Fuller claimed to have built the first and second domes at Forest Hill and ID-Chicago respectively. This is the implicit version suggested in Mark's photo-documentation in *The Dymaxion World*, p.178. The ID-Chicago dome is implausible, given that Fuller's engagement at ID-Chicago started only in October, after the first BMC summer session. Further, most of the experiments at ID-Chicago consisted of pent-hex panels, strut-hub assemblages. It is possible that either Duberman or Fuller (and Marks) confused that session with the second in 1949 -- in which case, the summer '49 BMC dome indeed would have appeared as the third (See Duberman's *An Exploration in Community. Black Mountain*, p.297).
[278]Ltr. 3/1/80 RBF to K. Snelson, p.22.

the Venetian stock and the intertensioning, kept the longest unsupported mast section to only five feet[279] [Fig.2.08].

The experimental gains made at BMC were significant. Even with a flimsy material like the Venetian blind, he was able to demonstrate the viability of the structural idea. It allowed him to work through the chordal factors accurately, and develop some preliminary ideas about the organization of its various components. The next step was to seek more rigid industrial materials and greater machining accuracy. His engagement, a full-time teaching engagement at ID-Chicago, awaited him in the fall of 1948.

2.4.2. ID-Chicago, Geodesic Dome as "Private Sky" as The Garden of Eden

Serge Chermayeff, who had recently assumed directorship at the Institute of Design, was primarily responsible for Fuller's appointment.[280] Possibly because Fuller's grandiose scheme for architectural and design education coincided with his, Chermayeff gave Fuller an almost free rein on the master workshop of the Departments of Architecture and Product Design, which comprised some twenty final year students. Fuller, in turn, confidently declared the tenor of his "Comprehensive Technique" and the spirit of his undertaking:

> This is a science and not a boast, - even if a most embryonic claimant to the designation.[281]

Fuller had intended for the geodesic structure to be used as a dome-house, or a "private sky," as he called it. At ID-Chicago, this was encouraged by Chermayeff's outline of a design brief, which he proposed earlier in spring. Chermayeff explained that he was interested in a new type of rustic dwelling. In opposition to the urban dwelling, which he characterized as "primarily a synthetic environment," he proposed that the rural free-standing dwelling would be "more closely in touch with nature":

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[279]Ibid., p.21. There is no extant photo-documentation of the mast that Fuller described; merely his reconstituted sketch. Further, two separate accounts cast doubts on Fuller's attribution of the date of his first mast. First, Snelson observed (in Ltr. K. Snelson to R. Motro) that among Fuller's assortment of geometric models for his evening lecture to (BMC), during the first summer session that there "was no such thing as a tensegrity or discontinuous compression structure in his collection, only an early, great circle, version of his geodesic dome."

Second, Stuart recounted that Fuller had used strutted tetrahedra to make a "mast (flimsily) at Black Mountain College *last summer*" (Ltr. 2/5/50 RBF to D. Stuart in BFI-EJA Green, Itl., my emphasis).

[280]Ltr. 1/28/48 Serge Chermayeff (President, ID-Chicago) to RBF in BFI-CR124, confirming Fuller's teaching appointment. The fall lectures were contained in approximately 100 hours of Wire-recordings, titled, "Geodesic Structures" and "Energetic Geometry" (See BFI-MSS 48.11.01).

[281]Ltr. 2/9/48 RBF to S. Chermayeff in BFI-CR125.

Our dwellings in nature have essentially the characteristics of urban dwelling. We don't live in direct, physical contact with nature. Would it be possible to develop a dwelling type which would virtually be a green-house enclosure, *a living garden*, interior space zoned for various activities including a 'cave,' *an enclosure within the enclosure, for special privacy*. Such a problem would require fundamental research in terms of light control, insect control, humidity control, acoustic control and would find its solution in completely unprecedented forms and structure[282] (Id., my emphasis).

Chermayeff's brief was probably shaped by his knowledge of Fuller's list of research projects, which included the "high-standard autonomous dwelling," even though these projects per se do not prescribe a "Garden of Eden."[283] This was, in essence, a re-articulation of the broad objectives of Fuller's own Dymaxion project. As a measure of the symbolic value Fuller assigned to this project, he dubbed the research pursuit as a "Garden of Eden."

2.4.2.1. An Industrial Vision of the Garden of Eden

In thinking about the autonomous dwelling, (Fuller) did not think of man as taking position apart from other man. Instead it was a switch to frequency modulation of man's facilities to increase his range of coming and going and his range of high standard existence as he enjoyed more and more of the fruits of the earth.[284]

For Fuller, the implication of industry on the design of a single family house remained an ideological one -- how to remain individuated and yet connected to a collective, how to reconcile between the personal and the shared. Like the 4D-Dymaxion project, he believed that his new "private sky" would be able to overcome this dilemma by engaging "all-surrounding superforces of the complex environment of man's actual and comprehensive universe."[285] This was in opposition to the biblical Garden of Eden, which if rendered as a social cryptogram was, Fuller argued, the "first important failure of the political theory of isolationism."[286] Now there was an added dimension in the widening gap between reality as described by science and the reality as experienced in everyday life which the industrial "Garden of Eden" would resolve.

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[282] Ltr. 4/28/48 S. Chermayeff to RBF in BFI-CR126.
[283] Cynthia Lacey, "Index of Survey of Fuller Research Foundation ... 5/1/46 to 3/8/48," BFI-MSS 46.08.01 in BFI-CR135. Henceforth as "Index of Survey."
[284] R. Hamilton, Transcript of "A talk by R.B. Fuller: Stretching our Resources to Adequate Levels," in BFI-HEv2.
[285] R.B. Fuller, "Motion Economics," p.28.
[286] Ibid., p.29.

Meanwhile, the "tentative reentry" into the Garden of Eden, Fuller proposed, would be achieved by developing a high-standard autonomous dwelling with key enabling mechanics[287] [Fig.2.11a]. The autonomous house would be an integration of its structure and mechanics. These were two aspects of building, Fuller observed, that had developed on separate lines. The mechanics had moved towards higher performance ("more with less") than the technology of structure; and though becoming smaller; it had grown extensive, thus creating an increasing mechanics-to-enclosure ratio. This schema of the house as one consisting of mechanics and structure was based on the automobile. Thus, for example, the "mechanics" of the building, Fuller listed, included circulatory components for reprocessing and supplying energy, sanitary controls; and mechanical extensions or "extra corporeal extensions" like household gadgets.[288]

The urgent and corresponding task to augment the increasing perfection in the mechanics, Fuller identified, was to develop a new minimal enclosure that would be an efficient chassis. While the end was the creation of the autonomous house, it would remain secondary in the context of the geodesic enterprise. In Fuller's personal record of the autonomous house package developed at ID-Chicago, he proposed that the mobility of the domicile required "Siamese twin relationship of house to utility."[289] The primary focus was to develop a new structure of high integrity, "so perfect" that one would be "almost completely unaware" of its presence. It would, Fuller proposed, be like the "human's own integral mechanics," for example, one's tongue and clothes.[290] This certainly was the idea behind his self-valving "gills" in a sketch for a "celestial private sky" [Fig.2.11b]. The utopian intent of this sketch lies in its implicit confidence, not only in the creation of a structure-enclosure to valve natural energy, but also; its potential to displace the mechanics altogether.

[287]"The Tentative Reentry of the Garden of Eden," was the title of Fuller's lecture for the 61st Annual Mtg. of the American Society of Landscape Architect, 29 June 29 1960. The theme for the meeting was "Planning for Space."
[288]R. Hamilton, "Mechanics," unpubl. MS. in BFI-HEv2.
[289]"T.B.I. (Trial Balance Inventory)," in BFI-HEv5.
[290]Transcript of Wire-recordings at ID-Chicago, BFI-MSS 48.11.01,12/16/48, p.3. See also R. Hamilton's argument of "mechanics versus structures" in his MSS Notes in BFI- HEv2 (ca. 1950).

2.4.2.2. Apocalyptic Undertones of "Everyman's Eden"

On a cursory inspection, Chermayeff 's design brief did not drastically differ from or alter the "mountain-top, moorable, skyhouse boat" that Fuller had propositioned in his 4D-Dymaxion project. The new "Everyman's Eden," as one journalist eventually billed this industrial version of the Garden of Eden, perpetuated the escapist theme of its predecessor. It offered no revolutionary social structure. It was merely a belated and extended recognition that, under the progressive destruction of the American natural landscape, escape into nature did not mean moving further into the frontier. It was now a make-do environment in suburbia; for one only needed to refigure one's immediate yard.

Fuller had previously championed population dispersion and decentralization as ways to escape the shackles of institutional control and the destructive effect of cities. For example , he explained the necessity for developing an autonomous water source and "liquid air" as a power source:

> It would be primarily our function to develop the availability of water, so that there would be *no political hold on the human family* in this respect.
> The house would probably make enough liquid air not only to run itself, but to supply its transportation unit.[291]

However, the new dispersion, contained in the ID-Chicago Garden of Eden project, was formed by a different apocalyptic overtone. Fuller surmised that there was a new and urgent reality after the nuclear detonations of Nagasaki and Hiroshima. Following the arguments of the military strategists, Fuller similarly agreed that the scattering of the cities and industries and civil preparedness in peace-time were "the only practical defense."[292] Atomic warfare changed the scenario for defense because of its extensive capacity and range in territorial destruction; thus, one military source suggested that deployment and mobilization were prudent forms of deterrence:

> A country could 'absorb' a considerable number of atomic bombs, especially if it has prepared for attack by dispersing its essential war industries, military stock piles, and armed forces (particularly getting them out of the vicinity of large cities) and by making each of the

[291] "SSA Minutes of Meeting," 12/16/31, pp.8-9.

[292] Among the material Fuller used to support his "High-standard Autonomous Dwelling" project were a number of defense-related summaries that argued for decentralization: "No adequate Defense against the Atomic Bomb" in *Army Talk 106* (War Department, 19 Jan. 1946); *Army Talk 139*, War Department 14 Sept. 1946; The United States Strategic Bombing Survey (The Effects of Atomic Bombs on Hiroshima & Nagasaki – Chairman Office), 30 Jun. 1946; The United States Strategic Bombing Survey (The Effects of Atomic Bombs on Hiroshima & Nagasaki – Pacific War), 1 July 1946 (See copies in BFI-HEv4).

smallest subdivision as economically self-sufficient and independent as possible so that the effects of each bomb strike would be localized.
If now instead of a single country, we consider the entire Western Hemisphere, properly organized, as the defensive unit, it is immediately apparent that even a large-scale surprise atomic bombing attack could hardly destroy its ability to retaliate before counter-measures could be initiated and the atomic war carried to the aggressor country[293]

The Garden of Eden proposal, thus, was a denial of the portent nuclear warfare. When Fuller described his Garden of Eden brief, code-named T.B.I. (Trial Balance Inventory), as a "comprehensive chattel mortgage," it was disguising the apocalyptic total death, in a nuclear confrontation. The designer had to assume only the "best of contents," costing $18,000, for a family of six, to be organized under the assumption of a "city of 50,000 bombed out in 10 days."[294] T.B.I. thus repressed the apocalyptic fear by sedating its dweller with a consumerist paradise of mix-and-match paraphernalia from a wood-working machine to a Steinway concert grand piano. The Garden of Eden was the kind of "anticipatory apparatus" that Fuller had earlier described during the war years:

Life-rafts, life-belts and life-boats in plentiful evidence, together with frequent drills mutely assure the sea-traveler. The forthright investment in anticipatory apparatus may pay off, although the apparatus is never used seriously.[295]

However, for the moment, the proposed regeneration of American urban life lies in the idyllic setting of personal gardens rather than in the communal Eden. This paradise thus restored, a veritable pleasure garden would reconstitute and redeem urban culture and the hideous landscape that industrial life had engendered. The idea of the Garden of Eden returning to affect the shape of the city was proposed by Fuller. He suggested this need to reverse the urban to rural strategy for the "industrialized house":

My own set problem was to produce the right house with the right solutions, introduced in remote places and then advance into the populated places, on its reputation. Then what the public will demand is what they want.[296]

2.4.2.3. A Research Program Spurred by Impetus from Civil and Military Deployment

From Stockade to DDM-Fuller House, Fuller had sketched an innocuous background of interests in the study of tension and compression under very different functional conditions.

[293] *Army Talk 139*, War Department, 14 Sept. 1946.
[294] R.B. Fuller, "A Preview of Building" 4/1/49, in BFI-CR129, p.3.
[295] R.B. Fuller, "Ltr. of transmittal" [Departmental], 1/10/44 in BFI-HEv4.
[296] "Industrialized House Forum" at M.I.T. School of Architecture & Planning, Jan 6-7, 1950, p.25.

These formal and technical developments were also consciously selected and presented by him to advance his research agenda for the autonomous shelter.

World War II, the wars of air and missiles, brought the deadly meaning of great-circles, literally, closer to home. The war signaled the end to the false psychological comfort of "relatively remote front." Fuller himself ominously observed on the eve of his geodesic research program that with the integration of world resources, war now is total:

> With the development of totality, war has come to be waged not as much on many fronts as on many spots. Differentiation of lands and sea has been lost in significance of one-sky ... Total war involves ultimate controlling of missiles from anywhere on earth to anywhere on earth Long distance is total and the concept of front has vanished.
> As offense obtains omni-directional parity, supremacy lies in relative defense advantage. Relative defense advantage lies in the direction of relative mobility, in the ability to dodge widely without loss of poise - not to dig in.[297]

The events in Hiroshima and Nagasaki gave his research agenda a new poignancy. It directly addressed a systematic evacuation of the city through the portability of personal, public and tactical environments. The new geodesic structuring would gain its credence in fulfilling security objectives because of its lightness, fleetness and mass-producibility.

2.4.3. Fortifying the claims

The deployment of T.B.I and the autonomous house project were meant to demonstrate the practical application of the geodesic structure to a an imminent crisis. However, the primary strategic value of Fuller's experiments from fall to summer of 1950, at ID-Chicago, lies in fortifying the "definition of terms" of his geodesic patent. Fuller worked earnestly on a range of geodesic variations. These consisted of the hub-and-strut and the pans of interlocking or interconnected sheets or plates. They were intended to demonstrate how that a geodesic structure could be "skeletal" or "continuous" respectively.

2.4.3.1. The choice of the Icosahedron--a Practical Option

Despite his preference for the symbolic elegance of the cube-octahedron, Fuller finally settled on the icosahedron as the base polyhedron for his geodesic structure. Fuller had also

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[297] R.B. Fuller, "Preview of Building," p.208 (See also Univ. of Michigan, Ann Arbor, Mich. 7th Annual Conference "A Mid-century Report on Design Progress" (Apr.1, 1949), in BFI-MSS 490400).

considered the spherical octahedron and the tetrahedron; at one point even opting for a "generic" definition of geodesic structure as a sub-division of spherical polyhedra whose modularly-divided edges are interconnected by three-way geodesic grids, and wherein such edges are geodesics.

Fuller's choice of the icosahedron breakdown was a strategic one. The icosahedron contains the maximum number of twenty equilateral triangles; and its spherical counterpart thus guarantees more similar parts in production. The increased number of triangular surfaces meant more points and directions to dissipate any potential loadings; and with shorter chords, there is increased slenderness ratio, heightening the rigidity. Further, as the number of triangular facets increase on the spherical surface, the closer it approximates the sphere: and the chords approach arcs. Thus, the larger the number of sub-divisions, or the higher the frequency of triangulations, more the polyhedron becomes indistinguishable from the sphere.

In "A History of the Development of Domes and a review of recent achievements world-wide," Makowski misread Fuller's 1951 patent, assuming that it was a "triacon" breakdown.[298] Nevertheless, referring to Fuller's spherical icosahedron breakdown, he noted:

> Practice shows that, for larger span domes, *the primary type of bracing, which is truly geodesic*, is not sufficient since it would lead to an excessive slenderness ratio of the bracing struts which are too long; therefore, *a secondary bracing has to be introduced which is no longer geodesic*[299] (Itl., my emphasis).

Fuller himself recognized that the spherical icosahedron could not be considered purely geodesic since only the edges of the spherical triangle lie on the great-circle lines. He inserted this detailed description:

> The structural members may be aligned with all lines of the three-way grid or just with selected ones of those lines. If the members are accurate, or spherical, they will coincide with the grid lines; if they are straight or flat they will be chords of the great circles which are the grid lines.[300]

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[298]While Fuller's "preferred construction" is based on a grid formed by modularly dividing the triangle of spherical icosahedron along its edges; his omnibus claims also included a "Triacon" breakdown (that is a subdivision of the spherical triacontahedron. See Fig.15 of Patent); though not recognized or acknowledged by Fuller as such. What obliterated this pattern was the realignment of the longitudinal axis of the constituent weave-pieces along the edges.

[299]Z. Makowski, *Analysis, Design and Construction of Braced Domes*, p.35.

[300]U.S. Patent #2,682,235.

Because U.S. Patent #2,682,235 alluded to such a broad coverage, and one based on a geometrical pattern, Don Robertson noted that the claim was as close as one can get to patenting a principle. However, it is also clear that Robertson himself counseled Fuller towards this claim:

> One possibility to be considered is *to assert claims to the pattern of the geodesic structure*, including also more specific claims directed to the locking feature of such structures in which the diamond sections are interlocked as by inserting the ends of the members of one section into sleeves or ferrules fixed to the ends of an adjoining section or module[301] (Id., my emphasis).

Besides containing the largest number of equilateral triangular facets, the "five fold interactions" of the icosahedron provided "self-blocking or counter rotational brakes in the pattern of surface vertex truss interactions." More significantly, Fuller's preference for it was influenced by its position in his energetic accounting system in the hierarchy of polyhedra:

> The icosahedral stage is the max-or-min limit of extreme distortion between the DYMAXION and the octahedron and is the DYMAXION-contracted-to-sphere or convexity stage of hierarchy of primordial expansive-contractive transformations, it is the universe-subsidence from when one interaction center contracts, and it is the dynamic equilibrium of expansive-contractive forces in the omnidirectional discontinuous-compression-continuous tension STRUCTURAL INTERACTION ADVANTAGE in six-function resultants.[302]

Thus, the primary breakthrough of the prototyping process as recorded in "Project-Noah's Ark#2" was neither, as Ward erroneously surmised, "the materialization of the great-circles" nor "the first studies of the hardware and materials that would make the domes a palpable reality."[303] Both these aspects of the geodesic experimentation had already been adequately demonstrated in the BMC and ID-Chicago domes. Rather, its significance lies in the declaration of a new way of gridding the sphere, stepping away from the limitations of the basic triangle configuration in the great-circle geometry which depended on the cube-octahedron. Nevertheless, the multi-polar method of subdivision of the spherical surface to produce a geodesic geometry for structural application remained.

Joseph Clinton identified that there are fundamentally two types of subdivisions of a polyhedron, the bi-polar and multi-polar. The bi-polar consists of latitude-longitude division producing ribbed and lamella domes; and multi-polar subdivisions producing the geodesics of tetrahedron, octahedron and icosahedron.[304] Conceptually, this differentiation already suggests

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[301]Ltr. 7/12/51 D. Robertson to RBF in CR-BFI?
[302]Ibid., p.11.
[303]J. Ward, *The Artifacts*, Vol.3, p.31.
[304]J. Clinton, "Advanced Structural Geometry Studies Part 1: Polyhedral Subdivision Concepts for Structural Applications," pp.1-2.

that Fuller's great-circle geodesic was derived from an all-around projection of map-making rather than based on the primary architectural binary of up and down. Such a binary system developed around gravitational forces favored bi-polar breakdowns, producing ribbed and lamella domes.

There are three possibilities of orientation with respect to the three-way gridding of the icosahedron, namely, the face, edge or vertices of its constituent equilateral triangles. Fuller's approach at this point dealt primarily with the edges. This method termed alternate or Class I geometry, consisted of equal arc division of the central angles of any given polyhedron. Fuller explained that his new discovery was based not on the great-circle geometry, but rather on a topological subdivision of the surfaces of an icosahedral spherical triangle, after a series of investigations between January and July of 1950.

Two primary aspects of his investigations together with those of his students led to and expanded this research route. The first one arose from a pragmatic necessity to find new ways to subdivide the basic triangles to create greater rigidity in the triangulation. The second involved the simplification of the joint systems, which had previously consisted of the hub-and-strut or panels fastened along the edges. Such simplification, he believed, was achievable by using self-fastening parts. The intermediate experimentations arising from this requirement produced component types called "bandages" and "egg-crates"[Fig.2.10d & e]. The term "bandage" was used previously to describe the interweaving of twelve great-circles in the spherical cube-octahedron. The nomenclature using everyday-life references, is itself telling. Besides the quaintness and innocence that they evoked, each term was also a direct illustration of covering for the spherical surface along an extended idea of weaving; so was the next step which led to the "zig-zag" process. It was a process for tessellating a spherical surface based on three-way gridding.

2.4.3.2. The Significance of Zig-zag and Three-way Gridding

The process of "zig-zag" elegantly connoted and exceeded the mere tessellated projection on a spherical surface in three ways. Firstly, it returned figuratively to Fuller's notion of energy -- energy quanta like projectiles, zipping through a latticework of least distance paths; sliding along and yet not colliding with one another. This figuration materialized the energized circuit that Fuller conceptually alluded to in his *EG*.[305] Second, the "zig-zag" enabled the making of a collapsible assemblage and recast the inter-transformability of his jitterbug in a new way. Third, the apparent simplicity of the "zig-zag" considerably simplified the production and construction of the dome components. As thin, linear elements, they could be stamped or printed on a rotary printer and assembled without the need for an elaborate coordination of joints as was required in the hub-and-strut and panel systems. Yet, despite the elegance that this structure promised, Fuller did not include it in his first geodesic patent application of December 1951. It would, however, reappear in the second patent application, four years later, in a system of paper-board domes.

2.4.3.3. Pragmatism of the Zig-zag

Each zig-zag motif allowed for a pragmatic re-aggregation of two spherical icosahedron equilateral triangles in a new way; namely, as a rhombic-shaped diamond. This would eventually give rise to other patterns of subdivisions of a spherical surface. The move towards the diamond geometrical configuration improved four aspects in the geodesic art. Firstly, there are more similar and smaller triangles of substantially, though not precisely, equal dimensions, whether the eventual spherical surface is constructed from pan or from hub-and-strut systems. Immediately, the new configuration reduces the number of triangles in the great-circle geometry from ten to six. Second, though the diamond configuration generally produced more interfaces or created more hub-joints than a great-circle division, they both avoided the dominant connection problem at the hub. For example, there are twelve and ten struts at the hexagonal and pentagonal points in the thirty-one great-circle geodesic structure respectively. Third, the linearity of the elemental "zig-zag" allowed for more manageable panels or pneumatic bags to be fitted in between the diamonds, solving the skinning problem encountered in the hub-strut BMC & ID-Chicago domes. Finally, the "zig-zag" indirectly created the notion of "trussed" geodesic elements [Fig.2.30a & b] which directed Fuller to reexamine the hub-strut configuration in a three-dimensional manner. Initially, this appeared as a more fantastic arrangement which he had dubbed "high speed expanding, skinned & trussed 3-way geodesic structure" [Fig.2.30c]. This system of assemblage, containing both hubs and cables and arranged in a tetrahedral configuration was, in essence, two concentric spherical icosahedra. This idea of cable tensioning was not new; one that Fuller had employed in his earlier working details for the thirty-one great-circle dome [Fig.2.16b-c].

[305] Clinton recounted a hypothetical question that Fuller had advanced about imaginary atoms on the surface of sphere. Given that they either repel or attract, Fuller posed: "Where would they arrange themselves?" (Notes from Author's Interview with Joseph Clinton, 10/22/94, Santa Barbara).

Fuller proposed that the structural experimentation or "species evolution" as he called the work, was shaped by the "practicable limits for ease of manufacture, storage, packing, shipment, handling and erection."[306] In retrospect, the experimentation could also be seen as broad tactical moves rather than accidental or chanced explorations. Fuller described the urgency of "Project - Noah's Ark #2" as an "utter emergency priority data," which "if it had not been prepared would occasion the almost unbearable protraction of his mortal difficulties." He strategized the need for "the realization in all range of magnitude of structures from high speed printing press methods of industrialization and facile untrained techniques of installation."[307]

In the broad sweep of study of geometrical configurations and experimentations in structural "embodiment" from weave, hub-and-strut, panels and trussed strut-hub and cables, Fuller and his most prolific students, particularly Jeffrey Lindsay and Don Richter, collectively articulated a blueprint of four different types of domes and their respective structural refinements.[308] The fiberglass pan-assemblage developed into the radomes, the zig-zag into the cardboard dome, the hub-and-strut into the more elaborate trussed system. These tactical moves culminated in the strategic claims of U.S. patent #2,682,235 which Fuller filed in December 1951.[309]

2.4.3.4. A "Patented Error"

Up until the time when the geodesic patent claims were filed, an outstanding problem encountered by Fuller and his experimenters was in the geometry of three-way great-circle triangular subdivisions. This triangular subdivision, the type filed in Fuller's geodesic patent, is presently known as a class-one alternate breakdown. In a dome with frequency higher than four, that is, a dome based on four regular subdivisions of the principal spherical triangle of the polyhedron, they observed peculiar left-over triangulations or "window openings" at the intersections of chordal elements on the spherical surface [Fig.2.38]. They had adduced the cause in the inaccuracies of their calculations. The continuously reworked sets of chordal length and

[306]U.S. Patent #2,682,235, 29 June 1954.
[307]"Project - Noah's Ark #2," p.14.
[308]Others playing minor roles at ID-Chicago were Ysidore Martinez and Louis Caviani.
[309]Duncan Stuart argued that a patent as an object and process were cumbersome. Idealistically, he argued, it would have been more in line with Fuller's radical position, if, like Galileo, he "simply wrote cryptographic to all of his friends to establish prior art." Rather, the fixation with patent "cluttered up (his life) with a paranoia that seemed to govern him." Stuart offered this reason:

> Well, Bucky came from a cultural milieu where that's what a person did ... that's how one organized one's life, and he wanted to be a success somehow ... measured in some terms ... It gave his life a kind of social structure which it would otherwise have lacked (Notes from Author's Interview with Duncan Stuart, Raleigh-N.C., 4/26/95).

central angle calculations among Fuller's working files attest to this assumption. This "anomaly" probably accounted for the design of various "turbine joints" to circumvent the problem of the "inaccurate" window openings [Fig.2.22b].

In 1950 at M.I.T. Fuller finally gained access to logarithmic tables worked to five places of accuracy. Besides believing that this might provide more accurate calculations of the chord factors for the geodesic geometry, Fuller also highlighted another advantage:

> (By) getting the calculations through at 0X° XX' XX.XXXXX," i.e. at 100,000th of a second of arc ... we will be masters of our tolerances.[310]

Nevertheless, the inherent nature of the "windows" in the grid translation remained unexplained even after the patent was granted.[311] This problem had been disguised in the lower-frequency dome because of the higher tolerance of connecting parts. However, in the larger domes which necessitated higher frequency spherical triangular subdivisions, the cumbersome problem surfaced. Duncan Stuart was primarily responsible for an in-depth study of an alternative for the triangular subdivision as part of his research initiative at Skybreak, Carolina. The basic work was done in the winter of 1950 alongside his experimental gridding of the sphere with lesser circles [Fig.2.19c]. Stuart proposed the sub-division this way:

> (I)f we can 3-way grid a face lying in a lesser circle to sphere with straight lines, that the same pattern may be extended to surface of sphere and the straight lines become geodesics. This will be true regardless of our method of gridding(sic) the flat face.[312]

The method Stuart proposed was clearly antithetical to Fuller's energetic concerns that had earlier predisposed him towards using the method of great-circle gridding. In the same way, Stuart's spherical triangular breakdown, based on the "triacon" polyhedron (rhombic triacondehedron) was a conceptual breakaway because it escaped the limits of Fuller's principal spherical triangular boundary. Fuller's preference for the icosahedron stemmed from his experience with the limits of the great-circle geodesic; namely, to overcome larger dome configurations which inevitably produced larger geometrical subdivisions. Also, to maintain an

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[310] Ltr. 11/5/50 RBF to J.W. Fitzgibbon in M. Fitzgibbon's Private Collection of Letters. T.C. Howard also recounted that despite "twenty-place tables," Fuller maintained that they did not have "accurate enough trig(onomtery) tables" (Notes from Author's Interview with T.C. Howard, Raleigh-N.C., 4/26/95).

[311] For more technical treatment of this phenomenon, see J. Clinton's "Advanced Structural Geometry Studies Part 1: Polyhedral Subdivision Concepts for Structural Applications," (pp.18ff). This prompted T.C. Howard to suggest that Fuller's geodesic patent was a "patented error," one that Don Robertson, Fuller's patent lawyer became aware of only many years later (Notes from Author's Interview with T.C. Howard, Raleigh-N.C., 4/26/95).

[312] Ltr. 9/28/51 D. Stuart to RBF in BFI-EJA Green, p.1.

economy of scale, to minimize the number of kinds of parts, and to reduce the potential waste that might arise in odd sizes, Fuller had worked with a standard industrial sheet measure of 48-inches. Nevertheless, in the summer of 1952, Fitzgibbon reported the completion of a "whole new system of mathematics in the grid system":

> (Stuart) has complete math on a wide range of frequencies not covered by the present calculations. This he is preparing as a surprise bundle for you & this note is not going to lessen the surprise when you see the magnitude and the importance of this work.[313]

Stuart's treatise on the triacon, "A Report on the Triacon Gridding System for Spherical Surfaces," contained truss data ranging from two through sixteen frequency.[314] In the triacon breakdown, constituent spherical triangles are linked to adjacent ones by diamond-shaped rhombi formed by connecting the vertices to the center points of opposite edges, with all lines passing through the centriod of the triangular faces [Fig.2.19a & b]. Thus, instead of sixty individual triangles of the icosahedron, the triacon breakdown effectively doubled up these triangles into thirty diamonds. Most importantly, the grid-line translation of the polyhedral lines intersect very precisely, simply and directly.[315] Though clearly standing apart from Fuller's method, the alternate system of triacon gridding (also known as Class II) was eventually absorbed into Fuller's geometrical fold. Stuart described the process thus: "(Fuller) never openly admitted that (the triacon) had been a contribution, he simply rubber-stamped his patent stamp on it."[316] For Fuller, Stuart's triacon was merely an "icosahedronal adaptation."[317] Elsewhere, he called Stuart's contribution one of many "omnisymmetrical omni-triangulated systems" that fell within the purview of his general geodesic principle [318]

2.5. Expanding the Research Project – Fuller and the Colleges : BMC and ID-Chicago (1949-52)

At the conclusion of the fall semester at ID-Chicago in 1948, Fuller had successfully fabricated a version of his thirty-one great-circle geodesic dome. This was a14-foot diameter dome of hub-and-strut. This consisted of six basic chordal tubes of 24ST aluminum, kept along the great-circle lines with internally laced tensioning aircraft type cables; and stayed in place by

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[313]Ltr. 6/9/52 J.W. Fitzgibbon to RBF in BFI-CR139.
[314]Document was dated 6/4/52, copyrighted to the Skybreak Carolina Corpn (Copy in BFI- EJA Green).
[315]Notes from Author's Interview with Duncan Stuart, Raleigh-N.C., 4/26/95, p.9.
[316]Notes from Author's Interview with Duncan Stuart, Raleigh-N.C., 4/26/95, p.44. Since BMC, Fuller's basic polyhedron for projection onto spherical surfaces had been primarily the tetrahedron, octahedron, cuboctahedron, the icosahedron, and the dodecahedron.
[317]See *The Artifacts*, Vol.III, p.78.
[318]R.B. Fuller, Entry #123.32 in *Synergetics*, p.43.

hubs and screws -- hence, the name "necklace" dome. There were six type of hubs, which were "cast, split aluminum blocks, milled to relieve the cables at the points where the cable cross provide the means for properly distributing compression load on the tubes"[319] [Fig.2.16a]. In January 1949, convinced that he had a structure that performed better than all previous ones that he prototyped, Fuller contacted retired Maj. Gen. Follet Bradley, a colleague of R. Gilmoor, one of the FRF trustees, to sound out his military connections. Fuller had maintained a record of the quantitative performance of his structures from 4D-Dymaxion to DDU-DDM Fuller House. In the new treatise, Fuller claimed that the new three-way curvature geodesic was thirty times more efficient than the DDM-Fuller House in terms of weight of material used to enclose a "interior usable cubic feet" of space.[320]

2.5.1. The Pentagon Dome – Accommodating Military Needs

Aware of the standing military needs for housing its officers and enlisted men, Bradley recommended that Fuller approach two military men put in charge of the problem: Maj. Gen. Grandison Gardner (Dir. of Air Installations) & Maj. Gen. St. Clair Street (Air Inspector).[321] Within a period of a week, Fuller contacted Gardner to arrange for a demonstration of the structuring capability of the new dome.[322] Over a weekend in March 1949, Fuller successfully installed the "necklace dome" in the garden courtyard of the Pentagon after an earlier rehearsal, in Chicago, at assembling the dome under three hours.[323]

Generally pleased with the military reception of his dome, Fuller agreed to Gardner's suggestion for further and more stringent tests on the dome.[324] Gardner had earlier suggested that tests be run on the dome in the cold hangar to evaluate its "thermal possibilities," and that Fuller and his "boys" consider building a dome for "two families or even four"[325] [Fig.2.15]. Under

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[319]Melvin Griffing (Mech. Products Section - R&D, Military Planning Division, Office of Quartermaster General), "Tube and Cable Structural Framework," 4/14/49 in BFI-CR136.
[320]R.B. Fuller, "Project - Noah's Ark #2," p.13 See also R.B. Fuller, *Designing a New Industry*.
[321]Ltr. 2/9/49 Maj. Gen. Follet Bradley, ret. (Aviation Coordinator- Sperry Gyroscope Corpn.) to RBF in BFI-CR136; also his letter of appreciation, Ltr. 2/20/49 RBF to Maj. Gen. Follet Bradley, ret. (Aviation Coordinator- Sperry Gyroscope Corpn.) in BFI-CR136.
[322]Ltr. 2/20/49 RBF to Maj. Gen. Gardner (Dir. of Air Installations) & Maj. Gen. St. Clair Street (Air Inspector) in BFI-CR136.
[323]Western Union Message, dated 3/10/49 Ysidoro Martinez to RBF (c/o Col. H. E. Watson, Air Tactical Command) in BFI-CR129.
[324]In Ltr. 3/25/49 RBF to Maj. Gen. Bradley in BFI-CR136, Fuller reported the success of his trip and the "favorable 'impression'" his "tent" created. He also indicated that the next summer session at BMC could be used for further experiment and study. See also Ltr. 3/25/49 RBF to Maj. Gen. Grandison Gardner (USAF-Washington DC) in BFI-CR136.
[325]Ltr. 3/15/49 Maj. Gen. Grandison Gardner (USAF-Washington DC) to RBF in BFI-CR136. See Fuller's reply, Ltr. 3/25/49 RBF to Maj. Grandison Gardener (Dir., Air Installations) in BFI-CR136, proposing that

these circumstances, Goldwowski's offer for Fuller to return to BMC again as the Director of the Summer Institute could not have been better timed to meet the military's interest in the dome project.[326] Over the next two years, Gardner followed Fuller's work enthusiastically. He was convinced that Fuller's new structure would be significant as a new military logistic ordnance and that it would be applicable for housing in the Arctic and, particularly; in places remote from highways and seaports. He explained:

> We have what appears to be a possible and very important application of this (geodesic) principle for shelter of fighter type aircraft in northern localities. I am not sure, however, that this particular construction is adaptable to that purpose on account of the requirements for very large doors.[327]

2.5.1.1. Air Corp Agenda and the Trans-polar Concept

The need of the military services for housing "to promote efficiency and good morale" was a real, legitimate and urgent issue.[328] Equally crucial, but less well known, was the military's interest in a broad range of tactical developments to deal with the eventuality of trans-polar warfare. Military interest in the Arctic increased as air warfare heightened the vulnerability of all the landward home-front [Fig.2.13]. One writer, C. Murphy, observed:

> The polar concept simply assumes that if another war is in the cards the arctic and subarctic regions will inescapably provide the pathways for the first and perhaps decisive blow.[329]

However, not all military strategists were convinced of such a war scenario. Based on the conclusion of a joint Canadian, British and U.S. scientific study, at Fort Churchill since 1946, large scale warfare in the Canadian Arctic was an impossibility. Nevertheless, the strategists recognized that techniques were still needed to "wipe out quickly and decisively using minimum of troops" any enemies who might gather foothold on any of the thousands of islands in the Canadian Arctic.[330] Despite skepticism in these quarters, Gardner's interest to get the dome tested at sub-Arctic temperatures (below 75-degree) nevertheless belied a military insider's

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the "field work of the project may be transferred to Black Mountain, North Carolina"; also Ltr. 3/29/49 RBF to Mrs. David Floyd in BFI-CR129. Upon Gardner's request, Fuller completed redrawing of a typical 1080sq.ft 3BR officer's dwelling (Ltr. 4/22/49 RBF to Maj. Grandison Gardener (Dir., Air Installations) in BFI-CR136).

[326] Ltr 3/16/49 N. Goldowski to RBF in BFI-CR129.

[327] Ltr. 10/22/51Maj-Gen Grandison Gardner to RBF in BFI-CR134.

[328] Lloyd Norman, "Air Force needs 154,000 more housing Units (Wants 114,000 in U.S., 40,000 Overseas)," *Chicago Daily Tribune*, 3 April 1949.

[329] Charles J.V. Murphy, "The Polar Concept. It is Revolutionizing American Strategy," *LIFE*, 20 Jan. 1947, pp.61-2.

[330] Reuter's Press Release, "Tests Show Big War in Arctic Is Impossible (Experts Regard Polar Invasion Unlikely)" 7 May 1949 (Copy in BFI-CR136; possibly sent by Gardner).

concerns. Fuller's dome promised to fulfill a radical type of housing for protracted survival in the Arctic.

Fuller was not a newcomer to these strategic and tactical issues of the military establishment. The DDU-DDM project had prepared Fuller well to understand the meaning of the military's logistic interests beyond the portable shelter project. Fuller appreciated and understood the significance of new tactical developments and logistics to deal with the potential of trans-polar warfare. An early report titled "Energy focused to Win," which Fuller co-authored with David Cort, his former associate at *LIFE* magazine, highlighted this awareness amply.

The eight-page document was written at the same time the DDU project shifted from "defense housing" into a tactical ordnance item for the Air Corp and the British military. Fuller's undated marginalia on a copy of this document, clarified the context of the project:

> Dave Cort's first draft (corrected as indicated by BF) of a World War Strategy. This draft corrected (as indicated) was handed in to O.S.S. in May '42 at their request. It represented the theme of B.F. strategy outlined in his Fortune office in 1938 and reacted to staff members of Time Inc...[331]

The document was assembled by a secret study group in Washington D.C., of which Fuller and Cort were participants, to collaborate with the O.S.S. at the outbreak of war in Europe. Billed as the "post-Pearl Harbor seminar," Cort related how in October 1941, "an unofficial committee" consisting of John G. Underhill, Buckminster Fuller, Babe Paxton, Hubbie Kay and Dave Cort had set about discussing "how the United States should win the war":

> At that time we were thinking of a LIFE story on all this, but then came Pearl Harbor and the security factor came in, or so we thought.[332]

The fundamental strategy, the report summarized, was to develop "the most striking power for the least weight" and to "exceed Hitler's *Wehrmacht* of 1939." The study group was more likely a screen to generate strategies for the purpose of propaganda and deception. At one stage, the group even envisaged a plan for the invasion of North Africa using the limited armament of the U.S. Army.[333] In November 1942 *LIFE* subsequently published "Air transport," showing a version of Fuller's idea to use the fuselages of planes on Arctic mission as

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[331]R.B. Fuller's Marginalia on a copy of David Cort & RBF's "Energy focussed to Win," in BFI-HEv36.
[332]David Cort, *The Sin of Henry R. Luce*, Secaucus, New Jersey: Lyle Stuart Inc., 1974, p.290.
[333]Ibid.,p.290ff.

workshops/advanced bases. The magazine of the German Military Services, the *Wehrmacht* considered the proposal sufficiently threatening to reprint the *LIFE* feature in March 1943.

Alongside the strategy, Fuller found an opportune moment to offer his map-making and portable shelter projects as tactical weapons. For this reason, Cort and Paxton persuaded John Shaw Billings, the Managing Editor of *LIFE*, to publish the Dymaxion map in March 1943.

2.5.1.2. Redeploying the Dymaxion Map

> The ultimate goal, Elsa ... is the Arctic Circle. The nation which first colonizes the Arctic will be the nation that rules the world.[334]

In explaining to Elsa Maxwell, a socialite-columnist, of the significance of his Dymaxion map "of squares and triangles," Fuller articulated his appreciation of the geopolitical significance of the trans-polar concept. To win the war, Fuller proposed to the group that there was "the necessity for a "relatively 'true' flat map" of the theater of combat. His new mapping method, presumably, would fulfill this need, by providing a method to triangulate the terrain quickly, and thus facilitating more accurate air-bombing missions. Brazil would be a strategic link to this project. As Head at BEW, Fuller saw strategic possibilities in the U.S. foreign service project of "good neighbor" to Brazil. Fuller recounted that in exchange for developing a broad national industrialization program for Brazil the "aside project (was) in getting Brazil to grant (U.S.) all kinds of advantageous geography for airports in order to build air lines to Africa."[335] From Africa, presumably, the activity of triangulating the terrain could be undertaken with less obstacles.

Fuller argued that his "one continent" map of 1938 [Fig.2.14a] was a re-statement of a new geographical awareness that preempted the military strategist's polar concept. It represented a heart of a continent bordered by North America and Russia. Thus:

> (T)his means instantly that it is U.S. and U.S.S.R, not the Axis, who hold the 'interior' lines. The world battle fronts become two trans-Arctic lines from Australia through China to the Aleutians and from the Atlantic through Greenland down through Russia to the Middle East.[336]

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[334]Elsa Maxwell, "Elsa Maxwell's Party Line. Designs for Living," *New York Post*, 22 Oct. 1942, p.12.
[335]R. B. Fuller, "Discussion of History of Patents in Society," BFI-MSS 48.11.01, 11/17/48, p.14; for a details of Fuller's Brazil project, see "A Compendium of Engineering Principles Pertinent to Brazil's Control of Its Impending Industrialization," 8/13/43 in BFI-HEv28.
[336]David Cort & RBF, "Energy focussed to Win" (also as "Foot-pound Hitting Power of an Air-borne Economy"), p.1. Fuller noted, in a marginalia on this reprint, that a "new and better projection has been prepared" for a "Mr. Atherton Richard (of) O.S.S. "

To augment the mapping project, Fuller offered OSS a second tactic to overcome the lack of overland routes. He proposed a series of air-transport-freight planes and gliders [Fig.2.15]. These contraptions, Fuller argued, had greater tonnage-advantage over the "waterbarn" cargo-planes besides making delivery close to the war fronts. At the fronts, the gliders could be transformed into logistical warehouses and as the front moved forward, they could be towed ahead to new positions.[337] This was the advanced base concept for a new type of warfare. It pivoted on the fleetness of the forward troops and logistics.

2.5.2. Students and the Military

Over two semesters at ID-Chicago and an extended summer of post-graduate studies at BMC, Fuller directed his dome project to fulfill the military interests.[338] Most of the twelve students from ID-Chicago constituting the Fuller's student "cooperative" were elated that the prototyping was edging towards a real product with tangible military support:

> (General Gardner) wants to come back to Black Mountain to see the model as soon as it can be made ready for him and before putting ten thousand government money into it. I don't believe I'm being overly optimistic when I say that this sounds almost certain to me.[339]

Under this climate of self-assuredness, Fuller explained to Lawrence Anderson on the eve of his teaching engagement at MIT, that his students' projects were "live frontier undertakings" and not a figment of the imagination.[340] The aura of "scientificity" and urgency were not lost on the participants of Fuller's dome project either. In fact, these imagined qualities heightened the prestige of their undertaking further.[341] Labeled as "fanatics," the members of Fuller's student cooperative, "Sphere Inc.," for example, lamented that their ground-breaking dome project should happen at "a less mature and somewhat escapist tradition of a mountain school (such as BMC)":

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[337]D. Cort, *The Sin of Henry R. Luce*, p.290.

[338]Donald Richter, Ysidore Martinez, Masato Nakagawa, Harold Young, Louis Caviani, Jeffrey Lindsay, Joseph Manulik, Mary Jo Slick, Eugene Godfrey, Alan Lindsay, Roy Moss, Robert Richter formed the core of Fuller's study group at BMC in the summer '49. They were supported by the GI Bill mainly because of Fuller's skillful billing of his course at BMC as "Advanced Architecture" based on his recent discourse at University of Michigan. The six others (Adam Atkins, R. Fine, Thomas Leonard, C. W. Perman, Ken Snelson, Paul Williams) were BMC regulars.

[339]Ltr. 6/13/49 Lee Hukar to Jeffrey Lindsay (and Spheres) in BFI-CR130.

[340]Ltr. 7/24/49 RBF to Lawrence Anderson in BFI-CR136.

[341]Ltr. 8/2/49 J. & J. Walley to D. Igel, et.al. in BFI-CR134. See also the heavily science and technology-based reading list, "Live Book Squad" (ca. Sept. 1949) that Fuller issued to all the colleges that engaged Fuller's participation.

> We are esteemed more for our publicity value as a promotional factor for increased enrollment than for any direct understanding of our aims, much less of our motivation and team cohesiveness inspired by the potential of direct service to our fellow men.[342]

At this point in the dome development, the military-tactical significance of the dome posed no problems of secrecy. Even Fuller's student collaborators in their hastily-formed designer-engineer cooperative, the "Spheres Inc.," were nonchalant towards military interests.[343] In summarizing the research objectives that had to be undertaken after the Pentagon dome demonstration, Fuller reported to Maj. Gen. Follet that "foldability" and not "air-deliverability" was an issue in the military shelter requirements.[344] In this regard, the issue of the dome "foldability" which Fuller accounted in his journal, "Project- Noah's Ark #2," grew out of the performance requirements of military logistics. Concurrently, Fuller also updated his idyllic Garden of Eden scheme to fulfill the Air Corp requirements.[345] This seamlessness between military and civilian interests operated continuously through Fuller's dome research projects and his emerging enterprises.

2.5.2.1. Ensuring Control in Military Dome Prototyping

The direct military involvement in the geodesic structure prototyping was as opportune as it was dangerous. Fuller felt compelled to ensure the distinctiveness of his work and control over the integrity of his process. He did this by self-financing all the initial costs of the prototyping. This option was, however, fraught with practical difficulties. For example, he lamented that the uncertainty of funds slowed his dome project because he could not afford to accommodate any error that might arise.[346] As with his previous projects, there were also private supporters and well-wishers. On the eve of his geodesic prototyping activities, for example, artists associated

[342]Ltr. 8/2/49 John & Jano Walley to Daisy Igel & Polita in BFI-CR134.
[343]Ltr. 8/2/49 John & Jano Walley to Daisy Igel & Polita in BFI-CR134. The group openly communicated with one another regarding the status of the on-going research reporting of the "favorably disposed" reception by the Air Corps towards the 14-footer great-circle dome at BMC.

Similarly the colleges were also aware of the military's interests and potential sponsorship of Fuller's project (See Ltr 5/24/49 N. Goldowski (BMC) to RBF in BFI-129).
[344]Ltr. 3/25/49 RBF to Maj. Gen. Follet Bradley (Aviation Coordinator- Sperry Gyroscope) in BFI-CR136.
[345]Don Richter, "Record of Don Richter," unpbl. MS. in BFI-HEv33, ca 1951. Richter reported that as part of the activities of "an extra-curricula students' cooperative" at ID-Chicago, the improved version of the "autonomous dwelling skybreak" was produced in compliance with Army request. This was the "super-camping structure," an autonomous package with the 50-foot diameter airframe structure hemisphere reported by Fuller at the 7th Ann Arbor Conference. It was designed to rise "into a rigid truss in seconds as its steel sinews (aircraft cables) are hydraulically tensed" (See also "A Preview of Building," 4/1/49 in BFI-CR129, p.2).
[346]Ltr. 5/14/49 RBF to Wells Bennett (Dean, Univ. of Michigan, Ann Arbor, Mich.) in BFI-CR133.

with ID-Chicago raised an auction of their work to support FRF, then passionately billed *Bucky Inc.*, in the public press.[347]

The geodesic research agenda for FRF, like those of his earlier projects, was formed by his sensibilities as a perpetual outsider. Summarizing the meaning of his DDM-Fuller House venture, Fuller spawned the truisms of an outsider's culture. He cited examples of small steel specialists and auto-racers that added effectively to technical improvements in their respective fields while remaining unaffected by complacencies that plagued the research culture of larger establishments.[348] Such was also the state of Fuller's own practice. Though his primary research apprenticeships were sited in large industrial corporations and state instruments like Phelps Dodge and the Bureau of Economic Warfare, he was paradoxically unaffected by them. One could suggest that his research niches, which he had carefully constructed and chosen, were so idiosyncratic that it was more prudent to leave him to his vices.

The real reason was perhaps that because Fuller positioned his research activities as pre-research, he thus circumvented any anxieties of having to conduct research in a corporate-industrial setting. By "borderline stage," he meant an activity that exceeded the dogged activity of merely establishing the feasibility of future research. The purpose of *FRF*, he proposed, was to explore " the borderline area of technology" that industry could not undertake:

> The Foundation is concerned with those phases of development which usually precedes the stage at which larger and more formal research bodies of universities or corporations initiate their activities.[349]

Writing about the role of government and institution in the research and development on prefabrication during this period, in a similar manner, he noted:

> I cannot agree at all that research and development into new technical fields can be successfully performed by a government research and development institutions ...
> No public legislature, no public funds will credit unprecedented approaches ... political mandate cannot command invention.[350]

By these operational guidelines and the pervasive use of the patent laws to fortify his proprietary rights, Fuller ensured control over his prototyping activities. Fuller did not appear to have any anxiety towards the involvement of the military. If there was, it was hedged more

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[347] "Bucky, Inc.," *TIME*, 7 Nov. 1949, p.57.
[348] R. Buckminster Fuller, *Designing a New Industry*, p.23.
[349] "Fuller Research Foundation Background and Purpose," p.1.
[350] Ltr. 3/29/49 RBF to Tyge Holm (Copenhagen, Denmark) in BFI-CR136.

towards how he could maintain vigilance over the claims in the invention without appearing to be paranoid and how he could sustain his personal research agenda amidst bureaucratic control and public scrutiny.

2.5.2.2. Fuller's Enterprises in the College -- Working Methods and Management

> The Harvard and MIT occasions sound just right. I can't help it, I suppose, if my joy at your eminence is accompanied by an anxiety as to whether you received at least an Honorarium & expenses for the sessions. Equally as much as I espouse Richard, the theorist, I do worry about the man, Richard, and resent the fact that you do have a "Preacher's Brood" at any time. I try to have faith as you do, but can one really have faith & bad temper at the same time?[351]

Cynthia Lacey, Fuller's able administrator and confidant from the DDM-Fuller House project penned the above caution on the eve of Fuller's newly-initiated enterprise in the college circuit. Perhaps because she recognized his self-centeredness, she felt compelled to query his emotive capacity to deal with the potential controversy.

Lacey's skepticism of Fuller's ability to accommodate to academic settings soon proved unwarranted. This was because his work was quickly welcomed as the quintessential kind of architectural experimentation that the architectural schools sought. Burnham Kelly, for example, recalling his experience teaching with Fuller at MIT, for example, described the creative and productive energy of Fuller's liminal position within academy. Even though Fuller was neither an architect nor an engineer, Kelly explained, he exceeded the creative imagination of both -- Fuller made the architectural community "see things differently, imaginatively" in the "rather pedestrian field of construction."[352]

By the time of the first issue of the Yale architectural student publication, *Perspecta-1* in July 1952, Fuller's status as an influential teacher was firmly secured. He was nominated along with Philip Johnson and Paul Rudolf as among the three architects who would inherit the mantles of the modern masters, F.L. Wright, Le Corbusier and Mies van der Rohe. Fuller's future vision of moon shelters and future design was the probable cause of the students' excitement about a new realm of design beyond the confines of culture. Thus, four years after the start of his collegiate circuit, a reporter quoted Fuller's confident claim that the "Isms(sic)" of architectural formalisms "(would) be finished by 1970."[353]

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[351]Ltr. 4/17/50 Cynthia Lacey to RBF in BFI-CR133.
[352]Ltr 10/25/95 Burnham Kelly to Y.C. Wong (Author's Collection).
[353]_, *Wisconsin State Journal*, 7 Aug. 1952 (cited in *Dymaxion Index, 1927-1953*, p.41).

Fuller had found a special calling in the various schools of architecture, namely as a champion in purging their laggard architectural curricula. The colleges provided a wide source of free publicity which legitimized and gave significance to his structural investigations in general, and the geodesic structure in particular. Their gains were mutual and reciprocal. Everywhere, the students doggedly calculated, as precisely as they could, chordal factors for various geodesic configurations. Others prototyped the domes in make-shift workshops. As Fuller's reputation mounted, his participations in the college projects reciprocally aggrandized their respective reputations [See Appendix II: A Chronology of Geodesic Dome Projects].

The college setting was conducive and productive for his dome research enterprises. His engagements were generally short and on an invitational basis, but these adequately augmented and simultaneously advanced many lines of his research project with few hitches. The colleges immediately provided a ready space to work, supported by eager minds and cheap labor [Fig.2.12a]. For instance, during the prototyping of the paperboard geodesic structures, one of the participating industries, Container Corporation of America (CCA) had considered approaching the Navy Laboratories to undertake some tests on the structures. Instead, Fuller and his "Student Research Groups," utilizing "the testing facilities of the universities where he (was) conducting experimental projects," was offered as a sure way of allaying the cost of a "million dollar program." Clearly, the proposition aimed to spur CCA into action since it entailed no up-front investments of equipment for the private enterprise.[354] Fuller, on the other hand, saw no distinct conflict of interest in this indirect use of public funds to serve the interests of private enterprise.

The experiences at ID-Chicago and BMC showed Fuller a new way of working and research which fitted appropriately into the orbits of his outsider culture. This was particularly poignant as both curricula and researches in post-war American universities were increasingly corporatized and institutionalized. Clearly aware of these developments, Fuller attempted many ways to work within the institutional ethos of the universities and yet subverted its structure. For instance, Fuller separately issued "certificates of 'Student Dymaxion Designer'" for students and researchers who had completed his appointed sixty-hours of seminars and had taken initiatives in "Comprehensive Design extensions"[355] [Fig.2.12b].

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[354] Ltr. 11/15/54 J. Dixon to M.T. Hunsworth (Container Corporation of America) in BFI-CR157.
[355] R.B. Fuller, Loose Notes, ca. 1949 in BFI-CR137. See also Ltr. 5/25/49 RBF to Carl Koch (M.I.T., Cambridge) in BFI-CR136.

2.5.2.3. Students as "Technical Frontiers-people" and Dome enterprise as a Disciplinary Object

> Let's not wear ourselves out on or expend our abilities or knowledge or credit in oblique sorties. We have plenty to give and much that is needed by directly forward engagement. Collectively the effort may be *synergetically* effective[356] (Itl., my emphasis).

Fuller implicitly treated the students as quintessential outsiders. However, as "technical frontiers-people," their untainted enthusiasm and unbridled energy needed proper channeling towards creative ends. They awaited proper priming and the inculcation of self-discipline. For this reason, Fuller proposed that his enterprise needed no "supermen," merely workers with "integrity and clearly viewed purpose."[357] Rather than a twist of irony to his professed belief in individuality, this demand was meant to differentiate it from rugged individualism, which he caricatured as a life measured by material selfishness.

Fuller was able to present his enterprise as an act of self-discipline, and to shroud it in the ethics of industry. The process of industrialization, he explained, was "the directed energies" of a "plurality of people" which amplified the individual limits.[358] Similarly, the discipline of dome-making as a creative act was also a product of coordinated collaboration. Further, geodesic dome, as a pedagogical object, illustrates the proverbial strength of the whole exceeding the limits of performance of its components. Over the years, as Fuller honed his methods of instruction, members of his collective graduated from "Dymaxion designer" to "Comprehensive designer" to "Anticipatory design scientist."

2.5.2.4. Fuller's Modus Operandi in the Colleges

Despite his general abhorrence for the idea of invention as business, Fuller was prepared to make his activities in these participating universities an exception. The impetus for collaboration was fundamentally economical. For example, he explained that the rationale of bringing the dome research enterprise to ID-Chicago was because it provided a ready show-case:

> (I)t is quite appropriate for an educational institution to initiate the design of such packaged scientific enterprises to put in its window to be purchased ... either by private industry or by public authority, as it is appropriate.[359]

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[356]Ltr. 09/19/49 RBF to Fuller Foundation Researchers & "technical frontiers-people" in BFI-CR134.
[357]Transcript of Lecture from Wire-recordings at ID-Chicago, BFI-MSS 48.11.01 10/25/48.
[358] Ibid., p.5.
[359]R.B. Fuller, "Comprehensive Design," BFI-MSS 48.11.01, p.1h.

Fuller personally recognized that there were two direct benefits to be gained from twinning his dome research enterprise to the universities. First, the university was an "enormous capital facility." Secondly, he believed that there was a "relative lack of bias" in the universities "towards expediency."[360] Underpinning this second benefit was his belief that the colleges were publicly perceived as a neutral enough terrain to advance knowledge in the public's interest. Thus, these conditions were conducive for him to prototype his work more readily.

His enthusiasm for the universities was nevertheless lined with anxiety. He remained suspicious of their capacity to protect his rights or give him real equity for the work undertaken under his auspices. Thus at ID-Chicago, he was instrumental in drawing up recommendations for the "design protection and ownership" committee that he chaired. Arguing from an ethical position that a "creative individual does not sell exclusive personal advantage or justice," he stipulated in the following strategies, how as an inventor, he might be "fortified to a degree against injustice." By:

> (1) using the publicity medium to clarify relations of the creative man to society,
> (2) providing an equitable means of protecting, distributing, and marketing creative work,
> (3) taking public position on behalf of the creative individual where and whenever appropriate.[361]

At MIT, through Carl Koch's invitation, and where Fuller fruitfully participated for two consecutive years in its architectural design curriculum, he evoked his shop-rights to protect his dome prototyping activities. Because he believed that his projects were of "immediate economic significance" and were "'probable' to occur," the opening up of these "vital areas" posed a recurring dilemma.[362] Indeed, he constantly guarded between maintaining an open channel for participation, securing measures that would ensure his proprietary rights and protecting the integrity of the work. His seminars represented, he explained, "continuous application of a continually increasing inventory of discovered principles." In this regard, all past undertakings as "retrospective disclosures" were obsolete. Most importantly, he professed:

> It is the vital problems that we teach the students at first hand by his own experience the general nature of designer strategy in such a manner that the individual can forecast his own participation in technical venture ....[363]

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[360]Ibid.
[361]Ltr. 1/20/49 RBF to All Faculty Members (ID-Chicago) in BFI-CR124.
[362]Ltr. 5/25/49 RBF to Carl Koch (M.I.T., Cambridge) in BFI-CR136.
[363]Ibid.

Fuller's suspicious attitude towards the universities was generally unfounded; and he obviously hyped the prospects of his "live technology" and exaggerated its value to industries. Unlike his professed accounts of jaded experiences with corporations, especially with the DDM-Fuller House, there were no substantial instances where the universities posed any clear and present dangers to his enterprises. In fact, the participation of the universities added diversity to the dome agenda, and invigorated it. Perhaps, he had curiously viewed universities as corporation-like entities which would be summarily protective of their interests, and thus would not stand for individuals in matters of patent.[364]

Despite the broad acknowledgment of his claims within the university settings, he was still bent on the control over his stable of structural projects. John Dixon, his assistant, for example, was delegated the duty of surveillance and monitoring of the research activities on geodesic structures in universities and by individuals that might be constituted as infringements on Fuller's areas of activities. Such administrative measures were generally unnecessary or futile. Despite the increasing prestige of Fuller's undertakings in the universities, the perceptions of their significance were often exaggerated. So were the threats. On the one hand, Dixon claimed that the university programs dealing with Fuller's geodesic structures covered "better than 75% of the architectural student population of the United States."[365] On the other hand, any structural experimental program that vaguely drew upon Fuller's inspiration, like the one ran by J. Owen (the Structural Investigative Program, at College of Applied Arts-Cincinnati University), was scrutinized for possibly infringing on Fuller's projects.[366]

2.5.2.5. On His Own Terms

Fuller was generally successful in getting the colleges to waive their proprietary rights accrued from his work with the students. This was primarily because in post-war America, the notion of research and development in schools of architecture was, for all intents and purposes, non-existent. To go one step further, Fuller even proposed adopting the Russian patent practices to circumvent the monopoly cartel of the Berne Convention which openly privileged the wealthy industrialized nations. Yet, in seeking redress of proper rewards for corresponding efforts, Fuller immediately touched a nerve of American Protestant ethics and the adage of old style entrepreneurial capitalism. Fuller explained how "real equity" for inventors could be established:

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[364]See Fuller's discussion of corporation and individual rights in "Discussion of History of Patents in Society," Transcript of Lecture, ID-Chicago, BFI-MSS 48.11.01, 11/17/48.
[365]Ltr. 7/9/55 J. Dixon to Lt. Col. William Woodruff (USMC) in BFI-CR164.
[366]Ltr. 5/11/56 John Dixon to John Owen (Middleton-Ohio) in BFI-CR175.

It is assumed that the kind of man who thinks well on behalf of the State sees inventively on behalf of the commonwealth ought to have greater and greater access to all affairs of the commonwealth....
The man who actually does the thorough job going actually all the way through from the original idea to producing it and making it available to the public actually *deserves the first of market*[367](Itl., my emphasis).

Overall, this idea of patent as commonweal must have appealed to the idealistic culture of modernism that pervaded architecture schools. Isolated among science and engineering departments which were increasingly ravaged by corporatized research practices, Fuller's curriculum as a social mission was attractive. Equally attractive was Fuller's self-presented heroics of a lone inventor, a perpetual outsider against the burgeoning corporate world of research and development.

In general, Fuller's dome prototyping activities in the colleges and his attempts to enfranchise their participations were successful. However, they were also marked by occasional doubts over their pedagogical value. Fuller had continually to ensure the participating colleges that the students had benefited significantly from working with him. He reminded Dean Pickens at Washington University, one of Fuller's more productive collaborations in his collegiate project, that his students were not engaged "in repetitive work." Rather, they were in the forefront of "pre-prototyping industrial functions."[368] Yet, it soon became clear that the new phase of the dome began to place demands on his working methods, making them increasingly routine. For this reason, Duncan Stuart explained that at NCSC, Fuller's subsequent project with the Marines began to reduce the students to "some cheap hired hands" who became "less and less involved with any of the design strategy."[369] These were unlike the earlier studio projects which depended on the direct participation of students in forming the briefs and conducting the researches.

By the end of 1956, Fuller's own prognosis of his earliest research endeavor had been fully realized. At ID-Chicago, which he characterized as an "awkward prototype of ... university exercises in design of complete industrial systems," the horizon had given way to "fundamentally reliable blueprints for interactive realization of a new enterprise."[370] With the successful and creditable demonstration of Fuller's geodesic dome program along with its increasing publicity, Fuller's operating procedures and conditions became more formalized. His dome research enterprise, John Dixon explained to colleges eager for Fuller's participation, was part of his larger

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[367]R.B. Fuller, "Discussion of History of Patents in Society," BFI-MSS 48.11.01, pp.4-8.
[368]Ltr. 4/18/55 J. Dixon to B.L. Pickens in BFI-E Series.
[369]Notes from Author's Interview with Duncan Stuart, Raleigh-N.C., 4/26/95.
[370]R.B. Fuller, "Comprehensive Design," BFI-MSS 48.11.01, p.1h.

"individually maneuvered strategy of survival," now known as "Comprehensive, Anticipatory Design Science."

2.5.2.6. The Appeal of Fuller's Program

Fuller's design philosophy was characteristically and ideologically ground-zero thinking. Its broad appeal stemmed from its modernistic and humanistic underpinnings. He was against a priori knowledge. In its place, he substituted a regenerative *a posteriori* knowledge. This was a type of secular but enlightened knowledge that could be perfected. By this reasoning, he theorized that although perfection was "not given to man to deal with," man nevertheless had "the ability to deal with things that are imperfect, that is, with things that begin and end."[371] To reach that end is the goal of all design activities. Thus, in moving through "imperfection scientifically," Fuller concluded, one explores "infinitely the finite universe":

> As we did so, isolating from universe the things which are finite, really bringing into relief the perfection - all that would be remaining would be perfections, and that is, we would not work directly for perfection, but perfection is alone remaining because we really mastered the finite.[372]

Given this confidence, the terrain of Fuller's exploration, which he called the "science of architecture," was expansive in a Baconian sense; and yet, it was inclusive. He described it as "the whole cosmos, physical geography, (man's) personal nervous geography."[373]

Treating perfection as a by-product of design rather than its subject matter fitted neatly Fuller's philosophical disposition towards life as a process or a state of becoming. Programmatically, in the dome design agenda, the logistical imperatives forming the core of the process became a precursor to the "systems" approach in design. This approach exceeded the team design idea that Walter Gropius introduced into the American architectural curriculum at the Graduate School of Design, Harvard University. Fuller's approach directly reproduced, albeit in an idealized version, his experiences on the American factory shop floors.

Fuller's projects vividly demanded a hands-on approach and teamwork which stood starkly against the conceptual and individual work that characterized the majority of design studio approaches in American schools. Though his design briefs were unusual and bore no discernible

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[371]Ibid., p.3.
[372]Ibid.
[373]R.B. Fuller, Transcript of Wire-recordings at ID-Chicago, 12/16/48, p.1.

functional or cultural antecedents, the act of making a new dome each time was tantamount to a "scientific direction." In Fuller's hyped characterization, each undertaking was a palpable demonstration and evidence of ground-breaking improvements. Even under such premise, Fuller's studio projects met with resistance. During Fuller's Fall '54 semester at Washington University, Dean Pickens reported:

> There is quite a rhubarb here about our 'Fuller Project'. The arti-boys are running us down with the front office because the students aren't making fancy renderings, etc.[374]

The geodesic structure had other appeals as well. Its aesthetic of lightness was both direct and transparent. The structure seems to conflate art, science and craft so seamlessly. This is because Fuller's design approaches treated structure as a positive gestalt, and as the cause of a form. It also forged connections to the structural, functional and spatial demands of emerging building types like large-span portable exhibition spaces and military logistic shelters.

As an object, the geodesic dome was a tangible demonstration of the new structural experimentalism, broadly characterized by Fuller as "architecture out of laboratory." It directly updated and embodied the productivist sensibility in design which Fuller developed since his 4D-Dymaxion House from the thirties. The approach was neither about architecture in engineering nor engineering in architecture; and as a new discipline, it exceeded the union of both. Rather than confined to the parochialism and mere technique of engineering or the tradition of architecture, his approach as "anticipatory design" required a fundamental re-visioning of reality:

> The first thing that I had to make clear to the architectural students was that we did no buildings out of materials. What we do is to develop visible modules structures out of infra-visible module structures. In other words, nature deals in structures in various octave within octave magnitude and what we are used to calling chemical materials are simply structures in which the modules are too small for us to see....
> (I)t is yet true that many men do not 'see' structures as dynamic principles i.e. in the terms of reliable energy behavior patterns.[375]

This avant-garde approach towards structure which entwined aesthetics, mathematics and science (especially, New Physics and material sciences) validated architectural practice in a new way. It updated a standing claim in architectural circles that creative activities of experimenters like Paxton, and now Fuller, are natural progenies of the modern architect's identity. For example, John McHale claimed that, after Paxton, Fuller was the only person to make "a

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[374]Ltr. 3/16/55 B.L. Pickens to RBF in BFI-E Series.
[375]R.B. Fuller, "Transcript – Meeting of the Forest Products Research Society, Grand Rapids, Mich.," 5/7/54 in BFI-CR158.

comprehensive move to confront" the "marginal attempts to fuse architecture and technology."[376] On the occasion of Fuller's "Bubble structure" at MoMA, Serge Chermayeff similarly offered a summation of Fuller's work in the following way:

> Having been fairly close to various stages of foetal development from aluminum 'spaghetti' to fiberglass 'armadillo' (geodesic dome) ... I think I see its historical context in our war spurred technical growth spanning from Paxton to Fuller.[377]

Chermayeff's enthusiasm for Fuller's design agenda was beyond this constructed historical connection. He confessed that in Fuller's works, he saw an exemplary cross-over from the vulgar "paraphernalia of commerce" into the realm of a new art type unshackled by cultural or temporal labels. He shared Fuller's design philosophy and observations about the complacency of the design profession:

> The profession as a whole is apparently content to remain in business using an archaic building technology until they are overwhelmed and obliterated by technical revolution developing around them.
> I take an equally serious view if the responsibility for guidance being taken over by those astute gentlemen of commerce, the industrial designers, the usefulness if whose energies is now lamentably offset by their social irresponsibility.[378]

Appropriately, Fuller inaugurated his teaching appointment at ID-Chicago in February 1948 with a public lecture tiltled "The Designer's New Responsibility." This social-ethical position appears to ameliorate his eccentricities and self-presented unconventionality. The colleges were receptive to his research and teaching methods. Both the theoretical speculations of his *EG*, and more directly, the dome prototyping projects, invigorated their respective design curricula in many ways. They represented a new but enlightened pedagogy going beyond mere directions of thinking about design, despite their logical and empirical beginnings.

2.5.2.7. Some Objections from the Establishment

Fuller distinctively used the dome prototyping to dramatize the ethos of invention. Invention was, to Fuller, a higher form of design. Other design activities merely create substitutions of perfection. The prime task for the "anticipatory" designer, he identified, was to look for "nuances" and the "surprise factor" as opposed to the obvious. He illustrated this in the classic example of the plastic salt-shaker as invention.[379] The plastic container, despite retaining

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[376] J. McHale, "Buckminster Fuller," *The Architectural Review*, July 1956, p.20.
[377] Ltr. 5/5/52 S. Chermayeff to RBF in BFI-CR138.
[378] Ltr. 2/16/47 S. Chermayeff to RBF in BFI-CR125.
[379] R.B. Fuller, "Discussion of History of Patents in Society," BFI-MSS 48.11.01, p.3.

the form of the aluminum salt-shaker was more than mere substitution. It is an invention because it alters the performance of the aluminum version. It enables salt to free-flow by preventing it from clogging.

Predictably, not all university architectural schools took well to Fuller's program or approach. They fundamentally Fuller's narrow definition of the function and the meaning of design activities. Primarily, design was viewed in the light of invention, and the inventor's ethos. Thus, when architectural knowledge is cast in opposition to "fundamental economic and technical knowledge," which he characterized his anticipatory design, the former quickly becomes parochial and conservative.

In this regard, the objection in 1953, of George Howe, then Chairman of the Department of Architecture at Yale, to Fuller's geodesic cardboard dome project with a renegade group of Yale students who called themselves the Fuller Study Group (FSG) was instructive.[380] Howe's general objection to Fuller's philosophy had a history that antedated the *SHELTER* project in 1932. For Howe, Fuller's prototyping activities at Yale did not constitute what were proper projects for architectural schools. These so-called "anticipatory designs," he recorded, were not pertinent to real-world problems:

> Personally, I think it is a waste of a time for them. These young men are going out into practice in the world today. It is obvious from the MIT study, "Housing Security Resource" that the problem involved goes beyond the dwelling unit itself, that in fact the discussion of the dome as a dwelling unit is academic at the moment.[381]

As usual, Fuller defended his undertaking by casting it as the staking of a new frontier. Although, he admitted that it had "not reached down to the lode ore," he prospected that its application would be vast.[382] To brace the significance of the geodesic paperboard dome experimentation in this case, Fuller cited his other related works at NCSC and University of Oregon between 1952-3. These hands-on experimentations, Fuller offered, were real-world practices, not theoretical suppositions of academic design:

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[380]The FSG (Fuller Study Group), was probably modeled after Gropius' TAC as future design collaborations between artists, architects and engineers.
[381]Ltr. 12/15/52 G. Howe to RBF in BFI-CR146. The "Housing Security Resource" study that Howe referred to was the product of a conference organized by MIT/Albert Farwell Bemis Foundation in January 1951. The conference examined the implications of housing as a national security issue.
[382]Ltr. 1/7/53 RBF to George Howe in BFI-CR146.

At all those universities the students are learning to work with the new resin instead of designers doing dream ideas on paper and then wondering whether contractor can possibly carry out such work.[383]

Also instigated by The Yale Collaborative, an extension of *FSG*, Fuller defended his approach even more vehemently:

Where awareness of the problems' possible identification is as yet non-existent, man is never forced to readopt fortuitous political compromise and reforms governing redistribution, regulation, or prohibition in regard to ever seemingly self-evident and generally accepted area of inadequacy which is generally conceded to be insurmountable and lasting characteristic of a perverse universe.[384]

For most of the students, including those at Yale, a project to correct "a perverse universe" was a suggestive and appealing act of resistance. Equally attractive was the rhetoric to reform the stodgy academic culture and the reward of an abundant future. The grand and expansive dimension of Fuller's designs also motivated them. Through "anticipatory" and "synergetic" processes, working from the largest possible picture, it was imagined that large social problems would be solved. The new designer, Fuller suggested in his jargon, only need commit himself to undertake "conscious participation in the events of the universe itself" thereby mastering the "purposed mutating of energy behavior" of the environment.[385] While this definition is widely suggestive of many meanings, the real attraction of Fuller's method, in the last instance, is that it is totally purged of any semblance or continuity with culture. In essence, the approach was promised as a harbinger of the highest form of future design in America.

2.6. Managing the Publicity on the Dome - Hype, Promotion or Propaganda?

The singularity of the form and the function of the geodesic structure endured academic criticisms. In the professional architectural and engineering circles, Fuller likewise often faced resistance and ridicule. Writing in "A history of the development of domes and a review of recent achievements world-wide," Makowski directly highlighted the gullibility and earnestness of architects in succumbing to the geodesic dome and its structuring concepts:

[383] R.B. Fuller, "Transcript – Meeting of the Forest Products Research Society, Grand Rapids, Mich.," 5/7/54, in BFI-CR158, p.21.
[384] R.B. Fuller, *Perspecta 2* Yale Architectural Journal, (Autumn 1953) "The Cardboard House," p.28. See Ltr. 2/17/53 Howard Perry (FSG, New Haven-Conn.) to RBF in BFI-E Series, in which Perry solicited Fuller's views "to balance (the) confused geodesic thinking of other faculty(sic) contributions"
[385] R.B. Fuller, "The Cardboard House," *Perspecta 2* Yale Architectural Journal (Autumn 1953), p.31.

(D)uring the 1950s and 1960s (Fuller) collected around him many highly motivated architects and inspired them with his ideas of prefabricated geodesic domes. This in turn produced an exceptional amount of publicity, drawing the attention of the general public to the advantages of braced domes in general and geodesic domes in particular....
(N)ow many people suspect that the great popularity of this form of construction has been helped *by the carefully arranged publicity campaign of public relations officers of various industrial organizations having a direct stake in the commercial acceptance of these ideas* [386](Itl., my emphasis).

Makowski also registered his general ambivalence on Fuller's achievements by his telling juxtapositions of Fuller as "the greatest living genius of industrial-technical realization in building," as a "public relation man par excellence" and as "a crackpot." And while he credited Fuller with "the general idea of the (geodesic) shape" and in advancing "the philosophy of the culture of geodesic dome," he still maintained that Fuller's dome success was finally due to hype, publicity, vested interest and self-promotion.[387]

The problems cited by Makowski were primarily Fuller's choice of the form of communication and Fuller's biases. These were not new patterns; rather, they were formed at the start of his 4D-Dymaxion enterprises. Indeed, his more receptive and primary audience comprised of, then as in the geodesic phase, architects, artists, material industries and businesses. This audience was formed as much by his choice and preference as it was determined by circumstances beyond his control. The condition was exacerbated by the fact that Fuller did not subject his geodesic works or his geometrical explorations directly to peer review as was expected in engineering, science and scholarly activities. For example, shortly after the Zeiss Dome-Jena, both Dischinger and Bauersfeld separately published their findings in *Der Bauingenieur* and *Zeitschrift des Verienes Deutscher Ingenieure* respectively.[388]

Fuller's personal bias, of course, induced him to hold engineering and engineers in low esteem. While he conceded that the reputation of engineers rested upon their role as "unprejudiced technical referees," engineers, as with all other professionals, were fundamentally parochial. They were, Fuller argued, defined by what they should not do, that is not "to tackle uncharted engineering projects."[389] However, this professional restraint was an opportunity, though laden with risks and obstacles, for an outsider like him:

[386]Z.S. Makowski, "A History of the Development of Domes," p.32.
[387]Notes from Author's Interview with Z.S. Makowski, Singapore, 11/14/97.
[388]See *Der Bauingenieur* ("Fortschritte im Bau von Massivkuppeln," 6(10), 1925, pp.362-66) and *Zeitschrift des Verienes Deutscher Ingenieure* ("Das Projecktions - Planetarium des Deutschen Museums in München," #68, 1924, pp.793-197).
[389]R.B. Fuller, "Comprehensive Design" (BFI-MSS 48.11.01, p.1b.

Untrained people who rush in where experts fear to tread have their reward mass-clinched for them in advance.[390]

Because of the reasons above, and throughout the history of the geodesic enterprise, Fuller primarily discoursed on the structure and its principles to the untutored, and for public consumption rather than to specialists. As late as 1959, even upon completion of the world's largest dome for Union Tank Car Company at Baton Rouge in Louisiana, Fuller professed to Makowski that there was no "technical treatise (on the geodesic technology) for release."[391] His hesitance was partly out of his own uncertainties about trade interests and national security. In a separate but related letter, Fuller explained to Applewhite that public knowledge of geodesic structures was restricted to individual domes, or "special cases" as Fuller called them. The public, inclusive of the engineers, had "not yet learned the theory of geodesic structures":

> I do not have a *completely working proven generalized theory* which I have used to design each and every new type and phase of geodesic domes ... I have not as yet published any theory. I am working on a complete book covering the subject. When published, any engineer anywhere can produce geodesic structures ... However I, and I alone, know that both U.S.A. and the behind-curtain (Iron Curtain) engineers are equally ignorant, ergo equally incapable, of initiating further advance on geodesic structuring[392] (Itl., my emphasis).

His primary "treatise" on the geodesic structure and principles would eventually appear, published rather belatedly in1960 as Robert Mark's *The Dymaxion World of Buckminster Fuller*. Even then, the book was mainly a biographical picture book retrospective of his experimentations, replete with captions that coalesced philosophy, self-mission and retrospection. Fuller had intended the presentation this way. However, its goal towards comprehensiveness as a "completely working proven generalized theory," though not fulfilled until the *Synergetics* (1975) book project many years later, immediately sacrificed both rigor and details on geodesic technology.

2.6.1. Claims Made over the Ford Rotunda Dome (1953)

Makowski's ambivalence towards Fuller's inventions and his achievements were not new. His doubts echoed earlier uncertainties among the engineering-architectural fraternities over similar claims of the fantastic structural capacity of the geodesic invention. They surfaced during the commissioning of Fuller's Ford Rotunda Dome at the company's River Rouge plant

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[390]Ibid.
[391]Ltr. 4/1/59 RBF to Z.S. Makowski in BFI-CR199. Makowski had sought information on "methods of analysis" and "relevant technical information on the design of (the dome) structures."
[392]Ltr. 4/2/59 RBF to E.J. Applewhite in BFI-CR199.

[Fig.3.64a, b & c]. *The Architectural Forum* found it significantly ground-breaking to be specially featured in its May 1953 issue.[393] Claiming that the use of the geodesic dome principle as a significant event in technological development, *Forum* offered these details:

> A translucent plastic dome was attached by scotch tape to 19,680 aluminum spars. Fuller's dome weighs one-eighteenth of a conventional steel dome's total, has weather resistant quality and is better adapted to shocks in the atomic age.[394]

The project to commemorate the fiftieth anniversary of Ford Company entailed the enclosing of a large gear-shaped central space over an existing building, the Ford Rotunda building, with a geodesic structure. The building was salvaged from the Chicago World's Fair "Century of Progress" of 1930. Fuller took exceptional pride in his first major architectural commission because the geodesic structure was approved by and built for the public showpiece of no less than "Mr. Industry himself."[395] This, in itself, was a validation of the supremacy of the geodesic structure.

Fuller's collegiate dome experimentations, as one author paraphrased Fuller, were tests of the "practicality of his ideas." The Ford Rotunda Dome, being the biggest, "affirm(ed) that practicality"[396] However, the stunning feat remained in the design, production, testing and construction of the structure. The project which was a 93-foot clear span domical enclosure weighing 17000lb took four months – from the time the contract for the design was received by Fuller in December 1952 to the time it was delivered and erected in May 1953.[397] The hemispherical trussed geodesic was made from aircraft alloy heat treated aluminum sheet struts.

In the dome research program, Fuller systematically used each prototyping opportunity to advance towards a lighter and higher performance structure. Up until the Ford Rotunda Dome, the biggest diameter for a geodesic structure prototyped by Fuller was around fifty feet. Even then, the structural performance was based upon "only calculations and educated estimates."[398] At Ford, and with its resources, Fuller was finally able to subject his dome to structural tests at the Aeronautical Engineering Department of the University of Michigan.[399] This was significant,

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[393]See "Exhibition Housing," *The Architectural Forum*, May 1953.
[394]Ibid.,p.16
[395]R.W. Marks, *The Dymaxion World*, p.58.
[396]Dick Compton, "The Dymaxion Dreams of R. Buckminster Fuller," *The Minnesota Daily "Ivory Tower"* Official Newspaper of U Minn. -Minneapolis, 15 Nov. 1954, p.9.
[397]R.B. Fuller, "Transcript – Meeting of the Forest Products Research Society, Grand Rapids, Mich.," in BFI-CR158.
[398]Ltr. 8/27/52 A. Fuller to Mr Hewitt in BFI-CR144.
[399]Ltr. 3/9/53 R.B. Fuller to William Groves (A.F. Bemis Foundation, MIT) in BFI-Hev6. Fuller reported that a test section (truss of 10 octahedra, 14 feet per edge, weight 55lbs, 0.032" strut thickness of 24ST ST-

since is not clear whether the thirty-one great-circle BMC geodesic dome was ever subjected to strain gauge testing; even though in early 1950, the NCSC Engineering Mechanics and Engineering indicated interests to conduct such tests.[400]

With the Rotunda project, Ford automobile technology, Fuller explained, provided him with Class-A tooling that maintained a tolerance in the positioning of the rivet holes and in the diameter of these holes of his trussed aluminum geodesic to 0.05 inch.[401] In addition to using Ford's automobile technology with respect to dimensional tolerance, he also exceeded it. Fuller explained the technological achievement in this way:

> Speaking in terms of Ford tool production operation, I can say that this structure which we put into place over the Rotunda was not evolved from surface contour curve drawings such as are used in making automobile bodies or hulls of ships but was developed from a system of control points. As we avoided the kind of tooling that derives from empirical contour sculpting from solid masses we were able to do with very small amount of 'material'.[402]

The automobile technology, besides enabling the speed of the erection, Fuller explained, also allowed him to drastically increase the efficiency of the structure, measured in the ratio of structure weight versus surface area. A dome of similar size of steel, he argued, would weigh twenty-nine times as much.[403] Though it was about one-third the size of the British 'Dome of Discovery' (at that time, in 1951, the most publicized dome built) Fuller claimed that the ratio of the weight of his structure to surface ratio of his dome was 1 1/3lb/sf versus 4lb/sf.[404]

2.6.1.1. Managing Professional Skepticism

By today's standard, the 7 1/2 tons of structure and enclosure deployed in the Ford Rotunda would perhaps be considered an over-designed structure. However, the letters in the May 1953 issue of *The Architectural Forum* were mixed over the claims of the new geodesic structure.[405] Robert Davison, then a research director with Howard T. Fisher, both long-standing adversaries of Fuller, appreciated the necessity to publish "dream stuff" and the bold patronage of Ford Company to advance architectural and engineering ideas that were conceptually exciting.

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3 ALCLAD Aluminum alloy; 30inches depth; 1/3 lb/sf in superficial top surface) carried 1200lbs/sf compared to 200lb/sf of factory floor load under the existing building codes.
[400]See Ltr. 1/14/50 D. Stuart to RBF in BFI-EJA Green, p.7.
[401]Ltr. 1/24/58 R.B Fuller to Brattinga (New York, N.Y.) in BFI-CR190.
[402]R.B. Fuller, "Transcript – Meeting of the Forest Products Research Society, Grand Rapids, Mich.," 5/7/54, p.4.
[403]Sam Rosenberg, "The Man in the White Suit," unpubl. MS., BFI-CR164.
[404]Ltr. 10/8/52 R.B. Fuller to Ford Motor Company in BFI-CR144.
[405]See Robert Davison, W. Vross, R. Le Ricolais & F. Severad, "Letters," *The Architectural Forum*, May 1953, pp.98-102.

Sharing a similar sentiment, another writer saw the geodesics "at the threshold of (a) new era of structural design." It was merely awaiting "the development of proper standards" to move the structure towards economical and "conventional construction."

R. Le Ricolais, on the other hand, believed that the "dome design" was not logically dependent upon a spherical geometry [Fig.2.27g]. Instead, he argued that it would have been both pragmatic and functionally prudent to consider a paraboloid of revolution.[406] The greatest reservation came from Fred Severd, a New York consulting engineer, who was not only unimpressed with the claims but was perturbed by what he viewed as a slanted publicity exercise with misleading presentation of the efficiency of geodesic structuring over a conventional steel dome:

> That this dome has publicity value is proven by the wide publicity given it. But when the impression is left that 2 1/2 lbs. per sq. ft. aluminum and plastic dome is equivalent to 50lbs. steel necessary for a normal structure, the uninformed are led astray ...
> Economy wise, the great amount of field work, reflected in 30 working days for the crew, goes counter to the modern trend of the 'sweat of the brow' being replaced by mechanical 'toys'.[407]

Fuller successfully avoided being drawn into the fray by ignoring these criticisms, but this was done at a price in the loss of creative exchanges and the public perception of transparency in his process. However, this did not erode the credibility either of his character or his artifacts. His knowledge of structure was, for all intents and purposes, intuitive-conceptual rather than rational-practical, and his explication of the structural working was empirical rather than analytical. Fuller depended mostly on a growing crew of technicians and architects to work out the practicality and workability of his structures. T.C. Howard, one of Fuller's collaborators, related several ironic instances of Fuller's lack of practical structural knowledge which could have turned their major commissions into disasters. On the Ford Rotunda dome, for example, T.C. Howard recalled how Fuller was talked out of a single layer hub-strut system in favor of sub-assemblies of geodesic octet-truss, given the potential of local surface buckling with added weight of a surface.[408]

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[406]B. Kirschenbaum proposed that Le Ricolais's ideas for large space-enclosing structures are counter-intuitive to those guiding Fuller's geodesic research. For Ricolais, large span geodesic represented a "conceptual failure in thinking about big domes." Further, structural experimentations should not be shackled by stringent control over the deployment of material over the structural envelope or issues of reducing joint sizes and lightness of material. Thus for a mile-wide dome, Kirschenbaum recalled, Le Ricolais proposed the use of 6-foot hubs (Notes from Author's Interview with B. Kirschenbaum, New York City, 10/5/94).
[407]F. Severad, "Letters," *The Architectural Forum*, May 1953, p.98.
[408]Notes from Author's Interview with T.C. Howard, Raleigh-N.C., 4/26/95, p.34 (See also Ch.3 of this thesis on the design alterations to the Union Tank Car Dome project).

Fuller is better described as an exemplary tinkerer and polymath than an engineer. His creative activities conducted as a perpetual outsider were clearly shaped by the circumstances of his informal training and partly out of his choice. For Fuller, self-taught experimentations remained alluring because of their unstated freedom from scrutiny. However, his position as an outsider was as lonely and troublesome, as it was productive. For despite the increasing recognition of his pioneering initiatives, Fuller confided to Applewhite his deep frustration and loneliness. Many potentials remained unrealized under his self-appointed position:

> I have much more, and possibly the winning capabilities in my as yet unrecognized and as yet seriously uncredited(sic) know-how resource inventory ... I am as yet *forced by the lonely circumstances to process my own 'sensitive' knowledge on my own initiative* [409](Itl., my emphasis).

2.6.2. Managing the Publicity in Architectural Media and Feeding the Architects' Interest

Generally, inventors would avoid prototyping in public. While advising his students of this basic tenet of practice, Fuller's own practice was contrary-wise. The issue of secrecy or the professional necessity to protect the clients' interest did not appear to deter Fuller from publicizing his geodesic works in the early years. He was neither overtly concerned about the incompleteness of his experimentations, although he had personally censured his students for showing half-completed works.[410] For instance, even as Fuller prepared Charles Eames to undertake the "Bubble House," an early attempt to prototype a geodesic dome-home, the joints for the wooden strut-dome had not been developed.[411] Neither was there a skinning system in place for George Nelson's version of the dome-home, destined for the MoMA Exhibition.

Particularly with respect to DDM-Fuller House project, Baldwin recalled how Fuller summed up the significant lesson it offered -- "the necessity to control publicity."[412] One of his tips to the poor student-inventor was the use of publication as protection since, as a public domain medium, it was "very safe" and "the best way to prove prior art." For this reason, he cautioned that "an ounce of true news publicity is worth tons of paid for advertising."[413] Yet the publicity Fuller generated by his rapid prototyping activities flaunted this rule. The publicity it engendered

[409]Ltr. 4/2/59 R.B. Fuller to E.J. Applewhite in BFI-CR199.
[410]Notes from Author's Interview with J. Baldwin, Santa Barbara-Calif., 8/31/94.
[411]Ltr. 8/10/51 C. Eames to RBF in BFI-CR137.
[412]Notes from Author's Interview with J. Baldwin, Santa Barbara-Calif., 8/31/94.
[413]R.B. Fuller, "Discussion of History of Patents in Society," p.7.

straddled between the demands to stake claims and the production of hype aimed at advertisement value.

While he did not pay for advertisement, his own management of publicity was a finely-tuned art-form, gradually refined over time. Examples of earlier, more dramatic publicity stunts abound: the Dymaxion House was coupled with Marshall Field's display of ultra-modern French furniture; he drove Amelia Earhardt in his DTU to Washington D.C. to receive the National Geographic Medal in 1934 and demonstrated it at the White House[414]; he drove his one-piece Phelps Dodge toilet, mounted on a pick-up truck, all around the East Coast.[415] Under the settings of *Fortune & LIFE,* publicity and advertisement became seamlessly coupled. Both his life-story and the life of his artifactual production became public demonstrations, feeding public imaginations in the form of syndicated press, popular weeklies and respectable architectural journals.

2.6.2.1. A Design Agenda After the State of National Emergency

> You could make a particular contribution to building or with respect to equipment, bringing out the dynamic aspects of design in our times.[416]

So proposed Bennett, Dean of the University of Michigan, in an invitation for Fuller to speak at the 7th Annual Ann Arbor Conference, titled "A Mid-Century Report on Design Progress," in April 1949. Fuller's offering in response, "Preview of Building,"[417] fundamentally spelled out the prospects of his geodesic project in peace-time. With the lessons of DDM-Fuller House looming in the background, Fuller reported to the gathering of architects about the new urgency assumed by his geodesic project. Like the highly publicized DDM-Fuller House, the geodesic project symbolized and extended a broad industrial optimism over national recovery after the War. Now there were the additional stakes of national security and survival.

His new research agenda spelled out five tactics to secure the stakes of future peace as America viewed them. It highlighted the urgency of preparedness; the strategic significance of new deployment of the military capabilities to equatorial and polar environments; the opening of

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[414]S. Rosenberg, "The Man in the White Suit," unpubl. MS. in BFI-CR164, p.4.
[415]A. Hatch, *At Home in the Universe*, p.147.
[416]Ltr. 11/29/48 Wells Bennett (Dean, Univ. of Michigan Ann Arbor-Mich.) to RBF in BFI-CR124.
[417]See expanded version of "Preview of Building" in *Ideas and Integrities*, 1969 (1963), pp.119-224, which is based on the 7th Annual Conference, "A Mid-century report on Design progress" and ID-Chicago lectures (transcribed by Jano Walley, 4/1/49 in BFI-CR129); also as BFI-MSS 490400 "Preview of Building."

environmental extremes of air and ocean depths; the new abundance engendered by newly "valved unlimited cosmic energy" (read atomic energy); and the emergence of new world society based on abundance, mobility and decentralization.[418] Directly, the geodesic works and the autonomous living package addressed the implied issues of decentralization, autonomy-sustainability, portability, nimbleness and fleetness. Indirectly and separately, as a side-bar, the agenda appealed to a reexamination of the aesthetic possibilities in the tensionism, new materials, explorations into new structural geometry; and advanced environmental mechanics.

2.6.2.2. Indoctrinating Haskell

There were factions within the American architectural community who continued to be receptive to Fuller's designs despite his liminal position in that community. The geodesic project appeared as prefigurations of a new discipline of structural experimentation and an industrialized housing with national security implications.

Douglas Haskell, recently appointed editor of *The Architectural Forum*, for one, had been deeply appreciative of Fuller's consistent and positive position on the issues and role of technology in architecture. During the war-years, the DDU and DDM-Fuller House exemplified an imageable answer to the "defense housing" question. In the spring of 1951, on the outbreak of the Korean War, Haskell again found it timely to contemplate a special feature on Fuller's geodesic works. His keen interest in Fuller is obvious in this in-house announcement at *Forum*:

> Because industrialism is proceeding so fast in the US and is *being spurred again by defense*, we shall include the story of Buckminster Fuller's latest efforts as part of the 'coming architect' picture ... Bucky himself is well known to us as not a youth, but he has associated himself with an excitably enthusiastic group of students coming up through the colleges - MIT, North Carolina, Illinois Tech., and others (Itl., my emphasis)[419].

Haskell's subsequent feature story on geodesics, ensuing from his news-story plan above, finally appeared in the August 1951 issue of the *Forum*. This issue was instrumental in fanning both public enthusiasm and professional interest in geodesic domes and space structures beyond the expectations of both Fuller and his early collaborators.[420] Spurred by the success of this

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[418] R.B. Fuller, "Preview of Building," in *Ideas and Integrities*, p.208.

[419] Douglas Haskell, In-house announcement of *The Architectural Forum*, 4/23/51 in BFI-CR137. Perhaps because of the detrimental effect of LIFE-TIME's popularization of his Dymaxion Map project, Fuller was anxious of a similar treatment of his new work; hence his reluctance of "it (his presentation on geodesics) spread out as a TIME-LIFE undertaking" (See Ltr. 4/12/51 Douglas Haskell (Editor, *A. Forum*) to RBF in BFI-CR137).

[420] See Walter Mcquade's 8-page feature "Geodesic Dome," in *The Architectural Forum*, August 1951.

feature, Douglas Haskell proposed a follow-up piece on the "research idea" of Fuller's research enterprises, the FRF.[421] Fuller was conscious that he had found a sympathetic promoter in Haskell, and reciprocated by fueling Haskell's appetite with potential scoops on his ongoing work. He even promised him a list of "young men" who "demonstrated consistent ability and competitive assumption of the initiatives in frontier developments of experimental structure and mechanics."[422]

Haskell's familiarity with and endorsement of Fuller's research program was not a recent development. In the thirties, he contributed to *SHELTER*. While disagreeing with certain excesses of Fuller's SSA group, he was sympathetic towards "the main direction" of Fuller's industrialized shelter agenda, and the editorial direction of *SHELTER*.[423] Later as an architectural critic of *The Nation* and associate editor of the *Architectural Record*, he continued to monitor Fuller's creative work positively.[424]

Like Fuller, Haskell was enthusiastic about the ingenuity of American technology. With the geodesic structural experimentation under way, he felt that the discipline of structure as a new creative impetus for architecture had been forged. Fitzgibbon reported:

> (Haskell) says in short that there are three answers open to the architectural student to return the architect to the status of master builder. One to join forces with the big builders, second to sincerely do work for individual clients searching out improved design methods, thirdly to follow the direction set in the work of Bucky Fuller.[425]

Haskell's cordiality towards and support of Fuller's agenda also stemmed from an ideological affinity. Characterizing Haskell as an "old-fashioned" American idealist and radical, Blake claimed that his ideological position compensated for uncertainty of his identity, given his early childhood in "some obscure Balkan backwaters." In this regards, his enthusiastic reception

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[421]Ltr. 11/20/52 J.W. Fitzgibbon to RBF in BFI-CR139.
[422]Ltr. 5/17/51 RBF to D. Haskell in BFI-CR137.
[423]Ltr. 6/1/32 D. Haskell (Treetops-N.Y.) to RBF in BFI-CR41. In particular, he objected to the way Peter Stone (a member of Fuller's SSA group) had represented the research activities of Bob Davison, then managing Pierce Research Foundation.
[424]Refer to "Douglas Haskell Collection of Letters" in the Avery Archives at Columbia University for more details of Haskell's activities as an architectural critic. For an overview of the role of Douglas Haskell in the discourse on modern American architecture, see Robert Benson's "Douglas Haskell and the Criticism of International Modernism" in *Modern Architecture in America (Visions and Revisions)*, Richard G. Wilson (ed.), pp.165-183; also R. Benson, "Douglas Haskell and the Modern Movement in American Architecture," *Journal of Architectural Education* 36 (Summer 1983): 2-9.
[425]Ltr. 4/3/52 J.W. Fitzgibbon to RBF in BFI-CR139.

of non-American pioneering technologists like Paul Weidlinger, Pier Luigi Nervi and Frei Otto, stemmed from his perception that they were working in the wake of free American spirit.[426]

The general austerity of Fuller's house program, first with Dymaxion and now with dome-home, *Garden of Eden*, probably struck a chord with Haskell's own quest to return to a quintessential American living arrangement, reminiscent of the frontier. Speaking at a major conference of industrial housing, the Inter-Industry Housing Conference in Washington D.C. in 1951, Haskell proposed a return to a house type long popular in America -- a large room for general family living including eating, cooking, and a smaller separate room for the quieter and more polite activities.[427]

For a generation of Americans recoiling from the effects of a second World War, this self-appointed austerity was clearly prudent. Likewise, the general consensus for industrialized houses was a sensible strategy. Thus, while P. Belluschi, another speaker at the Conference, rehearsed the idea of bringing the industrialized house to the level of "domestic object of consumption," Fuller openly provided the model of this dome-home as a demonstration of a viable option. Formally transformed and programmatically reduced, the dome-home updated the desires of 4D-Dymaxion House, particularly its prime objectives in being independent of the utility grid [Fig.2.21]. With improved methods of mass production, Fuller claimed that even its unusual form would become acceptable:

> Sales resistance to the unorthodox appearance of such a house - transparent plastic dome - would vanish with a sales price of less than half that of a commercial house ... Beauty has a way of revealing itself in unexpected forms; even in a shining ethereal-looking plastic bubble.[428]

2.6.2.3. A Role For Architecture in National Security

A month before the conference in Washington D.C., Fuller had presented his work at "Conference on Housing - A National Security Resource" in MIT, under a wholly different set of agenda.[429]

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[426]Peter Blake, *No Place Like Utopia*, p.215.
[427]John Hancock Callender, "Summary of Inter-Industry Housing Conference, Washington D.C. - Session on Housing Design," p.2. The conference (Feb. 13-14 1951) was sponsored by Southwest Research Institute with cooperation of the Urban Land Institute, National Association of Home Builders.
[428]Ibid.
[429]"Conference on Housing - A National Security Resource" held at MIT in Jan 19-20, 1951.

Carl Koch, a convener for the MIT conference, argued that architectural design could no longer be a stylistic concern. Rather, design now assumed the role of protecting the life of the country, since "for almost the first time in history, the demands of war and peace are synonymous."[430] Further, deployment and decentralization were foregone conclusions as the new form of air-warfare graduated cities into fronts. Thus, while industrial plants could be dispersed to areas outside atomic bomb targets, more civilian defenses would be necessary within the potential target areas. War and peace had collapsed into one sphere of concern, and Koch concluded:

> It meant that now some of our vital war weapons were at the same, tools of peace, we could create a combination sword and plow.[431]

Thus, for this group of architects and planners, the issues of community or monumentality in the dominant architectural discourse appeared misguided. Instead of communication in "life-belts" or dispersal areas, their peripheral servicing and decentralization became issues that were more pertinent. Mobilization, transience and contingencies were not mere attributes of consumptive mass society, rather; they were viewed as vital survivalist features as well.[432] Hence, Ralph Kaul of the Housing & Community Facilities Office in the National Security Resource Board recommended the consideration of non-permanent "community" since it was "uneconomical to provide immovable facilities with 20-30 years' amortizable life, for a period of 4-5 years."[433]

The observations and conclusions reached by experts gathered at the conference appeared to vindicate Fuller's prognostications of the war-years. They included a plea for the decentralization of settlements and industrial production and the development of an autonomous mechanical equipment package that would facilitate a mobile living environment. In the context of these perceived emergencies, geodesic structure as a new, efficient structuring strategy and dome-home as a housing solution were placed at the nexus of national security issues. The deployability of both promised logistics significance in conserving materials and manpower.

In tandem with the concerns raised at the MIT conference, Fuller and his collaborator James Fitzgibbon initiated a "deployment" project at NCSC-Raleigh. This entailed, Fitzgibbon

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430 Proceedings on "Conference on Housing - A National Security Resource," Jan 19-20, 1951, p.1.
431 Ibid.
432 See the reports to this effect: "Building Revolution Devised by M.I.T. Researchers for Survival," *The Architectural Forum*, March 1951, p.24; Fuller's speech to the Detroit Chapter-AIA was reported as "Calls Architects saviors of Future" (*Detroit News*, 7 Sept. 1951).
433 Proceedings on "Conference on Housing - A National Security Resource," Jan 19-20, 1951, p.14

described, an investigation into the dispersion of both industrial plants and cities on a national scale. As a form of "offensive" defense, the geodesic structures and the autonomous living packages would form the thrust of "mobile methods of construction and shelter"[434] [Fig.2.37].

Preparedness for war emergency, the capacity for rapid deployment, and the changing definition of war fronts had contributed significantly to shape Fuller's research directives. Viewing housing as a "security resource," Fuller's geodesic project was also partly spurred by his speculation that a substantial amount of money would be reapportioned from civil defense to housing. Besides, the act of public authority in "forc(ing) people into potential target areas and requirng housing be planned at higher densities," he felt, was "criminal."[435]

In January 1948, as Fuller poured over his EG study, he penned this letter to an old associate, Jake Butts, treasurer of the defunct Fuller House project. The threat of nuclear Armageddon, Fuller proposed, might speed up the plan for shelter industry:

> Should we get to the over-the-pole atomic warfare or pestilance(sic) rockets etc. only DEPLOYMENT by man to invulnerable degree of density of population with an absolutely flexible network of industrial interaction can win the day and that deployment depends first on super mass production of AUTONOMOUS DYMAXION DWELLINGS (A whole new mechanization network of installation techniques) as initial operating advantage."[436]

Now with civil defense increasingly viewed as an offensive weaponry, his agenda of dome-home and autonomous living package fitted the functional billing of three types of housing proposed by the experts. These included mobile housing for non-permanent workers, semi-permanent housing for operations of the defense plants and permanent housing in decentralized areas.[437]

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[434]Ltr. 11/17/60 J.W. Fitzgibbon to Dean D. Kenneth Sargent (School of Architecture, Syracuse University) in BFI-CR215. See also Jim Mitchell, Sherman Pardue Jr., Fred M. Taylor, "Deployment," *Student Publication of the School of Design* (NCSC), Vol. 2, No.1, Fall 1951, pp. 5-12.
[435]R.B. Fuller, "Deployment Housing - A National Security Resource," MS. in BFI-CR137.
[436]Ltr. 1/11/48 RBF to Jake Butts (Wichita, KS) in BFI-CR124
[437]Proceedings on "Conference on Housing - A National Security Resource," Jan 19-20 1951, p.17.

2.6.2.4. In Opposition to the New Monumentalism and Community

The research agenda and concerns that Fuller highlighted and enumerated at the Ann Arbor Conference were distant from the issues encountered in the architectural circles.[438] His address contained no statements on the need for architectural practice to address the apparent erosion of community or the rise of mass culture. While many contemporary architects discoursed on new monumentalism and reconstitution of communal life as ways to deal with these new threats, Fuller's quietism, suggested how he might have thought: that they were either irrelevant or anachronistic.

In the thirties, he eschewed the ideas of community and monument because of his productivist view of architecture. In this view, community was a product of industry and organization of material life, not the object of architecture; and monument was a shackle of oppressive tradition. Then, as now, the loss of art and aura in architecture because of the new market place and industrial techniques were not worth lamenting.

Matthew Nowicki, for example, was looking for a new humanist project in the "integration of architecture, landscape architecture, city planning, and other design arts into a 'single frame.'"[439] Louis Kahn, on the other hand, was arguing for an architecture that would redeem human assembly as a "transcendent social good."[440] Instead, Fuller saw a new emancipation in the forums for the consumption of popular culture. In place of a participatory civic public, he enthused in the mass consumerist public, seeing it as more participatory than complicit. As the ambitions of his meta-science project, *EG*, grew, he gradually proffered it as a meta-architectural language to displace architectural knowledge in the broadest sense. The material fact of energy, rather than culture, was the unifying element of diverse human knowledge. The geodesic works, as a sideline, served as an ecumenical instrument to sidestep the weight of architecture as historical culture.

Working along these ideological lines, Fuller proved phenomenally successful in the collegiate circuit. Characterizing Fuller as "the prime example of the guru madness," Johnson

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[438] See the compendium of post-war issues and stances confronted by the American architectural practices in Joan Ockman, *Architecture Culture 1943-1968: A Documentary Anthology*, New York: Columbia University Graduate School of Architecture, Planning, and Preservation, 1993.
[439] Joan Ockman, "Matthew Norwicki" in *Architecture Culture 1943-1968*, p.149.
[440] Sarah Ksiazek, "Architectural Culture in the Fifties: Louis Kahn and the National Assembly Complex in Dhaka," *JSAH* 52:416-435, December 1993, pp.416-435.

also implied that Fuller's charisma fed on the general gullibility of college students. Johnson summarized the effect in this way:

> (N)obody ... had the kids in the palm of his hand the way he did.[441]

Since the *SHELTER* debacle, Johnson probably felt, but seldom acknowledged his quiet envy for the effectiveness of Fuller's publicity. Putting this personal perception aside, Johnson's more germane concern was directed at the narrow concern promulgated by Fuller's design agenda. It prompted Philip Johnson to identify, albeit paradoxically, Fuller as the primary agent of one of the "seven crutches of Modern Architecture."[442] Criticizing Fuller's approach as giving centrality to pure structural pursuit, Johnson highlighted its comforting abandonment:

> You can be led to believe that clear structure clearly expressed will end up being architecture by itself. You say, 'I don't have to design anymore. All I have to do is make a clean structural order.'

While this criticism is partially true, Johnson was also guilty of grossly simplifying Fuller's design agenda. In characterizing Fuller's fetish for structures as a be-all of architecture, Johnson undervalued its symbolic significance and the wider context of its appeal.

2.6.2.5. Wachsmann and Fuller -- Discourse on the Joints

In the fifties, a number of outstanding American architects, besides Fuller, were working in this invigorated area of structural investigations and industrialized buildings. Among Fuller's contemporaries, the work of Konrad Wachsmann (d.1981) has been closely identified with or variously compared with Fuller's.[443]

Before his arrival at IIT-Chicago in 1949 to assume the headship of its new Advanced Building Research division, Wachsmann had already firmly established a formidable reputation as a skillful and conceptually rigorous constructor. The *General Panel System* (1942) and the

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[441] K. Simon & K. Goodman, Transcript of Interview with Philip Johnson (for a PBS documentary "Thinking Out Loud"), ca. 1993, p.2.
[442] Philip Johnson, "The Seven Crutches of Modern Architecture," in Joan Ockman's *Architecture Culture 1943-1968*, p.191.
[443] For a recent comparison of Fuller and Wachsmann, see Peter Blake's *No Place Like Utopia*, pp.96ff; K. Frampton's "I tecnocrati della Pax Americana: Wachsmann & Fuller," *Casabella*, 1988 Jan.-Feb., v.52, no.542-54, pp.40-45; also "Whole Earth Men: Fuller and Wachsmann," *Inland Architect* (Chicago), July 1973.

Mobilar Structure Building System (1946), which he undertook with Walter Gropius, were legendary technical achievements though they did not go into production[444] [Fig.2.22h].

The relationship between the two men was cordial, and though not openly obvious, the rivalry between both men was implicit since they courted similar clients and worked in the broader field of space-structural experimentations. Fuller was aware of this public identification of his work with those of Wachsmann, and as such was careful to demarcate the superiority of his own approach. For example, in comparing the effect/weight ratio of Wachsmann's Air Force building project (380'wide, 700' long @ 15lbs/sq.ft = 4.5 million lbs.) with his own three-frequency triangular building of octet-truss, he concluded that his structural system was more efficient[445] [Fig.2.22g]. Privately, Fuller suggested that Wachsmann's research agenda "had not developed from any specific realm of (his) philosophy but from a diffusion."[446] At one point, he even suggested that though Wachsmann operated under a different philosophy and research system, any commonality between Wachsmann's work and his was a "matter of recent adoption." Fuller explained:

> When he (Wachsmann) was at the Institute of Design of the Illinois Institute of Technology his technical explorations in structures were in directions other than geodesic though he did, towards the end of his Chicago visit explore the use of my octahedron-tetrahedron truss in connection with the roof of his Air Force hangar. Though I am warmly sympathetic with Conrad (sic) Wachsmann's exploratory urges and technical strategies and I have heard him express enthusiasm for my work, it was clear that his explanations of his undertakings had not developed from any specific realization of my philosophy.[447]

Konrad Wachsmann, on the other hand, openly valued Fuller's experimentations and was more generous with his acknowledgment of his influence. As early as 1950, he identified Fuller's work among the materials he sought for his own prime project to exclusively explore "the scientific research, analysis and development of the industrialization of structure."[448] With Fuller's geodesic works successfully prototyped at ID-Chicago, Wachsmann was especially eager to see how his research agenda might set a path for his own work:

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[444]For a historical assessment of these projects, see Gilbert Herbert's *The Dream of the Factory-made House: Walter Gropius and Konrad Wachsmann*, Cambridge, Mass.: MIT Press, 1984.
[445]Notes from Author's Interview with B. Kirshenbaum, New York City-N.Y., 10/5/94. Kirschenbaum related that he had worked with W. Wainwright, on hangar for the B-36 bombers in Wachsmann's studio. This eventually led to the 1959 U.S. Air Force hangar (240m x 155m) using tubular steel space frame, and a fantastic high-grade nickel steel node for 20 struts that could be assembled using a simple hammer (See K. Wachsmann's *The Turning Point*, pp.170-191).
[446]Ltr. undated (ca. Dec 1958) R.B. Fuller to Stuart Campbell in BFI-CR196.
[447]Ltr. 12/22/58 R.B. Fuller to Stuart Campbell (Univ. of Birmingham) in BFI-CR196.
[448]Ltr. 4/26/50 K. Wachsmann to RBF in BFI-CR133.

I am now eager to get all your material, if I may say so, your complete life's work, to set up a very rigid foundation for my future work here (at IIT).[449]

At the height of interests in space-structures and systems building in the late sixties, Wachsmann attempted to organize a "Fuller Exhibition" at the Museum of Science & Industry-Los Angeles, perhaps out of his own interest to publicize the reality of large space-structures. Wachsmann's express interest was, he informed Fuller, in the public exhibition of full-scale models.[450]

The pioneering experimentations in space-structure of Fuller and Wachsmann were formed by an industrial imperative, and pivoted on a vision of design for mass-production. Consequently, their respective search was for lightness, for economy, and for rational and industrialized methods of construction. Their approach is distinct from experimenters working along an analytical imperative or, as Eekhout puts it, a "structural concept."[451] The latter are generally technicians, like Makowski, working along the line of refinement, and who are more concerned with structural optimization.

Through his research agenda on the industrialization of building, Wachsmann tried to establish a "type of universal variability in a primarily structural component"[452] [Fig.2.22e-f]. This led to his search for direction-less joints, interchangeability in building systems to allow great freedom in construction and connecuions, and to surpass the restrictions of monotony in mass-production. Despite his predisposition to systems, Wachsmann saw his work as a continuity of the cultural objectives of architecture.

Wachsmann believed in the necessity of "actual building" in which one learn radically of the future, both "foreseen and recognized."[453] Thus, a building as an artifact, through a radical form and arising from an industrialized system of production and assemblage, remained a bearer of culture. This was also the fundamental distinction that Frampton made in comparing Wachsmann's and Fuller's works, though placing both men in the broad framework of "Pax

[449]Ltr. 5/24/50 K. Wachsmann to RBF in BFI-CR133.
[450]Ltr. 8/11/66 K. Wachsmann to RBF, et.al in BFI-CR288.
[451]Mick Eekhout, *Architecture in Space Structures*, Rotterdam: Uitgeverij 010 Publishers, 1989, p.16. See also "Analysis, Design and Realization of Space Frames. A State-of-the-Art Report" (Yoshikatsu Tsuboi, ed.) in *Bulletin of the International Association for Shell and Spatial Structures*, IASS, Vol.25 (1984) n.84/85, pp.11-105.
[452]Mitchell Rouda, "Konrad Wachsmann" in Muriel Emanuel (ed.) *Contemporary Architects*, p.160.
[453]K. Wachsmann, *The Turning Point*, p.10.

Americana" technocracy. Frampton's own bias for tectonics as a cultural trace inevitably led him to a more positive assessment of Wachsmann:

> Where Wachsmann's thought was always grounded in building culture, that is to say, in tectonic detailing and in the rational fabrication and assembly of structural components, Fuller invariably regarded construction as nothing more than a special case of man's interaction with nature, particularly where the specifics of this interaction could be defined in survival terms.[454]

While Frampton employed a history-nature dichotomy to distinguish between Fuller and Wachsmann, Blake advanced a more impartial assessment of their work which equated their broad humanist-modernist concerns. Their passions for precision, Blake explained, were primarily buoyed by an optimism in technology and a quest for order in an otherwise "chaotic, overpopulated, self-destructive world."[455]

In reality, both men were separately driven by their respective concerns and inclinations, though sharing a common ground of structural experimentation. For Fuller, precision was taken mainly as dimensional tolerance in machining. It was the measure of increasing industrial efficiency and directly, a cipher of civilization. In Fuller's account, America, as the epitome of industrial civilization, towards which other nations were trending, saw machine tool evolving from craft to the automobile, and finally the aircraft industries. For Wachsmann, the issue of precision was manifested in an almost fanatical, if not exclusive, search for a perfect universal joint design. It was an end in itself. His joint designs exuded both immediacy and purposefulness.

B. Kirschenbaum, who had the privilege of being a student of Wachsmann at IIT in 1949 and a subsequent collaborator of Fuller, characterized the former as a "worker," a direct hands-on person who dealt with his design in the workshop. Fuller, on the other hand, merely delegated work and counted on the initiatives of collaborators:

> I think you explore yourself and Bucky sort of incorporated the findings of the explorations and then ... the thing was that you worked, and you do something and show it to Bucky and he would incorporate it in his oeuvre, you know.[456]

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[454]K. Frampton's "I tecnocrati della Pax Americana: Wachsmann & Fuller," *Casabella*, 1988 Jan.-Feb., p.119.
[455]P. Blake, *No Place Like Utopia*, p.96
[456]Notes from Author's Interview with B. Kirshenbaum, New York City-N.Y., 10/5/94.

Since he funded these geodesic enterprises, it was natural for him to claim the joint designs as his own. However, his franchisees and his student experimenters executed most, if not all of these joints in the geodesic artifacts [Fig.2.22a-d]. Though he was instrumental in advancing the geodesic enterprises, his primary interests were conceptually driven rather than hands-on. Many of his collaborators directly cast doubts over his proclaimed shop skills, despite his own assertion as "officially a machinist" and the public portrayal of him as "master mechanic in the Kettering mold."[457] T.C. Howard, for example, recounted his experience with Fuller while working on the MoMA "Bubble House" in the New York workshop of the puppeteer, Bill Baird:

> He may have been a machinist, but he was scary around the equipment (band-saw), I must say. Maybe he had forgotten what to do, but he was not a skilled machinist ... I don't think. And I had wondered about how much he had to do with back in the machine shops doing the cars ... I think somebody else developed that.[458]

The extant joint details directly attributed to Fuller are indicative of his singularly pragmatic-functional considerations; they were means to and results of rapid prototyping. Joseph Clinton, who taught alongside Fuller at SIU-Carbondale in the late sixties, described the joint design variously as "optimal," "ad-hoc" and "contextual" to the joint problems, to heighten their characteristically ephemeral and make-do qualities.[459] In contradistinction to the pragmatic joints developed by Fuller and his collaborators, Clinton noticed a distinct paradox in Wachsmann's joint-project. Despite their subliminal representations as "unique theses" and the elaborate tooling processes involved, it was difficult to fathom his objectives.[460]

By objectives, Clinton was referring to the transcendental sort. This paradox likewise applies equally to Fuller's severe make-do joints. Despite their directness, the geodesic project in totality would, as it unfolded, display its transcendental nature eventually. In the mid-fifties, Roberto Mango, an ardent supporter of Fuller, when comparing him and Wachsmann, already made remarks about the larger Fullerian project to this end:

> I have been very much impressed by the Wachsmann structures and ideas, even if I felt that many of his ideas were either taken from you or carrying to the same conclusion by coincidence. And his structures don't seem to match his conception as your prototype, *instead talk by themselves even if you don't give any comments*. I don't want to criticize him but I do feel strongly that his influence towards society may be secondary and *help our way of clarifying again what people may not catch from you*. In other words, is good to have at least two different sources of information: one may confirm the other (Itl. my emphasis).[461]

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[457]"Fuller's Domes Catch On at Last," *Business Week*, 10 May 1958, p.114.
[458]Notes from Author's Interview with T.C. Howard, Raleigh-N.C., 4/26/95, p.43.
[459]Notes from Author's Interview with Joseph Clinton, Santa Barbara-Calif., 10/22/94, pp.32-35.
[460]Ibid.
[461]Ltr. 11/2/54 R. Mango to RBF in BFI-CR159.

Likewise, William Wainwright, another student of both Wachsmann and Fuller, noted that while Wachsmann was a "more limited man than Bucky," he had more to do with "actually being in charge to get something done." In retrospect, Wainwright charged that their fixation with thinking ahead and thinking of big patterns were oddly limited, and symptomatic of "Freudian avoidance."[462]

Rather than avoidance, the significant meaning of their work remained as valiant attempts, albeit in naïve ones, to address two issues confronting the architectural profession. On the one hand, the discourse of the joint, contained in larger systems approach, was meant to arrest the run-away problem of builders gaining grounds in the technology of building, thus diffusing the value of art in architecture. The second, which Fuller himself identified, was how to maintain architecture as an "anticipating rather than curative" discipline when a increasing section of its talents were funneled by "enormous army-like" practices like Skidmore & Merill into "drafting and catalog machines."[463]

2.6.2.6. A New Aesthetic Appeal -- From Light to Tension

Other than Wachsmann's interests, boosters for Fuller's ideas among the art-architectural fraternity were never lacking. Despite the debacle of all of Fuller's repro-shelter projects, Fuller was successful in maintaining a credible position as an advocate of modernity and of future design among more radical designers and artists. Geodesic structuring and the widely speculative *EG*, together provided a palpable art-architectural agenda. Through the energy motif of structural-tensionism in *EG* and the geodesic project, the emblematic light-lightful nexus of 4D-Dymaxion phase was completely transformed.

In architectural circles, and as early as 1950, John Entenza, then editor of *Architecture*, was interested in publicizing Fuller's *EG*. A promoter of sorts, Entenza was probably captivated by the newness of Fuller's ideas and the novelty of *EG*. John Moehlman, one of Fuller's students, offered this reason:

> John (Entenza) wants something new (he is rather tired of the run of the mill architectural submissions) and is quite enthusiastic over the energetic development.[464]

[462]Notes from Author's Interview with William Wainwright, Boston-MA., 4/19/95, p.12.
[463]R.B. Fuller, "The Comprehensive Man," BFI-MSS 59.03.02, p.36.
[464]Ltr. 11/13/50 John Moehlman to RBF in BFI-CR135.

In 1965, after much persuasion, Entenza provided funding through the Guggenheim Foundation to support *EG* as a book project; but it took another decade before *EG* appeared in the final form as *Synergetics*. The delay was caused by circumstances totally dictated by Fuller. He had a greater ambition for EG as a meta-science project, and he was generally cautious about Entenza's enthusiastic but limited promotion.[465] The potential of it being spoilt by omission or distortion was probably lurking in his mind.

Eleven years after his first EG tract of 1944, and on the occasion of the Institute of General Semantics' A. Korzybski Memorial Lecture in New York, the portentous findings of EG was offered:

> Bucky has developed and discovered some extremely important information about "systems" for interpreting the world around us.[466]

Fuller was convinced that *EG* and the evidence in geodesic structuring promised "partial fulfillment of A. Korzybski's prediction" in *Science and Sanity* -- namely, that physics would unveil a "multi-ordinal structure" of language based on "multi-dimensional geometry (with) multi-directional order, giving (a) multi-dimensional order."[467] As *EG* gained a critical mass of empirical evidence in the geodesic structuring, Fuller began to advance its broad claims in public confidently and to distance himself from these early supporters. For this reason, his dedication of *Synergetics* (1975) to H. S. M. Coxeter, the outstanding Canadian geometer, rather than beguiling, is a purposeful move to legitimize a self-enterprise previously appreciated as art into science.

2.6.2.6.1. The Aesthetic and Symbolic Appeals of Tension

In the mid-sixties, Fuller clarified his singular role, through his working models of the 4D-Dymaxion House, in edging and influencing Calder's "mobile architecture":

> My name isn't Cezanne. Sandy (Calder) may have forgotten all this ... I have heard that Sandy felt the name 'mobile' was suggested to him later by Marcel Duchamp, but this (version of my influence) is the way it really was.[468]

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[465]Notes from Author's Interview with Duncan Stuart, Raleigh-N.C., 4/26/95.
[466]Ltr. 2/13/55 John Dixon to M. Kendig (Institute of General Semantics) in BFI-CR164.
[467]A. Korzybski, *Science & Sanity, An Introduction to Non-Aristotelian Systems and General Semantic*, Lakeville, Conn., International Non-Aristotelian Library Pub. Co., [4th edn., 1958], p.449.
[468]Ltr. 10/6/65 RBF to Albert Moore (Falls Village-Conn.) in BFI-CR274.

Similarly, he claimed that in 1928 he brought to Isamu Noguchi's attention the chrome-nickel-steel developed by Henry Ford. The permanently burnished reflecting surfaces of the new metal, he explained, enabled Noguchi to go beyond the problems of tarnishability, which he analyzed, led sculptors to depend traditionally "on the shadow (and) on the negative of light, to define their work." Thus:

> This permanently burnished surface acts like a mirror. You can only tell what the shape of the sculpture is by the way it distorts the reflections of familiar objects. It made sculpturing a truly abstract and dynamic art ....What is unique about Noguchi's sculpture is that it was not produced as a shadow sculpture later to be chrome plated, but was designed originally for image reflections.[469]

Though provocative, the veracity of these claims cannot be ascertained at this point. One could even venture that Fuller probably over-exaggerated his role in influencing these two prominent artists. As his own fame mounted, he also disproportionately inflated his sense of propriety and the scope of his influence. Nevertheless, one could still propose that Fuller, perhaps more than anyone else, was broadly effective in rendering both light and tension as productive elements in the new creative arts.

As early as 1931, Fuller began to speculate on a dramatic bi-polar schema for art and science. Science as a "radial direction life-in philosophy," he proposed, was dissective. It was also "singular, male, compression, pressure, internal, intellect, abstraction, eternity, (and) subconscious." In contrast, Art as a "radial direction life-out knowledge" was compositional. It was "plural, female, tension, vacuum, external, sense, articulation, time, (and) conscious."[470] Recasting these implicit Freudian characterizations, one suggest that tension, according to this schema, would be analogical to the psychological Id, deeply invisible but pervasive; while compression as Ego, remained locally sited. By the time of his first teaching engagement at ID-Chicago in 1948, however, Fuller began to render the significance of tension and its implications for a new architecture in iconic terms.

To understand the broad appeal of tension to Fuller, one must consider how he treated physical forces metaphorically and metonymically. He also considered their roles as cultural leitmotifs in a rather essentialist way. For Fuller, tension was symbolic of metaphysical infinitude and flexibility.

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[469]Ltr. 9/25/63 RBF to Dwight Pennington (*The Kansas City Star*, Kansas City-Kans.), in BFI-CR246.
[470]See "Universal Architecture Essay No.1," p.68.

> (T)ension is a fitting symbol of intellection (sic), being practically unlimited in length with relation to its cross-sectional area. Being also flexible, the tensed structural member is instantly adjustable to load changes and may, therefore, receive eccentric loadings at any point along its surface, because it tends to pull true and, with loading, becomes cohesively taut ...
> (M)ind (is) represented by tension and 'matter' by compression.[471]

Tension suited his belief in the dominance of mind-over-matter. Tension was, for Fuller, a positive gestalt in the epoch of energy. The iconographic significance of tension, Fuller proposed, was its vitality and cosmic presence. To dramatize the universal efficiency of tension, Fuller offered this schema of cosmic order: the planetary universe was held together by tension continuities while the planets, like ball-bearings are locally islanded as compression points.[472] In contrast, he portrayed compression as having "no magnitude of growth."[473] Compression represented things secular and localized. This was the old power system of "brute force," in the "pre-mechanized society." It represented a static, feudalistic and conservative culture. In nature, compressional forces are islanded in localities, concentrated and static like the planets.

These ideas reappeared in Fuller's deterministic view of history. Human history, Fuller speculated, as encapsulated in the stream of artifactual production, was paradoxically geared to make the mechanical and structural "efficiency" of nature realizable:

> Until the advent of the age of marked superiority of metals in tension over tensile abilities of natural fibers and 'raw' stones, it was useless for man to over contemplate this structural efficiency of nature.[474]

Further, under his mythologized renditions of metal as tension and stone as compression, American political history was presented in this way:

> In 1851 when steel brought parity of tension-compression, we have Abraham Lincoln in America, just at the time of the Civil War saying he thought it could be possible that historically, might be coming into a period where right makes might ... (M)ight was that compression, that stone.[475]

There were practical ramifications in adopting tension as a primary motif in his designs. In his stable structural experimentations from 4D-Dymaxion House to Fuller House, structural

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[471]R.B. Fuller, "Enter Alloy: Exit Rust," *Nine Chains*, pp.184-186.
[472]R.B. Fuller, "Transcription of Energetic Geometry Lecture at Cooper Union," April 24 1950, in BFI-EJA Blue, p.10.
[473]Ibid.
[474]R.B. Fuller, *Nine Chains*, p.189.
[475]Laleh Bakthiar & Leila Farhad, eds., *The Interaction of Tradition and Technology*, p.112. For more a more extended version of this speculative history, see Ltr. 12/30/43 RBF to Joseph Stevens in BFI-HEv4.

tension held a special and captivating meaning. Even in his Dymaxion Transport Unit (DTU), he explained, was constituted under the primary effects of tension:

> Tension lines, pull lines, really represents the activity of the intellect. The same thing happens with the automobile. You can pull it without as much frictional loss as pushing it from behind.[476]

Snelson, despite his subsequent fall-out with Fuller, gave perhaps the most perceptive rendition of the appeal of his structural research agenda. He characterized Fuller, in relation to the "center for avant garde art" at BMC, as "a bull in a china shop." Fuller's little "real interest in art," Snelson explained, and perhaps Fuller's own professed artlessness, augmented his radical and enigmatic position. Most importantly, he recognized that the structuralism of Fuller's tetrahedral world was more than a source of novelty and excitement. It was a critique of the elementalist point-line-plane staple of the new European art of the Bauhaus and De Stjil:

> Though the cube was the keystone of Bauhaus architectural thinking, no one seemed to think or care whether the cube was a sound structure or not.
> (Fuller) provided the astonishing insight that the only structurally firm polygon is a triangle- and argued for a kind of structural space completely different from the usual cubical considerations. It was not easy to see the connection between his interests in space and the aesthetic attitudes toward it from the view of the sculptor or architect.
> To my mind and eye, *the enlightenment of treating three-dimensional space as structure* was new and refreshing in a world which indeed seemed stuck in the rectilinear clichés of the Bauhaus[477] (Itl., my emphasis).

Structure in general, and tension in particular, highlighted new creative possibilities; the scope of which, supposedly, is limited only by the mind. This proposition in itself was broadly appealing to artists and architects alike. For this reason, the geodesic structure, was pedagogical instructive. It was intended to illustrate the motif of cosmic efficiency and limitlessness. Until the appearance of the tensegrity structure, the geodesic structure nearly evidenced Fuller's fantastic speculation on the prospect of creating a structure that is nearly all tension.

2.6.2.6.2. In Search for a New Visuality

The vitalism in Fuller's structural project, described by Snelson, was not its only characteristic or meaning. Further, Fuller's view of a restless interior beneath the surface of a given form was not one conjured by him single-handedly. He was building on a general public awareness of and interest in the structure beneath the form. With the invention of the X-ray and

[476] Minutes of 2nd SSA Meeting 12/9/31, in BFI-CR42, p.10.
[477] K. Snelson, "Not in My Lifetime. (Snelson's autobiography)," unpbl. MS.

its use in demonstrating the physicality of the atomic world, general interests in internal invisible motions, vis-à-vis tension, were heightened.

The three-dimensional space-structure contingent upon energetic considerations, Fuller's *EG* also coincided with progressive interests in a new visuality and in the search for wholeness. Martin Reinhold proposed that the similarity in the projects of Gyorgy Kepes and Fuller stemmed from their respective effort in finding a "bridge" and wholeness across all knowledge systems via the "image."[478] Drake similarly argued earlier that the aesthetic theory and practices of Kepes and Moholy-Nagy respectively were pivoted upon a new type of visuality to generate that image. Kepes's visuality as a "non-verbal language of vision," Drake continued, was an essential means to ensure that man would "unite with his knowledge and regain integration." Further this quest for wholeness was not merely an aesthetic project. In some quarters, Drake proposed, wholeness as isomorphism, or the "search for similarities," was a strategy of survival.[479] Kepes similarly suggested the integrative aspect of the new vision:

> (I)ntegration, planning, and form are the key words of all progressive efforts today; the goal is a *new vital structural-order*, a new form on a social plane, in which all present knowledge and technological possessions may function *unhindered as a whole*[480] (Id., my emphasis).

Fuller was not a neophyte in this search for a new communication platform. This search for an economy of communication to service the emerging world-man had echoes in his earlier work. Prior to *EG*, Fuller's vision to forge a unified basis of communication for all knowledge prompted his active promotion of Ogden-Richards' BASIC (British, American, Scientific, International Language) English in his self-published *SHELTER*. This was a project to locate 850 words, across disciplines, to do the work of 20,000.

Now augmenting Kepes' project for a new visuality, Fuller offered the strategies for a unified vision in "structurality" and "modelablility" of *EG*. Through these two concepts and others enumerated by Kepes, their common intent was "to advance to the furtherest(sic) frontiers of knowledge and to combine all knowledge to see the world as a whole"[481] [Fig.2.26a & b]. With *EG*, Fuller was convinced of the kinship between his ideas and the natural philosophy of Goethe. He even proposed to a scientist at MIT that Goethe anticipated "an (Energetic) Gestalt"

[478] Reinhold Martin, "Crystal Balls," *ANY17*, pp.17.35-17.39.
[479] Drake, "Alfred Korzybski and Buckminster Fuller: A Study in Environmental Theories, Ph.D. Thesis [Speech], Graduate School SIU-Carbondale, 1972, p.52.
[480] Gyorgy Kepes, *Language of Vision*, Chicago: P. Theobald, 1944, p.12.
[481] Gyorgy Kepes, *Structure in Art and in Science*, London: Studio Vista, 1965.

since Goethe's interest in "progressive radial and peripheral polarity, etc." was "akin" to his concept of Energetic Geometry.[482]

While "magical" would be an almost apt description for the appeal of *EG*, Fuller explained that it was caused by the subliminal "reality" and not "fantasy."[483] However, three features in Fuller's work, enumerated above, were surely striking to the retinue of artists, architects, industrial designers and organicist-scientists. Firstly, the speculative *EG* and the artifactual geodesic was driven by an imagined universal integration along many lines: between science and art, between technology and art, between art and architecture, architecture and technology, between the macroscopic and the microcosmic. Second, this couplet consisted of a set of formalistic propositions in which structure as a general conceptual category acted as a primary unifier. Finally, it provided a refreshingly different coordinate-structuring system which physicalized dynamism more effectively than the cubistic structure. Rendered in a populist frame beyond its utopic intent, the motive of Fuller, Kepes and Moholy-Nagy was the provision of a space for the layman to access patterns of knowledge directly and which circumvented specializations.

2.6.2.7. Geodesic Structure and its New Design Potentials -- George Nelson's Bubble House (1951)

Putting aside the communicative significance of Fuller's *EG* and his structural artifacts, there were more direct ramifications of the geodesic structure for use in everyday life. The perception of its uses was also diverse. While Douglas Haskell was persuaded by an austere view of the house environment in the dome-home, George Nelson saw a world of new environments of various scales. At the level of the house, geodesic structure promised open-planning and spatial efficiency. It would place new demands on new types of furnishings, an area that directly interested Nelson.

George Nelson and Charles Eames were among America's foremost industrial designers closely associated with Fuller in the opening years of the geodesic enterprise. Both were trustees of his FRF, a board constituted towards the end of 1948.[484] Of the two men, Nelson had a longer

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[482]Ltr. 6/3/51 RBF to Dr. F.J. Zucker (M.I.T., Cambridge, Ma.) in BFI-CR137.
[483]See Fuller's letters to Einstein: Ltr. 1/17/48 RBF to Albert Einstein and Ltr. (undated) RBF to Albert Einstein, both in BFI-EA-Blue Trunk.
[484]C. Lacey, "Index of Survey," p.2. The *FRF* board was probably constituted towards the close of 1948. It consisted of George Nelson (New York); R. Aitchinson (McCormick Armstrong Corp., Wichita, KS); Charles Eames (Los Angeles, Calif.); Cynthia Lacey; R.E. Gilmoor (Sperry Corp.); E.A. Locke (VP, Chase National Bank). By the time of the next known report of *FRF*, on 11/13/50, the Board was reconstituted as

standing relationship with Fuller. Eames probably met Fuller only recently either through the Institute of Design or through Nelson.[485] In 1939, on secondment from *Fortune*, Fuller organized the Yale-LIFE "Conference of House Building Techniques" in New Haven, Connecticut during which he collaborated with Nelson, then at *The Architectural Forum*, to display the latest building techniques, not the least of which included his own Phelps-Dodge bathroom.

Besides their general sympathy for Fuller's work, their positions as trustees of the FRF intimated their intuition of some significant breakthrough in Fuller's work. Nelson readily heeded the commercial prospects of Fuller's ideas. These ideas, Nelson proposed, merely needed to be designed. For this reason, he advised Fuller on various business projects. One included a strategy to package and market the Dymaxion map as an educational aid.[486] Another advised of a joint venture on a new line of furniture design, presumably to furnish Fuller's line of new dome houses. Nelson summarized their collective effort:

> (W)e represent an impressive amount of imagination and capability ... to further the aims of the (Fuller) Research Foundation.[487]

For this reason, Nelson was instrumental in rallying the support of his "art friends" for an auction to benefit FRF and getting *Interiors* to cover the BMC experimental dome effort.[488] While Fuller would direct his technical ingenuity towards the new structure, Nelson would proffer his vision of a household landscape in this future house. He had earlier envisaged a plan for setting up a joint business venture to undertake projects, probably on the basis of the method developed in the aborted Goldgar-Fuller initiative.[489]

William Parkhurst (President); Richard Hamilton (Secretary); RBF (Treasurer, Chairman of Board, Director of Research); George Nelson, R.E. Gilmoor, Charles Eames, Don Richter and Cynthia Floyd.

[485]George Nelson was one of several graduate student of the Ictinos Club-Yale University Architectural School, who had, in May 1930 attended one of Fuller's lecture presentation on the Dymaxion House. Further, according to Fuller, Nelson had "assembled the Dymaxion Model uninstructed" See "Public Presentation of Fuller and Dymaxion Items," *Dymaxion Index 1927-53*, p.2.

[486]Ltr. 12/10/48 G. Nelson to RBF in BFI-CR136.

[487]Ltr. 3/1/48 R.B. Fuller to G. Nelson in BFI-CR126

[488]Ltr. 10/26/49 G. Nelson to RBF in BFI-CR131.

[489]See "Synopsis of Desirable Performance Characteristics for Unitary Clothes Storage Item," 2/3/48 prepared by Fuller in BFI-CR125; also Ltr. 3/1/48 G. Nelson to RBF in BFI-CR126.

The short-lived Fuller-Goldgar joint venture was an attempt by Fuller to rework his Wichita House under a more amenable setting. It was undertaken in anticipation of his departure from Fuller House Inc. (See "Minutes of Meeting between Mike Goldgar & RBF et.al.," 5/10/47, New York in BFI-CR125).

In June 1947, Fuller was appointed as an industrial consultant in Mike Goldgar's newly established Promotional Design Division. His task was to retool his Fuller House into a "new industrially produced home," and realize it in a plan for one-hundred houses at Mt. Kisko in New York. To gain gaining immediate public credit, the plan was proposed for American Veterans (AMVET). Goldgar and several others formed a cooperative to offer the "integrated service" associated with the initiative, but the project did not transpire.

With the prototype dome-home structure under-way, the development of a new cornucopia of household furnishings to match the shell was imminent. It was under this imagined opportunity that prompted Nelson to initiate the prototyping of Fuller's first dome house and to dub and publicize it as The Bubble House. While the preliminary exploration was in a model form, he had envisaged that the ensuing publicity would secure funds for a final production version, to be displayed in the MoMA garden.[490] Nelson subsequently instigated Deborah Allen of *Interiors* to present Fuller's full-sized geodesic structure and its high standard autonomous dwelling mechanics. The Bubble House, dubbed an "Everyman's Eden" appeared in the June 1949 issue of *Interiors*.[491]

In contrast to the mere use of industrial materials in houses like P. Johnson's Glass House-New Canaan (1951) or C. Eames' House-Santa Monica (1949), the Bubble House as a type of factory-produced house, Betty Pepis, an architectural writer proposed, was "far more extreme." With it, the commoditization of the everyday objects extends directly into the making of the whole house, and vice versa. Pepis further reported that in Nelson's Bubble House project, the tents under the environmental conditioner of the dome was "much in the fashion of (Nelson's) recently designed lamps":

> With such a concept of a 'family shelter' architecture as we know it, would tend to disappear and interior design would become all important. Mr. Nelson referred to the possibility that it might 'liquidate' the architect, who today plans the exterior of buildings, while it might create new and exciting vistas for those designers who are concerned with the interior fittings of a home ...
> Manufacturers have taken into account the limitations imposed by such things as picture windows - furniture must be low enough not to block the view - and open floor plans- there is a room divider in almost every space, and practically all furniture today is finished to look well on all four sides.[492]

A year before the publicity splurge of the August 1951 issue of *Architectural Forum*, Nelson had proposed to apply the geodesic structuring principle to his own house design. He

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The Fuller-Goldgar phase is often veiled from most biographical accounts largely because it sits uncomfortably in Fuller's self-history of no self-promotion and denunciation of advertising in general.
[490]See Fred Taylor's account of the making of the "George Nelson's" Bubble House in "The Bubble House," *Student Publication of the School of Design* (NCSC), Fall '52.
[491]Perhaps seeing this as a Nelson's project, Fuller was cautious over the tenor of the dome publicity. He cautioned Deborah Allen:

> If you make mention of the autonomous GEODESIC STRUCTURE I will deeply appreciate it if you will subordinate the mechanical novelty and emphasize the broad concept of the undertaking and its purpose, not only of providing advanced housing, but as an humble candidate for detonation of a conversion of man's abilities to positive creations (Ltr 4/28/49 RBF to Deborah Allen in BFI-CR133).

[492]Betty Pepis, "Architect Offers Bubble for House (Says Plastic 'Space Container' with sleeping tents May Replace Present Structure')," *The New York Times*, 18 June 1952.

intended to use this "Private Sky" to illustrate a new type of dwelling and to publicize it in *Interiors*.[493] However, MoMA's inquiry in the use of the dome-house as the next demonstration in the 'House in the Garden' project was, in Nelson's words, better than any imagined sponsorship or publicity.[494]

Nelson likewise wasted little time in soliciting the interest of Monsanto Chemical Company, a plastic manufacturer, in the fiberglass dome. The opportunity to publicize the use of relatively new industrial material in houses of conventional design was in itself dream stuff, to say nothing of the extra publicity value in the radical form of the dome-house. This was an opportunity to represent the building material of the future. Nelson's business shrewdness obviously concurred with the observations of Monsanto executives. He reported that, despite the obvious obstacles like water-proofing difficulties in the adhesive technology, the dome-home project was merely an experimental stage, not necessarily the end-market for fiberglass technology:

> (I)t was perfectly obvious that whether or not people choose to use this type of shelter for houses, there were innumerable other uses that would be completely acceptable & that if structures could be presented which competed favorably with the Quonsets, they (Monsanto) had no doubts that there was a very large immediate market.[495]

Since the 4D-Dymaxion House, Fuller had projected the factory-produced house as the new mother of industries. By this, he meant that it would integrate a wide spectrum of seemingly isolated industrial activities. Fuller's war-years projects, the DDU-DDM-Fuller Houses, had also uncannily inculcated his awareness of the vulnerability and desires of the industrial material producers. With geodesic structuring, Fuller began to forge the valve to tap their potential support.

The range of structural experimentations in "Project-Noah's Ark#2" cursorily examined the relationship of dome-structuring sizes to material types and their respective industrial production processes. In the course of his further experimentations, he would cautiously chart and direct the varied interests of the material industries, taking full advantage of their respective potentials in advancing the dome research project. In the case of Nelson's Bubble House, Fuller

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[493]Ltr. 10/2/51 G. Nelson to RBF in BFI-CR141. Prior to this, the Bubble House, the dome-house was variously called "glass garden home" (*The Telegram* (Toronto), 14 Dec. 1949); "Dymaxion Sun House" (*This WEEK* (supplementary) 18 Dec. 1949), "Geodesic Structures Skybreak. (Ltr. 11/29/50 RBF to John Entenza [Editor, *Arts & Arch.*, LA-California] in BFI-HEv10).
[494]Ltr. 11/27/51 G. Nelson to RBF in BFI-CR141.
[495]Ltr. 12/4/51 G. Nelson to RBF in BFI-CR141.

exercised this strategic prudence in his actions by allocating the polyester glass work to Monsanto. This was because his own research cooperative at Raleigh had courted the support of its rival, Dow, for the supply of styrene.[496]

The Bubble House project for MoMA's "House in the Garden" exhibition series was never realized, even though a model was made and funds were raised for a prototype. Still, the publicity blitz from February through August in 1952 not only highlighted the honed skills in publicity of both men; it also revealed the scope of the public interest in the dome-house project.

As a "house of the future," the Bubble House was pitched next to Kiesler's design, dubbed the "egg" house.[497] Unlike Kiesler, Fuller was more able in tapping a wide range of publicity media, including a relatively new medium, television. In total, Fuller made three appearances on CBS national television in 1952; first in February, on "Mike and Buff Show" showing his geodesic invention; the second, in August, with an interview by Durward Kirby that previewed his MoMA model; the third, a week later, again on "Mike & Buff Show," interviewed by Arthur Drexler, then an employee in Nelson's office. George Nelson, on the other hand, blitzed the popular press and professional journals with architectural renditions of the geodesic structures.[498]

In seeing the house as technical, social and psychological facts, Nelson's own view of the "house of the future" was not too far from Fuller's. As a fact of the first category, Nelson had proposed that the house was "not different from a sharpener or a tractor," rather; it was a result of "design and production processes" and an "item of consumer use." The house as a social fact, Nelson explained, pointed to an industrial sensibility of "social actions, by groups that pool their requirements and resources."[499] The interesting twist in Nelson's rhetoric on the modern house, as with Fuller's discourse on the factory-produced house, was that their designs were modern "because they are traditional" since modern was "the only way to carry on the great tradition of American housing." To be modern was to be without "style" and to be responsive to the

[496]Fuller's marginalia on Ltr. 12/4/51 G. Nelson to RBF in BFI-CR141.
[497]Fred Taylor, "The Bubble House," *Student Publication of the School of Design* (NCSC), Fall '52, p.20.
[498]Beginning with a *PARADE* (a nationally syndicated Sunday supplement) article "You may Live in a Bubble House," 25 June 1952; this was followed by G. Nelson's "Architect Offers Bubble for House," *The New York Times*, 18 June 1952 p.23 in which he offered plastic space containers (developed by Rauma at M.I.T.) with sleeping tents; "After the Modern House," *INTERIORS*, July 1952, pp.80-89; "New Concepts of Housing Put on Exhibit" *N.Y. Herald Tribune*, 27 August 1952, p.14, and "You May Live in A Bubble House," *Science Digest*, September 1952.
[499]George Nelson & Henry Wright, *Tomorrow's House. How to Plan your Post-War House Now*, Simon & Schuster, 1945, pp.2-3.

conditions of the "now." More significantly, the modern updated a significant American trait of individuality over regimentation:

> Individuality in houses, as in people, is a fundamental expression of something real ... Individuality is possible only in a modern house because no other approach expresses life as it is today. And without expression there can be no individuality (not fashion, not "surface difference").[500]

Nelson was by no means alone in this enthusiasm for Fuller's geodesic works. Charles Eames, another FRF trustee, was also cognizant of their broad design significance.[501] Eames himself credited the lead of Fuller's experimentation with fiberglass on the involute geodesic dome at BMC, with his own design investigation of a low cost chair using fiber-reinforced polyester shell.[502] Likewise, Fuller's use of corrugated cardboard provided clues for his expendable furniture:

> Every problem we work on is touched by your influence in some way, but I wish you would look at this & see if it comes so close as to do harm to your geodesic structure aside from the consideration of the toy as a conditioner of your idiom.[503]

Unlike Nelson who was more driven by the limelight and perhaps even the financial promise of Fuller's projects, Eames' enthusiasm was perhaps driven by curiosity. He too had offered Fuller a similar opportunity to realize an "all-year-round" domicile.[504] However, regardless of their motivations, Fuller fundamentally saw his working relationships with them in the same manner as those of his collegiate franchisees did:

> Having been making 'provisional' deals with architects I admire & trust to handle business in their area until we can see the shape of evolving 'best' plan of operation (e.g. Saarinen in Detroit, Mitchell & Ritchie in Pittsburgh, Bob Little in Cleveland, John Waley at ID, with C. Eames in the west).[505]

It is to the activities of his collegiate franchisees and his cooperatives that the study will now address.

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[500]Ibid., pp.6-7.
[501]Fuller has been variously compared to Eames. R. Kronenburg, for example, proposed that Eames "had the aesthetic sensitivity which Fuller lacked." Kronenburg quoted Peter Cook's distinction of C. Eames and Fuller as "the operator and the Guru" respectively. See R. Kronenburg, *In Houses in Motion (The Genesis, History and Development of Portable Building)*, London: Academy Editions, 1995, p.48; also fn.36, p.136.
[502]Ltr. 4/25/50 C. Eames to RBF in BFI-CR136.
[503]Ltr. 8/31/50 C. Eames to RBF in BFI-CR135.
[504]Eames had offered to design a "Bubble House" for a certain Nat Mendelsohn (See Ltr. 7/17/51 C. Eames to RBF in BFI-CR137; also follow-up Ltr. 7/17/51 C. Eames to RBF in BFI-CR137).
[505]Ltr. 10/12/51 RBF to C. Eames in BFI-CR141.

2.7. False Starts – Fuller's Relationship to his Franchisees

In 1949, Sphere Inc., an amateurish attempt by Fuller's ID-Chicago students to capture the commercial potential of the geodesic structure was illustrative of the excitement the new invention created. Fuller responded to this enthusiasm by actively and openly franchising subsequent college-students to participate in his dome research enterprises. In the next few years, these initiatives appeared in the various FRF divisions and numerous "Dymaxion" licensees. By early 1952, he reported, no less to a former adversary, Howard Fisher, that his new-found enterprises had gained remarkable grounds. There were, he reported five branches of FRF working in tandem – in Chicago, Detroit, North Carolina, Montreal and Fort Worth.[506]

2.7.1. Franchising & Managing the Dymaxion-researchers

The scope of the efforts of these "research divisions," however, remained within the limits set by Fuller's research agenda. While individuality was encouraged and viewed as instrumental in the creative process in advancing the geodesic art, individual identification with their respective creations was curbed and contained by Fuller. His new breed of cult-like corporate-individual inventors was to be led by a depersonalized and idealized axiom: "Prime design has no patrons. It takes the initiative"[507] [Fig.2.20].

Fuller acknowledged the use of FRF as an instrument, among other objectives, to "license enterprises to develop and manufacture on royalty basis" and "to make grants to research groups outside its corporate structure."[508] On a day-to-day operation, FRF was a legal instrument for Fuller to pursue his research using income earned elsewhere to circumvent the technicalities of taxable income. He maintained this operative device until the formation of his own prototype engineering firm, Synergetics Inc. in 1955.[509]

Fuller ran his dome research enterprises and monitored his student-license franchises like a tight ship with one skipper. To ensure control, Fuller granted non-exclusive licenses for

[506] Ltr. 4/23/52 RBF to H. Fisher (Ames, Iowa) in BFI-CR138.
[507] Quoted in Larraine Wright's "Rebels with a Cause," *SIU Alumnus Magazine*, Fall 1989, p.3.
[508] Ltr. 11/22/49 RBF to Lee Hukar in BFI-CR132, p.1.
[509] See "Accounting Data for Synergetics & Geodesics," 30 April 1955 in BFI-Archive Box2:
Cambridge (Branch of FRF): Income $20,940.00; Expenses $33,172.35,
Raleigh (Branch of FRF): Income $1600; Expenses $10,173.54,
FRF: Receivables $11,689.12; Liabilities $33,939.76, Net Loss $1,342.08.

specific operations "within reasonably pertinent limits" in return for a nominal royalty. Fuller saw these enfranchisements as beneficial to the students rather than parasitic. He believed that their exposure to his knowledge was a strategic advantage, especially when "the new industry" based on the structural invention brings in the "real money."[510]

Fuller's new research cooperative of designer-engineers, the various FRF divisions, was based on his short-lived cooperative of the thirties, the SSA, which he had used to advance his Dymaxion project and productivist agenda.

The reasons to revive this organization arrangement in the geodesic research enterprises were multi-fold. It was a way to address the growing dilemma of working as a lone inventor in a corporate setting of research funding, working and business. The position of a lone inventor, using his own resources and working at his own pace, was thus increasingly limited. Further, the scale and complexity of new industrial objects, using Fuller's example, between a war airplane and a fountain pen, had tremendous repercussions on the capacity of the lone inventor. While the latter was within the scope of his inventive capacity, the former exceeded that capacity and undermined his short-range interests. The lone inventor could only "prospect methodically in empirical research and deal conscientiously in isolation of the next obvious step for commercial grooming."[511]

However, the new industrial situation also created new opportunities and niches for the lone inventor. The institutional entities like government, corporation and professional bodies, Fuller believed, were shackled by their organizational inertia, politics, hierarchy and specialization. In a few words, they were ineffective in advancing meaningful changes. The actual creative work that would advance meaningful changes is embedded in the area of pre-research; and this was often missed by these institutions. Pre-research leading to "anticipatory design" was the frontier still open to the lone operators: it was awaiting their initiatives to turn "specific and unsolved social problems" into "design of appropriate physical mechanisms."[512] To meet with the scale of the demand and the pace of the prospecting, only a cooperative of the sort Fuller envisaged, he argued, could close the chasm between the simple phases of entrepreneurial "technical prospecting" and the "far more complex total process" of institutional organizations.[513]

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[510]Ltr. 11/22/49 RBF to Lee Hukar in BFI-CR132, p.1.
[511]R.B. Fuller, "Comprehensive Design," BFI-MSS 48.11.01, p.1b.
[512]Ibid.,p.1a.
[513]Ibid.,p.1b.

In this way, Fuller believed that any compromise of the broad discovery of interactive principles, commonly identified by the public in the "consumer contact instrument," would be averted.

However, in advancing his new cooperatives and his new breed of corporate-individual inventor, new sets of pressure points and conflicts arose.

2.7.2. Jeffrey Lindsay and FRF-Canada

BMC and ID-Chicago were sites of the early geodesic structure prototyping activities. They also forged significant working relationships between Fuller and his youthful collegiate collaborators. Jeffrey Lindsay was the most significant of these collaborators in the opening years of the geodesic prototyping enterprise. The Lindsay-Fuller collaboration is representative of the dynamics and problem of Fuller's attempt to cull the support of the young college talents and to enfranchise them in his enterprises.

Lindsay was one of the twelve students from ID-Chicago constituting the "cooperative," Spheres Inc. who formed the core of Fuller's study group at BMC in the summer of '49 [Fig.5.09b]. Prior to this, Lindsay had studied for two semesters with Fuller at ID-Chicago. After the '49 post-graduate session at BMC, on his own initiative and with Fuller's blessings, Lindsay decided to return to Montreal-Canada to set up a research-prototyping wing to advance Fuller's dome project. This he did with his friend, Ted Pope. On 20 October 1949, his proposed "Fuller Research Laboratory" was organized as FRF-Canada.[514]

The dome research project at FRF-Canada entailed a broad range of considerations based on Lindsay's experiences under Fuller at ID-Chicago, though not limited by them. His interests in plastic and fiberglass technology suggested that he was probably responsible for the development of the prototype fiberglass "pan-type" dome at BMC in the summer 1949 [Fig.2.17a-c]. The pan-type dome, also called "curved space geodesic structure," was made out of separate triangles locked together by fiberglass plastic splines. These surface triangles represented modulated curvatures; the inward and outward curving was caused by the inversion of alternate vertices.[515] Elsewhere, the added rigidity of this indented great-circle dome was described as the "pineapple effect."

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[514] Ltr. 12/19/49 Jeff Lindsay to RBF in BFI-CR132.
[515] Ltr. 8/2/49 John & Jano Walley to Daisy Igel & Polita in BFI-CR134.

For the above reason, Lindsay's role in implementing the research direction of Fuller's "Noah's Ark #2" cannot be undervalued. Firstly, he was responsible for many of the drawings and details for the early prototype domes executed at ID-Chicago. Secondly, Lindsay's research focused primarily on plastics, films and industrial plexiglass (48" width sheet at 0.016" thickness); the last probably directed Fuller's focus on dome design based on continuous roll "alcad alloy."

Lindsay's dome research tactics were initially based on dome-size groupings, constructional types, industrial or manufacturing processes and material types.[516] He also postulated two possible strategies for the geodesic dome enterprise; namely, to develop luxurious "private skies" (55-ft. diameter and bigger domes) and low-cost "volume enclosure"(25-ft to 55-ft. diameter dome). Both projects were envisioned as dwellings. The technical sophistication of the former, he argued, meant that it required the encouragement of the plastics industry. The latter, already demonstrated at ID and BMC, used available tooling facilities of local workshops. Because of its simplicity, he claimed, it was merely awaiting a "frontal attack." As mass consumer items, he believed as did Fuller with his repro-shelters, that the dome-dwellings would probably help in the advancement of "total industrial complex."

Lindsay quickly discovered that even the proposal to make low-cost "volume enclosure" was impossible given the lower industrial production capacity of Canada in comparison to America. On the basis of this perceived setback, he returned to the tube-and-hub prototype. He argued that it was because it was a "natural for the more varied sizes which may be required before a production of any one type is warranted."[517]

Lindsay's primary innovation in the Fuller geodesic dome research enterprise was the development of the first truss geodesic structure of tubes and sprits. The sprits, using a sailing nomenclature, consisted of a tongue bolt suspension assembly and an extensor screw [Fig.2.18a-b]. The sprits and cables in particular created an effective trussing that simultaneously reduced the local buckling of segments of the dome and stiffening it. Lindsay was probably responsible for developing a version of this system of external cable tensioning of hub-strut at ID-Chicago. It is not clear why this was abandoned. Instead, Fuller finally opted to lace cables through the hollow tubes in the Pentagon Dome [Fig.2.16c].

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[516]Ltr. 1/31/50 Jeffrey Lindsay to RBF in BFI-CR132.
[517]Ltr. 10/3/50 Jeffrey Lindsay to RBF in BFI-CR135.

Lindsay's first prototype, a 49-footer termed the aluminum geodesic "Weatherbreak (a FRF-8C270)," was the premier FRF object eventually publicized in *The Architectural Forum*, August 1951. With "FRF 8C270," the sensation of the geodesic structuring was launched successfully. On that occasion, Lindsay argued that it was "the first convincing proof of (Fuller's) theory."[518] The nomenclature "FRF 8C270" stands for a Fuller Research Foundation eight-frequency dome made of C-section metal extrusion, measuring 270-inch in radius. An eight-frequency dome is constituted from further division of the edges of the constituent spherical triangles into eight equal parts. The subdivisions produce more triangulations, and hence give greater rigidity to the dome. The higher the frequency, the more the subdivisions of triangles.

Of all the extant members of Fuller's research cooperatives, Lindsay took the logistics of military requirements most seriously, recognizing as did Fuller, that the military establishment was the potential primary client.[519] Using his own money and under his operational initiatives, the resilience of the geodesic dome as a logistic object for extreme weather use was first publicly tested. His 45-lb. "firecracker umbrella" Arctic shelter that was tested by the U.S. Ordnance in May 1950 at Mt. Washington in New Hampshire.[520] A year later, he prepared the brief of the "FRF 8C270 'Weatherbreak'" and circulated it on a restricted basis to the Canadian Department of National Defense, Arctic Institute, and Aluminum Company of Canada.[521] Finally, he managed to convince Colonel Baird, the leader of the Baffin Island ice-cap expedition, to acquire his "2C108 'Weatherbreak'" as a shelter in extreme-weather testing.[522] In all likelihood, Baird's commission came through Fuller who knew that he had considered pneumatic structures for such an expedition.[523]

In these early dome research initiatives, Lindsay shared his investigations in geodesic mathematics and industrial experiences with Fuller. Despite his own initiatives, he constantly sought Fuller's assurance of the accuracy of basic geodesic mathematics:

> I am more sure now than ever that the mathematics is correct and that we will be successful ... We are doing a total recalculation on everything but the cord(sic) factors which are the last pre-cutting data. I hope that you can supply that information for us.[524]

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[518]Ltr. 3/7/55 Jeffrey Lindsay to RBF in BFI-CR164.
[519]This decision was probably affected by the disheartening reception of their project by the Canadian government at the "Ottawa Conference" in January 1951 (See J. Lindsay & Ted Pope, Report of the "Ottawa Conference," Jan. '51, in BFI-CR137).
[520]Ltr. 6/9/50 Lee Hukar to RBF, et.al in BFI-CR256.
[521]Ltr. 5/3/51 Ted Pope to RBF in BFI-CR137.
[522]Ltr. 6/25/52 Jeffrey Lindsay to RBF in BFI-CR139.
[523]Ltr. 12/18/49 Joe (Kenosha, Wis.) to RBF in BFI-CR132.
[524]Ltr. 10/3/50 J. Lindsay to RBF in BF-CR135.

Fuller was enthusiastically acknowledged as the guardian of the research cause, or the "Aga Khan" of the cooperatives; so Lindsay nicknamed him. So convinced was he that Fuller's *EG* was the master template for the geodesic works that he pointed this out to another fellow dome researcher, D. Richter:

> It looks to me as though Bucky has finally tied up the Energetic Geometry with the geodesic structure in such a way that we can really consider unlimited omnidirectional expansion showing our structures to the third power advantage.[525]

Over a period of the next six and a half years (1949-1955) working under his assumptions of an egalitarian collective, Lindsay claimed his work as a "furtherance of (Fuller's) aims." This spirit and good faith, he reflected, would be reciprocated by Fuller's professed commitment:

> You stated (early) that if we students were to participate in the furtherance of your aims that you must tell us all, and that in doing this you recognized that we automatically became 'partners' in your big picture of bringing salvation to the world through comprehensive design and thinking ....
> You and I agreed that I was to have Canadian rights to whatever patents you held through FRF in return for royalties, and continuing pooling of our resources through FRF of Canada.[526]

In June 1953, the successful and prominent public demonstration of the Ford Rotunda Dome changed the tenor of Fuller's relationship with his cooperatives, and vice versa.[527] The increasing evidence of commercial viability of the geodesic dome made Fuller wary of his collaborators and the expanding circle of collegiate franchisees. Fuller began to see and to use the issues of exclusive rights on the geodesic technique as sanctions. This posed a dilemma for Fuller as he attempted to sustain the amicable relationships that he had started with his cooperative organizations.[528]

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[525]Ltr. 7/25/50 J. Lindsay to D. Richter in BFI-CR133.
[526]Ltr. 3/7/55 J. Lindsay to RBF in BFI-CR164.
[527]The significance of the Ford Rotunda Dome for Fuller's self-image was probably a factor in the issue of the second edition of the *Dymaxion Index, 1927-53*. Fuller's contract with Ford Company was signed in December 1952.
[528]In Ltr. 4/28/52 RBF to J. Lindsay in BFI-CR139, Fuller attempted to resolve a fissure in his loosely formed research cooperative. He mentioned of "the complete lifting of the fog that has hung over the New York-Montreal valley," referring to his collaboration with Lindsay and Richter. However, upon his review of Fuller's contractual agreement and manufacturing rights, Lindsay registered his unhappiness over its five-year make-or-break clause (Ltr. 5/9/52 J. Lindsay to RBF in BF-CR139). Because of this legal restriction, Lindsay grew skeptical of the idealism of Fuller's " Dymaxion world." A month later, Lindsay described that their "(working) relationship is more moral and emotional than can be contracted" (Ltr. 6/3/52 J. Lindsay to RBF in BF-CR139).

To demonstrate his loyalty to Fuller and the cause, Lindsay had reassigned all the findings of prototyping efforts to Fuller. He did this, he recounted, on the assurance of a "great prosperous and trusting future together." It was a decision, he confessed, in 1955, that he deeply regretted as he sensed that Fuller was attempting to renege on his commitment.

> Your reaction was such as to crystallize for me the void between your teaching and your personal emotional constitution, which had for so long been an enigma to me ... (Y)ou should search yourself for the cause of the anxiety which you attribute to me. I refuse to be your goat .... I therefore challenge you to examine these patterns and thereby release yourselt from these distrusts which are not a credit to you nor a part of me.[529]

Lindsay's growing dissatisfaction was spurred, in a way, by his experiences on completing another geodesic experimental structure he had procured. After the barn-dome at Hackney Farm in the spring of 1954, Lindsay confessed that, as a "capitalist," he had finally developed "a clear picture of the commercial potential of geodesic structures"[530] [Fig.2.18a]. While his eagerness to participate in Fuller's project was initially driven by a sense of mission, albeit one inculcated by Fuller, and his own perception of the commercial potential of geodesics; he now felt that the former was suspect, and the latter untenable. Lindsay was dismayed by the absence of rewards due to him; and like Snelson and several others he cited in his letter to Fuller, he attributed this to Fuller's fear of betrayal and a sense of paranoia. His incessant quest for control, tactics of isolation and non-support were becoming patterns of deep insecurity.

2.7.3. Model for Other Branches of FRF

Besides the collaborative efforts of Lindsay, Fuller's work in these early years were substantially advanced by a number of faculty members at the newly-constituted School of Architecture at North Carolina State College (NCSC) in Raleigh. They included primarily James Fitzgibbon and Duncan Stuart, who would subsequently constitute a corporation to advance the geodesic dome, called Skybreak Carolina Corporation.[531] Fitzgibbon [Fig.5.09b(1)] would eventually manage the design and research arms of Fuller's geodesic enterprises (Geodesics Inc. & Synergetics Inc.).

Fitzgibbon (b.1915) was educated at Syracuse University (1933-38) and the University of Pennsylvania (1938-39). A Rome Prize finalist in 1939, he worked as an architect for United Engineers-Philadelphia for four years (1939-43), mostly on power generating plants,

[529] Ltr. 3/7/55 J. Lindsay to RBF in BFI-CR164.
[530] Ibid.
[531] The other "trustees" included Manuel Bromberg, Roy Gusso and George Matsumoto.

manufacturing plants, chemical laboratories and office buildings.[532] He was teaching at University of Oklahoma (1944-48) before leading, along with several of his colleagues, twenty of its students to NCSC-Raleigh.[533] His new teaching appointment at NCSC entailed a reorganization of its design curriculum. In the summer of 1949, en route to NCSC, Fitzgibbon met Fuller at BMC. Despite the short stopover and meeting with Fuller, Fuller's teaching methods and ideas duly impressed Fitzgibbon.[534] Over the next six years, he was instrumental in bringing Fuller to NCSC to conduct numerous dome prototyping exercises, and even successfully lobbying for Fuller to receive his first honorary doctorate, a Doctor of Design in 1954.[535]

Fitzgibbon had initially planned to model his design activities based on Fuller's research agenda along the lines advanced by Lindsay at FRF-Canada. FRF-North Carolina would enfranchise interests in the research activities by apportioning shares.[536] With the potential of prototyping the geodesic structure successfully realized, Skybreak Carolina Corporation as a commercial entity within FRF-North Carolina was envisaged. In the pipeline of the corporation, for example, were three dome proposals: the Aspen dome (150'-diameter geodesic icosocap, 64 frequency of long-leaf Carolina pine in 1x10 frame with triangular edges 26 inches each, polyester-fiberglass skin .05" thickness) to replace Walter Paecpke's tent; two other 90-footers, the Brewer House (Raleigh) & the Starbucks House (Winston-Salem), both envisaged as "Skybreaks." The idealism of the principal FRF mission would remain, Fitzgibbon assured a potential client. This was despite the apparent commercial intent of the enterprise:

> (S)uch an achievement will have a profound influence towards liberating architecture for the betterment & welfare of many men. Mr. Fuller's life has been directed towards this goal & we are honored to be associated with him in this task.[537]

However, the ambitions of FRF-North Carolina and Skybreak Carolina were short-lived. This was perhaps because Fuller began to take more stringent legal measures to control the activities of his enfranchisees. Even during the constitution of the proposed corporation in October 1952, its activities were primarily confined to manufacture and to distribute wood domes under 100 feet in diameter, using Fuller's geodesic principles.[538] The emerging problems in

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[532] J.W. Fitzgibbon, "CV," ca.1968, M. Fitzgibbon's Private Collection of Letters.
[533] J.W. Fitzgibbon, "Synergetics Inc.," undated, M. Fitzgibbon's Private Collection of Letters.
[534] Author's Notes from Interview with M. Fitzgibbon, St. Louis-Mo., 9/15/94.
[535] Until his death in 1983, Fuller received forty-seven honorary doctorates, the last one in 1981, bestowed by Texas Wesleyan University.
[536] Ltr. 2/12/51 J.W. Fitzgibbon to RBF in M. Fitzgibbon's Private Collection of Letters.
[537] Ltr. 3/8/52 J.W. Fitzgibbon to Inghram Hook (Saratosa, Fla.) in BFI-CR138.
[538] W.M. Parkhurst, "Skybreak Carolina Corporation – Formation & Constitution," 10/15/52 in BFI-CR139.

controlling his licensees were hinted by Fuller's counsel, W.M. Parkhurst. He had previously highlighted the cautions taken by Fuller as pre-conditions for the formation of the proposed Skybreak Carolina Corporation:

> When Bucky gives me the details of the organization of the corporation, he said he wanted to keep control and for that reason, I have provided for two classes of stock. The class that I have sent you is entitled to all of the dividends, and the class which is retained by Bucky has all the voting power but no dividend rights.[539]

In this regard, like Lindsay's FRF-Canada, the franchisees in Skybreak Carolina and FRF-North Carolina were increasingly brought under the purview of Fuller's legal instruments. Moreover, as the geodesic patent claims were finally filed in December 1951, the issue of controlling the franchisee's activities was probably brought into clearer and immediate focus. The fate of Fitzgibbon's dome-house project, the Brewer House, executed as part of FRF-North Carolina's initiative, illustrated this amply.

2.7.4. The Case of the Brewer House

For both Fitzgibbon and Lindsay, the prospect of producing a demonstrative working geodesic "skybreak" for a house was a tempting proposition. In the case of the Brewer House, perhaps, the project made Fitzgibbon less cautious of the integrity of their prospective clients. Kidd Brewer was a local entrepreneur who speculated on suspect flood plains in the valleys around Raleigh (present-day Crabtree Valley Mall); and wanted a geodesic-house built on a promontory overlooking one of these valleys to draw public attention.[540]

Fitzgibbon's own enthusiasm was also spurred by the prospect of future jobs, as Brewer promised to use his connections to "key men" in Washington DC to promote the use of the eventual dome-house as housing and shelter requirements.[541] Further, the prospect of making the "skybreak" was, Fitzgibbon explained to Fuller, tantamount to "building a 20th Century house."[542] The neologism "skybreak," Fuller explained to John Entenza, who was in search of a design story, was for a fundamental reconceptualization of enclosure-shell and its mechanics:

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[539]Ltr. 5/9/52 W.M. Parkhurst to J.W. Fitzgibbon in BFI-CR135.
[540]Notes from Author's Interview with T.C. Howard, Raleigh-N.C., 4/26/95; also Notes from Author's Interview with M. Fitzgibbon, St. Louis-Mo., 9/16/95.
[541]Ltr. 2/12/51 J.W. Fitzgibbon to RBF in BFI-CR135.
[542]Ltr. 4/18/51 J.W. Fitzgibbon to RBF in BFI-CR137.

Apparently the young designers liked the word. It certainly dramatizes the finally complete divorce of the enclosure function from mechanics, in fact the disappearance of the old partitioned enclosure.[543]

Fitzgibbon had planned to use the Brewer House project [Fig.2.25] not only to demonstrate the structuring capacity of the geodesic dome but to premiere a new residential type where the walls were neither space-givers nor environmental conditioners. It was, Stuart enthusiastically reported, a "wonderful" design that was also "a major advance in housing technique," using a sixteen frequency 46-foot diameter hemispherical geodesic structure and skinning system that Lindsay had designed.[544] The structure was initially specified as a "tubular triangulated truss network icosacap with concentrically suspended aluminum leafed neoprene coated nylon bags." However, by February 1951, the skinning system was changed to "fibre-glass covering, four inner tents of Saran & one inner tent plastic screen."[545] Fitzgibbon's primary contribution in the Brewer House was to "architecturalize" the domed space, that is, to make the geodesic structure appear less as an implement and more as a spatial definer.

Fitzgibbon envisioned the invaluable publicity that the project might generate. The prospect of the Brewer House as a project of venture capital and the plan to use it as an exhibit to generate income did not sit well with Fuller. He promptly registered his deep reservations against the project. There were several features in his objections. In general, he cited that the venture proposition was "not just unacceptable and preposterous but also - dangerous" to the FRF mission.[546] Firstly, the disparity of risk-taking primarily advantaged the client, Brewer and directly made him a beneficiary. Second, despite working under the umbrella of FRF, Lindsay's contracting arrangements to fabricate the geodesic structure in Canada was a dangerous precedent. It meant that he could operate beyond his legal domain, namely, across the Canadian border. Third, Fuller feared that he was losing the position of the arbiter of "the safety & welfare of the IDEA," presumably, the deployment of the invention for the repro-shelter project. Fourth, he was uncertain whether the structure could be erected satisfactorily; and finally, he feared losing "control of (his) life's work."[547]

It was at this point that Fuller concluded that the best way to rein in the enthusiasm of his collaborators and to maintain the helm position of his enterprise was to employ his franchisees as "salaried representatives" and to assist them with any prospective manufacturing deals. By this

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[543]Ltr. 11/29/50 RBF to John Entenza in BFI-HEv10.
[544]Ltr. 11/18/50 D. Stuart to RBF in BFI-EJA Green.
[545]Ltr. 10/16/50 J. Lindsay to J.W. Fitzgibbon in BFI-CR135.
[546]Ltr. 2/14/51 RBF to J.W. Fitzgibbon in BFI-CR135, p.1.
[547]Ltr. 2/14/51 RBF to J.W. Fitzgibbon in BFI-CR135, pp.4-7.

method, he surmised that he would be able to keep his FRF research activities "free of 'promotion' & unworthy business" and to ensure that the franchisees' "responsibilities and means might grow exactly as fast as the idea may be healthily nurtured, but strictly under (his) authority until (he has) legally and equituosly(sic) transferred that authority."[548] Fuller would, however, accede to this plan only in 1954, with the formation of Synergetics Inc. & Geodesics Inc.; putting Fitzgibbon in charge of the North Carolina divisions of these two enterprises.

The over-enthusiastic initiatives and speculations taken by Fitzgibbon & Lindsay might appear indiscreet in light of Fuller's otherwise openly professed selfless mission. But practically, the cost and resources for prototyping was a hard reality; a condition which another franchisee, Don Richter, vividly described as limiting his own experimental work:

> Unfortunately we have been limited to only theoretical work on the sphere involute structure, the pneumatic stayed rib dome, and other types without financial aid. Even theoretical work requires a minimum of expenses. I cannot continue living on the understanding good will of my folks.
> I hope with all my heart that all your years of struggle to help mankind and our small recent effort will meet with success soon. For the present, we are trying to obtain a contract to make some custom built cabinets.[549]

In many of the early phases of dome prototyping, the franchisees bankrolled their own projects. On occasion, they merely sought business opportunities from Fuller to prototype their works.[550] Nevertheless, they reported their findings diligently to Fuller, amplifying his knowledge on the performances of his structures under real-life conditions.[551] Lindsay described his own expenditure amounting to $32,000/- in developing prototypes to interest an aluminum manufacturer, Aluminum Canada (ALCAN).[552] Skybreak Carolina's first thirty-foot diameter geodesic dome, a sixteen-frequency flat strip dome made of 5/16" x 15/8" pine latticework with bolted overlapping joints, was solely funded by the Fitzgibbons.[553] Even the subsequent "cocooning" of the dome, that is, skinning it by spraying with a protective film like the Navy did with its ships and equipment for storage purposes, was paid by the collaborators.[554] This was despite the tremendous publicity obtained by Fuller when the Marines decided to use it for its first air-lift demonstration.

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[548] Ltr. 2/14/51 RBF to J.W. Fitzgibbon in BFI-CR135, p.9.
[549] Ltr. 8/21/50 D. Richter to RBF in BFI-CR133.
[550] Ltr. 11/25/51 J. Lindsay to RBF in BFI-CR134.
[551] See Ltr. 4/3/52 J.W. Fitzgibbon to RBF in BFI-CR139, on the effect of wind load on the 30-footer; also Author's Interviews with T.C. Howard, W. Wainwright and D. Richter.
[552] Ltr. 4/3/52 J. Lindsay to RBF in BFI-CR139.
[553] Notes from Author's Interview with M. Fitzgibbon, St. Louis-Mo., 9/15/94, p.57.
[554] Notes from Author's Interview with T.C. Howard, Raleigh-N.C., 4/26/95, p.98.

2.7.5. Looking for Clients and Opportunities

Despite Fuller's harsh objections on the manner of undertaking the Brewer House project, he made no subsequent objections to his respective franchisees' efforts in seeking out opportunities to prototype the geodesic structure. This was because the actual work would be undertaken by the franchisees themselves. Lindsay openly courted the support of ALCAN to assist in the prototyping of one of his involute geodesic aluminum-pan type structure.[555] Fitzgibbon continued to search for "dome prospects" for the 30-foot wooden geodesic dome prototype.[556] And as the big price-war in the tobacco industry caused a rush to build tobacco warehouses in the south, he responded with an ambitious design for a sixteen frequency 224-foot diameter, space trussed geodesic dome.[557]

Besides the prototyping work, the franchisees also provided direct intelligence on the market and strategic applications of geodesic structuring. For example, after Lindsay's privileged viewing of the three-quarter spherical radar storage dome, or a radome, made of balloon of fiberglass, he informed Fuller of its fundamental design flaw: "Men get dizzy (like motion sickness) inside because there is no apparent horizon." [558] Fuller's own radome would benefit from this observation.

In many instances, Fuller himself was in the thick of such activities; at other times, acting behind the scene and using the franchisees and licensees as surrogates for what he would otherwise personally deem as promotional activities.[559] Further, these activities did not appear to be impeded by uncertainties over the accuracy of the geodesic mathematics or the lack of knowledge over the actual structural performance of the dome under loads,[560] or unsettled problems like the skinning technology for the dome.[561]

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[555]Ltr. 2/7/52 J. Lindsay to RBF in BFI-CR139.
[556]Ltr. 6/7/52 J.W. Fitzgibbon to RBF in BFI-CR139.
[557]Ltr. 6/17/52 J.W. Fitzgibbon to RBF in BFI-CR139.
[558]Ltr. 5/21/52 J. Lindsay to RBF in BFI-CR139.
[559]See RBF's contract with Dr. Menzel (Harvard Observatory), 4/11/51 in BFI-CR137. Fuller signed a "non-exclusive, terminable basis" contract that gave commission for transaction and future production of "(FRF) 3-way geodesic structuring principles to parabolic antenna, related devices." In addition, the commission for the Aspen dome project (ca. Nov. 1948) for Walter Paepcke was facilitated by S. Chermayeff (See Ltr. 11/2/48 S. Chermayeff to W. Paepcke in BFI-CR127).
[560]Ltr. 11/25/51 J. Lindsay to RBF in BFI-CR134.
[561]Ltr. 4/9/51 W.M. Whitehall (Peabody Museum, Salem) to J. Lindsay in BFI-CR137. Whitehall, one of Fuller's acquaintances had been persuaded to consider the "skybreak dome" as a solution for the temporary exhibition needs of the museum but he had reservations over the skinning material.

2.7.6. Explaining Away his Promotional Efforts

At the start of his great-circle geodesic experimentations at BMC and ID-Chicago, Fuller had already established contacts with a wide spectrum of interest groups and media, particularly the newspapers, weeklies and professional journals. He exuded the same unremitted confidence in the tenability of his new project as he had done previously with the Dymaxion projects, despite unsettled issues pertaining to the theory and practice of geodesics. As early as 1949, he reported to a features editor of a newspaper that the possibility of manufacture of his new experimental house was "in the near future."[562] He continually and skillfully recast the geodesic structures in all forms of desires, by its various names: "sky fence," "Skybreak," "super-tent," "autonomous geodesic," and many others.[563]

Even before the demonstration of his thirty-one great-circle "necklace" dome at the Pentagon, Fuller was already trying to revitalize the interest of a benefactor of his DDM-Fuller House project at Wichita, the machinist union boss, Walter Reuther. Aware of Reuther's proposal to produce twenty million houses with the aircraft industry,[564] Fuller offered him his geodesic solution. He proposed that given the material logistics and proposed housing target of twenty million houses, his geodesic structuring was a timely breakthrough in engineering approach. It would also overcome the obstacles of the limited capacity of the American steel industry. He then reported and claimed that he had "completed successful full size working experiments (of) high standard living space exclosure(sic)," which was an improvement twenty times over the DDM-Fuller House in terms of volume enclosure per pound of material used:

> Thus new principle identifies as GEODESIC STRUCTURING represents then four hundred fold initial logistic advantage ... and holds high promise instrumenting your (housing) program.[565]

Perhaps because of the public debacle of the Fuller House project at Wichita, Reuther did not respond to Fuller's offer. Nevertheless, after the publicity blitz on the geodesic structure in

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[562]Ltr. 2/20/49 RBF to Milton Amsel (Housing Editor, *New York Star*) in BFI-CR129; also Ltr. 1/10/49 M. Amsel to RBF in BFI-CR129.
[563]See Jeane Rockwell's "Fuller describes unusual idea of Future Homes" in *Ann Arbor News*, April 1949 which reported on Fuller's presentation at the "A Mid-Century Report on Design Progress" at University of Michigan, College of Architecture & Design (7th Annual Ann Arbor Conference), 4/1/49; and "News" in *The Architectural Forum*, May 1949, p.16.
[564]See W. Reuther's press release, "Reuther Asks Mass-built Homes, Making Use of Idle Plane Plant" / "20,000,000 Houses in Ten Years Attainable, UAW Chief Tells Senate Group. Aircraft Makers Skeptical," in *The New York Times*, 14 Feb. 1949.
[565]Telegram 2/18/49 RBF to Walter Reuther (UAW, Detroit-Mich.) in BFI-CR136.

the August 1951 issue of *The Architectural Forum*, Fuller wrote to the labor union again; this time to Gordon Cole, editor of *The Machinist*. He offered the service of his structure as a strategy that would be "immediately useful in (Cole's) campaign for housing solutions."[566]

While one is inclined to view these claims as promotional and publicity-seeking, Fuller had already, at this point, rationalized his life-work in a broad ethical manner. It was, he explained, "tak(ing) responsibility for something not yet recognized," asking "bypassed questions," of which the failure to recognize them was tantamount to perpetuating a "vacuum(sic) block in the circulatory system of industrial economies." This endeavor, he argued in his ID-Chicago lecture, "Comprehensive Design," was a "physical linkage," an essential bridge between industry and government. However, his dominant industrial apprenticeship and his general suspicion of politics and government predisposed him towards the incorporation of "physical linkage" into the activity of industry:

> Until adequately conceiving as constituting 'technical' category and there-after engineered into industrial technology as social tools these problems cannot be taken up for consideration as commercial enterprise or for legislative measure.[567]

In this regard, there was no project too small to be unworthy as candidate for his brand of rapid prototyping. With the first prospective customer of his dome-house, Mrs. Eleanor Cannon, Fuller promised "a colony of living space enclosures 'blossoming' within the enclosed garden," and a true planetary domicile. However, because there was an absence of any working prototype "weatherbreak" or an attending package of "autonomous" mechanics at this stage, the project warranted both risks and some "temporary shortcomings." However, the undeveloped state of these technologies did not deter him from projecting its Edenic metaphor. Fuller also proposed the modern geodesic structure be rented as form-work for concrete construction:

> It may be that we can evolve a comprehensive rental policy ... for all customers. It would be theoretically ideal and desirable. This could carry an installation charge ... and so much per month on our capital investments, overheads and profit. We could thus bring large capital investment reserves of insurance companies, etc. into action as we establish rental behavior patterns.[568]

The patterns of Fuller's encounters with his collaborators illustrated that there was a fundamental difference between the collegiate experimentations and those of his professional franchisees. The latter, being less object-oriented, were more keen to bring the dome project within the familiar touch of architecture - taming the implement and adjusting its Platonic, pristine quality to real site and ground conditions; in other words, "architecturalizing" the site and

[566]Ltr. 8/8/51 RBF to Gordon Cole in BFI-CR147.
[567]R.B. Fuller, "Comprehensive Design," BFI-MSS 48.11.01, p.1b.
[568]Ltr. 4/29/52 EBF to J.W. Fitzgibbon in BFI-CR139.

program of geodesic technology. Their works, and their effects as business and art of geodesics, are the subject matter of the next chapter.

2.8. Conclusion

The development of the geodesic structure in the short span of several months, between Fuller's departure from the Fuller House project Wichita and his first summer engagement at BMC, was not a flash of genius. Rather the process, and the fecundity of dome variations produced, attested to a continuous process of keen observations and gestations. His geometrical tinkering in *EG* led from his cartographical project for re-presenting datas on a spherical surface on a cube-octahedron. This led the great-circle studies which formed the productive template for geodesic structures. Thus Fuller's process in developing geodesic structuring, in light of all prior arts, is assuredly original.

His geometrical investigations were driven by his interest in transfomative geometry, particularly the relationships between the sphere and the regular Euclidean polyhedra. The transformability of his contraption, the "jitterbug," provided a paradigmatic discovery of the relationship between criss-crossing of great-circles of the spheres to a class of polyhedra comprising of the tetrahderon, the octahedron and icosahedron. In the thirty-one great circle compositions, he found the connection to the near-spherical polyhedron made up of the similar number of chordal components, the icosahedra.

Programmatically, the research agenda for the geodesic structure was formed by Fuller's prospect for an enclosure system that would, as an energy valve, integrate both mechanics and structures. This was augmented by his keen interest in a shell structure that could be assembled quickly, compact and portable. His practical experience on the DDM-Fuller House project at Beech Aircraft in Wichita, Kansas in 1947 reinforced his believe that a filigree spherical structure with tremendous strength could be machined and assembled rather than built. The qualities of such structures fulfilling what he perceived as primal motifs for survival, coincided with the needs of national security, vis-a-vis rapidly deployable structures. For this reason, the research and realization of the geodesic projects were significantly affected and shaped by military-strategic imperatives, continued from the DDU-DDM period. Rather than an incidental or an accidental relationship, Fuller's contact with the military was opportunistic. It added vitality to the inauguration of the geodesic research, its subsequent prototype development and production.

The American architectural schools, the professional community and Fuller's primary collaborators participated in realizing pivotal experimentations. They unfolded the broad ramifications of the geodesic project, and in tandem with Fuller's research agenda, they articulated the new pressure points in design education, architectural practice and theory.

The early geodesic experimentations were closely identified with a loose collection of research units working within the rubric of Fuller Research Foundation (FRF) as a corporatized cooperative. The constituent groups were either formed in an ad hoc manner or they were instigated into action by Fuller. Initially, it contained various cells working around the common concerns articulated by Fuller, but with each working group drawing upon its own expertise and initiatives. As the full potentials of geodesic structuring surfaced, Fuller eventually sought greater management and control of the workings of these groups as well as the professional skepticism and publicity related to the project.

Ch.3 The Art and Business of Geodesic Domes, 1955-60

In the mid-fifties, with the templates for the geodesic structure established in the college experiments and the patent claims lodged, and a rudimentary core of dedicated franchisees converted into his employees, Fuller was poised to advance his new enterprises. This chapter explores the patrons, both state and private, that Fuller sought and the contexts under which the art and business of geodesic domes were conducted. As the geodesic dome graduated through various uses and contexts, it created new realms of public desires and symbolic meanings.

3.1. Organizing the Enterprises

The implementation of Fuller's geodesic project fell solely on the shoulders of his backroom boys. The success of the Ford Rotunda Dome (May 1953) [Fig.3.64a - c] and the numerous difficulties Fuller encountered in controlling the activities of his franchisees convinced him that they were more suited as employees in his research enterprise.

The growing interests of the military in the dome as an ordnance added to Fuller's decision. While the colleges provided settings as public workshops for his projects to bask in the free publicity of local press, Geodesics Inc. and Synergetics Inc., [Fig.5.09b(2)] established separately by Fuller in 1954, were his private laboratories. While in many instances, the activities of these two entities and the colleges overlapped and blurred, they were, Fuller claimed, "exclusively in the business of doing research and testing prototypes." They drew upon the funds out of his own pocket, design fees and royalties. The creed of operation of his research laboratories, Fuller proposed, was:

> We'll build only what others won't ... Usually the moment a design is finished, somebody buys it.[1]

The activities of Fuller's research laboratories were multi-faceted. The one organized by Synergetics Inc., dubbed the "Dome Farm," posed itself primarily as a prototype research station dealing with the engineering of elements, angles of attachment and types of framework, the prototyping of full and partial scale models, the testing of these models in destructive loading tests, and finally the development and working out of new geometries and configurations along

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[1] "Fuller's Domes Catch On at Last," *Business Week*, 10 May 1958, p.115.

the broad geodesic structuring principles. In most instances, the structural analysis of the domes was farmed out to engineering consultants.[2]

The identity and research agenda of Geodesic Inc. were formed by the logistics requirements of the U.S. Armed Forces, primarily, the Marines. It was incorporated in September 1954 "to carry on the work of Mr. Fuller of designing and prototyping, directly or indirectly for the Armed Forces of the United States, geodesic structures embodying his patented principles."[3] The two branches of Geodesic Inc. at Raleigh, North Carolina and Cambridge, Massachusetts [Fig.3.31b] developed different areas of specialty for military logistics, mostly on their own technical initiatives. Raleigh's primary trademark product was a framework of aluminum or magnesium conforming to geodesics principles with an externally or internally suspended skin of a variety of coated synthetic fabrics. Its primary clients were the U.S. Marines (Aviation) and the U.S. Quartermaster. Under the initiatives of Col. Henry C. Lane and Asst. Commander W.O. Brice, the Marines initiated a program, after June 1955, "to adopt these structures for 99% of its shelter requirements which include men, trucks, planes, helicopters, storage."[4] The Cambridge branch, on the other hand, focused on designing and prototyping dome-shaped structures where framework and skin of polyester resin reinforced with fiberglass. These elements were molded together in panels which, when fastened together and erected, would constitute a geodesic structure. Its primary client was Lincoln Lab-MIT and military contractors developing the DEW-line (Distance Early Warning System).

3.2. <u>Military Dome Program (1951-57).</u>

> (I)n 1927, stimulated by other factors, I had assumed that the very same set of generalized logistic conditions as those spelt out by Colonel Lane (of the U.S. Marine Corps) in 1952. I assumed these *airpower logistical developments as being both ultimate and eminent to world-around trends*, and at that time, I fortunately arranged to do something about it[5] (Itl., my emphasis).

With the imminent success of the geodesic dome in military logistic demonstrations in 1956, Fuller also felt compelled to historicize the thrust of his research project as a way to

[2] For example, Amee (M.E.) Uyanik was responsible for the analysis of many of Synergetics Inc. & Geodesic Inc. (Raleigh) domes in the mid to late fifties (See "Preliminary Report No.1 on a Proposed Loading Test for Geodesic Dome for Union Tank Car Company, Chicago-Ill.," ca. April 1957).

[3] _, "Geodesics, Inc." (In-house information flyer), undated in BFI-G-87 Box Geodesics Inc. See also Ltr. 4/8/55 J.W. Fitzgibbon to Brig. Gen. Harold E Watson (USAF, Wright-Patterson Air Force Base) in BFI-CR256.

[4] Ibid., p.1.

distance it and himself from the limited military objectives of the Armed Forces. Apologists of Fuller's work with the military are generally reticent of the meaning and significance of this patronage. For example, an apologist termed the Marine phase of Fuller's geodesic enterprise in a word that Fuller had popularized - "precessional," or in Fullerian parlance, doing the right things for the wrong reason or backing into the future.[6] However, this explanation skips over the more protracted efforts that Fuller undertook in soliciting military patronage on countless occasions in the course of his dome enterprises. At the start of the geodesic experimental phase in 1949, Fuller maintained a line of communication with interested military persons at the Pentagon that he had established since the DDU and DDM-Fuller House projects. With each successive stage of the geodesic prototyping, field tests and developmental work, Fuller continued to link up, both directly and through the assistance of various intermediaries, U.S. military interests in a broad range and variety of logistics needs. However, the real sizable and significant demands for domes transpired towards the end of 1953, with the entry of the U.S. Marine Corps (Air) into the geodesic prototyping enterprise. Robertson, Fuller's patent lawyer, characterized the significance of the Marines' participation as a "starting spur" to a broadening use of geodesic structures.[7]

3.2.1. The Marine Dome Program (1953-55)

A second prong of military interest after the early Air Force inquiries on the dome for military housing came from the Bureau of Aeronautics in the Department of Navy. This time, the use of the dome as logistics for advance military bases was proposed. While responding to Fuller's interest in the Navy's shelter development program, Commander Lawler also outlined its own program "to develop a portable cold weather aircraft maintenance shelter for use by Marine Corps Aviation Units at advance bases."[8] In the hope to solicit Fuller's interests in this latter project, Lawler even assured him exemption, perhaps from bureaucratic and security red tape, for submission of his design proposals for consideration. In December 1951, using his graduate studio setting at MIT, Fuller submitted a 90-ft diameter "internally turreting" double-dome

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[5]Ltr. 6/30/56 RBF to Maj. George J. King (Division of Public Information, Hdqrs. USMC, Washington D.C.) in BFI-CR178.

[6]Notes from Author's Telephone Interview with Don Moore, 4/16/95. Don Moore, who collaborated with Fuller on the Conning Tower Program in the early sixties, reported of Fuller's dismay with the gun-making activity of Bangor Punta leading him to subsequently withdraw his consultation with its recreational subsidiary. Bangor Punta is a New York based conglomerate whose subsidiaries, in the seventies, made police equipment and a variety of crowd control devices (Wesson-Smith Division), textile and pleasure boats and owned farming and railroad operations.

[7]D. Roberston, *The Mind's Eye*, p.45.

[8]Ltr. 9/27/51 J.T. Lawler (Comdr., USN, Head Aircraft Maintenance Branch, BuAer) to RBF in BFI-CR134: refers to RBF's 9/3/51 letter, acknowledging him for his "readiness to be of service."

hangar of basic geometrical diamond assemblies[9] [Fig.3.09a – b]. Intending this opportunity to pave the way towards real prototyping, Fuller proposed a series of fabrication methods – fiber-glass polyester diamond component structures, aluminum tubular strut frame with concentrically-mounted and outwardly-stretched hemispherical orlon tents, and plastic-glazed Styrofoam diamond shape interlocking tongue and groove building blocks. The factor foremost on Fuller's mind was its internal functioning as an Arctic geodesic maintenance hangar:

> As the inner dome is not swept by exterior air and because no metallic heat train interconnects the inner and outer domes, condensations and frosting on interior surface is reduced or eliminated. The interior dome provides favorable internal aeronautical apace shaping, resulting in self-protecting internal flow enclosing the rolling-doughnut shaped circulation of heated air.[10]

The features of an internal dome that rotate to control air circulation and to accommodate the problem of dome closure without the use of hangar doors appeared brilliant. However, the fundamental issues of fabrication and of structurally accommodating such openings were not considered. Rejecting the design on grounds that its details were "objectionable" and that the scheme had assumed a prepared foundation in level condition, Lawler nevertheless offered a caution that eventu[illegible] proved useful to Fuller's subsequent work on the Marine domes:

> Erection of the structure would be a [illegible]jor problem due to the number of parts and the amount of scaffolding and climbing which would be necessary.[11]

3.2.1.1. Colonel H.C. Lane's Report

Despite these interests, or what John Dixon described as the military's "earlier competent" conceptualization of the logistics potentials of geodesic structures, ordnance like the proposed geodesic Arctic maintenance hangar, he claimed, could only be fulfilled with the successful completion of the Ford Rotunda Dome. At the symbolic site of Henry Ford's industry, no less, the viability of geodesic structuring was proven nationally. While this explanation is partially true, the thrust of Dixon's skillful piece of historical construction is to diffuse Fuller's earlier direct participation in and solicitation of military interests. It implied that only with this public demonstration, rather than through Fuller's covert knowledge of and connection to the

[9] Ltr. 12/20/51 RBF to D. Willems (Comdr., USN, BuAer) in BFI-CR134.
[10] Ibid.
[11] Ltr. 1/23/52 RBF to J.T. Lawler (Comdr., USN, Head Aircraft Maintenance Branch, BuAer) in BFI-CR134.

military logistical requirements, was the Defense Services only able "to enlist budgetary support of geodesic structures by the due processes of democratic government authority."[12]

Dixon's presentation punctuated the completion of a cycle of military participation in and its rigorous demonstration of the efficacy of the dome. These findings are contained in the 1955 publication of Col. Henry Lane's "Final Report: A Study of Shelter Logistics For Marine Corps Aviation" [Fig.3.20a]. Fuller's project of converting armaments into ploughshare was evoked at this point, as Dixon reported:

> Bucky says that what is at first economically vital to a world mobilizing military must inevitably become economically vital to a world mobilizing civil society. For this reason it can be said with certainty, that in as much as the Marine Corps Aviation Division makes the first logistic bridgehead to tomorrow's economics and finds Geodesic structures of epochal importance in attaining that bridgehead, it can be predicted that the magnitude of civil economic reorientation which it signals is of the first order.[13]

In order to establish how Fuller dovetailed his ongoing research dome agenda into that of the military, it would be pertinent to trace the steps leading to the dome-testing at the Marine Corps Development Center, Quantico-Virginia and Col. Lane's *Final Report*.[14]

In October 1953, prompted by the enthusiastic review of the Ford Rotunda Dome in *Architectural Forum*, Maj. W.L. Woodruff (Division of Aviation, Hdqr. United States Marine Corps, Department of Navy), directed by his immediate superior, Col. Henry Lane, approached Fuller with their terse but, by now, a sufficiently well-rehearsed list of logistics requirements:

> In Marine Corps Aviation we are constantly searching for aircraft shelters which can be easily air transported and rapidly erected by squadron personnel.[15]

Col. Lane was the Head of Aviation-Logistics Branch, USMC, who according to Fuller, received his training in the architecture and building arts at the Univ. of Illinois."[16] In 1953, Col. Lane prepared a preliminary study of the logistic needs of the Marine Corps Aviation, in which he identified how the "austere (defense) budget" affected the problem of providing a shore

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[12]Ltr. 7/9/55 J. Dixon to Lt. Col. William Woodruff (USMC) in BFI-CR164, p.1.
[13]Ibid., p.2.
[14]Col. H.C. Lane, "A Study of Shelter Logistics for Marine Corps Aviation," U.S. Marine Corps, 1954. Henceforth as "A Study of Shelter Logistics."
[15]Ltr. 10/26/53 Maj. W.L. Woodruff (Division of Aviation, Hdqr. USMC, Department of Navy) to RBF in BFI-CR163; See also Ltr. 12/3/53 Maj. W.□□L. Woodruff to RBF in BFI-CR163.
[16]See Ltr. 3/19/54 RBF to Walter Paepcke in BFI-CR153.

establishment complex for the Third Marine Aircraft Wing.[17] A follow-up report expressed the dilemma in Marine Corps Aviation between mobility/greater flexibility and the weight of modern aircraft.[18]

3.2.1.2. Marine Domes and the Colleges of Architecture

By the time of Fuller & Fitzgibbon's first meeting with Woodruff at USMC-Washington D.C. in early January 1954, the Marines' project for a complex of advance base structures was almost a done deal. In response to the Marine's consultation proposal, Fuller proceeded to redirect and craft his itinerary for the colleges to fit that purpose - offering the extant work at NCSC (Jan.6-29, Spr.'54) as the project's first phase, to be followed by works at Tulane (Feb.1-27, Spr.'54), MIT (Mar.8-27, Apr.5-16, Spr.'54), Virginia Polytechnic Institute (Mar.16-Apr.2, Spr.'54), Univ. of Michigan-Ann Arbor (Apr.19-24, Spr.'54), Cornell (Apr. 26-May 28, Spr.54) & Princeton (Sept.20-Oct.8, Fall'54). These were subsequently followed up by a second series of work at Washington University (Nov.21-Dec.21, Fall'54).

While seemingly an ad-hoc reorientation of the college program to fulfill some general interests of Marines' logistic requirements, two of these domes (Tulane and NCSC) were in fact experiments towards fulfilling Fuller's contract to the Bureau of Aeronautics (BuAer) for a full scale 36-ft diameter dome. The former tested reinforcements of polyester resin with raw corrugated paperboard and a new sub-assembly geometry; the latter entailed "improved fastening," faster fabrication (scored, cut and printed) of corrugated paperboard and "polyestering" (polyester resin with glass fiber cloth). The final version tested waterproofing with aluminized Mylar, along with added improvements of the two previous domes. Because of their logical development, Fuller offered them as his gift to the Marines. He remained the sole proprietor, by right of the "pre-project-initiation voluntary agreement" between him and the colleges. Fuller had provided "personal and original financial underwriting of part of the materials" despite donation by various companies.[19]

The varieties of experimentations were also tactically prudent, as Dixon reported later of Col. Lane's assessment of the college work:

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[17]See "Informal Report on a Study of Requirements and Design of Shelters for Marine Aviation Advanced Bases," n.d., (ca.1953) in BFI-CR163, p.17.

[18]"Verbal Report of a Study on Improvement of Shelters for Marine Aviation (given at MCAS, Quantico-Va.)," 4 August 1954 in BFI-CR163.

[19]Ltr. 4/9/54 RBF to Col. H.C. Lane in BFI-CR163.

> Col. Lane agreed that it was essential that we avoid trying our case in any one design sortie, and conversely that we press for overlapping starts on a plurality of design strategies already explored and demonstrated by (Fuller) at colleges and that the many types be tied in the full gamut of available materials and available toolings.[20]

Concurrently, Dixon solicited the support of material industries by assuring them that despite prototyping the works in colleges, their commercial interests would be protected, since

> (Fuller's) search should not be encumbered by 'shop rights' claims or financial or other legal environments which might put in jeopardy the integrity of his continuing technical reconnaissance.[21]

Clearly valuing the publicity for all concerned, Dixon even outlined a proposal at this juncture for a trial lifting by helicopters of the 30-ft wood slat-cocoon dome that was built in 1952 by Skybreak Carolina [Fig.3.10]. However, he was careful to qualify the condition of Fuller's work in order to allay any misreading of Fuller's official acceptance of the consultation proposal of the Marines:

> The U.S. Marine is not retaining Mr. Fuller in any capacity. He is functioning as *an independent individual conducting research and development that now seems of interest to the U.S.M.C.*[22](Itl., my emphasis).

The dome, dubbed by Col. Lane as "the first structure of anywhere near comparable size to be flown in the completely erected state," was subsequently flown on 28 January 1954 at Orphan's Hill, Raleigh, North Carolina.[23] Treating the event as a news-novelty, *New York Times*

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[20]See J. Dixon, "Notes: of RBF's meeting with (Col.) Lane [Sept. 15-17],"9/15/54 in BFI-CR163.

[21]Ltr. 1/14/54 John Dixon to J.L. Rodgers (Bakelite Division, N.Y.) in BFI-CR153. Besides three drums (2/3 tons) of polyester resin from Bakelite Division (Union Carbide & Carbon), Lane also attributed support from Owens-Corning Fiberglass Corp., MMM's donation of 4000 square-feet of fiberglass cloth and Container Corporation of America's technical support on cardboard resources and technology. (See "Informal Report on a Study of Requirements and Design of Shelters for Marine Aviation Advanced Bases," p.14 in BFI-CR163)

[22]Ltr. 1/14/54 John Dixon to J.L. Rodgers (Bakelite Division, N.Y.) in BFI-CR153. Lane also unilaterally declared the context of the first meeting:

> Mr. Fuller volunteered to make first stage solutions of the problem of the subject of research in the three weeks remaining in a seminar of design research that he was conducting at the North Carolina State College, Department of Architecture which ended on 29 January 1954. To expedite matters this research was to be conducted at no expense to the Marine Corps. His offer was accepted and work commenced immediately (Col. H.C. Lane, "Informal Report," in BFI-CR163, p.7).

[23]M. Fitzgibbon recalled that J.W. Fitzgibbon, using a photomontage of their "cocoon" dome carried by a helicopter, first presented the idea of flying the dome to the Marines during their visit to NCSC in early January (Notes from Author's Interview with M. Fitzgibbon, St. Louis-Mo., 9/15/94).

reported in "Portable Battle Suite," 30 January 1954, that against the "harsh makeshift trench and uncertainty of terrain warfare," Fuller's alternative was like a "suite at Waldorf."[24]

3.2.1.3. Marine's Advocacy of Geodesic Structures

While there was no official contractual agreement between Fuller and the Marines at this point (and both parties were on a fishing trip, so to speak), the relationship was mutually advantageous and reinforcing. More directly, what Dixon omitted in his presentation was Fuller's goodwill towards Col. Lane's behind-the-scene advocacy for the portable geodesic shelters at the Bureau of Aeronautics (BuAer), particularly through his enthusiastic report, *"Informal Report of a study of requirements and design of shelters for Marine Aviation advanced bases"* (ca. Feb.1954) [Fig.3.20b]. Col. Lane further dispelled any reading of his advocacy of geodesic structures as a "quickie" solution. More directly, Col. Lane used his connection to influence the decision of the BuAer. He informed Fuller of his initiatives:

> (I) presented your estimates for the design of the 36ft and 108ft shelters. The figures were acceptable to them and a letter is being sent to you by the BuAer, requesting the firm quotations on the design of the two structures. BuAer told me that upon approval of the designs, a contract would be negotiated for the construction of the prototype of each size structure ... I asked them for an expression of an opinion of the possibility of the design contract being consummated. BuAer felt that if no situation arose which demanded the funds, the contract would go through without any difficulty.
> ... Once you receive the communication from the BuAer, it becomes a business proposition between you and them. Marine Aviation will drop out of the picture until the final designs are received and they will then be submitted to us for our approval. Just between the two of us, I intend to keep in close contact with you through your design, *appearing on a 'spectator basis'*[25](Itl , my emphasis).

To reassure Fuller further, and to "expedite preparation of the contract," Col. Lane made arrangements to earmark the thirty-five thousand dollars ($35,000) until BuAer received his formal quotation.[26] Finally, after half a year of collaboration, Dixon openly declared Col. Lane's pivotal role in the dome enterprise:

> On behalf of Bucky, I told Col. (Lane) how much Bucky appreciates the Col's (sic) work on behalf of Geodesic structures. How we feel that he is on the front line absorbing misunderstanding directed at the structures. Col. (Lane) thanked (Bucky) and said that he

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[24]For a sense of the immediate interests this event generated, see: "Building Flown by Helicopter in Unusual Test at N.C. State" in *Winston-Salem Journal*, N.C., 29 Jan. 1954; "Dome-shaped Shelter Gets Helicopter Ride in Tests for Value to Armed Forces," *Quantico Sentry*, 2/11/54; "Marines have Barracks that Fly," *Business Week*, 2/6/54.

[25]Ltr. 2/17/54 Col. H.C. Lane to RBF in BFI-CR163.

[26]See also J. Dixon, Notes on "Talk between RBF and (Col.) Lane," 2/19/54 in BFI-CR163 which provided the breakdown of the $35,000 contract for design of 36' & 108' domes. This contract was approved in June (Ltr. 5/28/54 Col. H. C. Lane to RBF in BFI-CR163).

knows that Bucky knows some of the problems of education that he, Col.(Lane), is up against.[27]

Because of Col. Lane's fervent support, the BuAer freeze on portable shelter was lifted, and this resulted in the final authorization to purchase "one air transportable geodesic dome personnel shelter for test purposes" [Fig.3.12]. The Marines' contract read:

> (T)he Fuller Research Foundation ... will make available a suitable building for test at a price of approximately $18,000. The building is a prefabricated 36 foot diameter geodesic dome shelter, constructed generally of a polyester fiber glass skeleton and skin structure, the components of which are formed around wet strength waterproofed paperboard cores. It is proposed upon purchase that for the purposes of both test and expediency, the structure be air transported by Marine aircraft from the place of manufacture to the custody of the Director, Marine Corps Development Center, Quantico, Virginia, for erection by Marines with technical advice from the supplier. Thereupon it is further recommended that the Marine Corps Development Center conduct a service test of the item to determine its usefulness as a personnel, administration, or maintenance shelter for Fleet Marine Forces in the fields and at advanced bases.[28]

Concurrently, Col. Lane's own enthusiasm to test other variations of the geodesic structures, especially those using lightweight magnesium alloy, impelled his own dome-promotional exercise. In particular, the successful airlift of the test-dome at Orphan Hill as a dry run of what he termed "zero installation time," was a potent carrot to entice prospective industries [Fig.3.24 & 3.25]. Col. Lane thus wrote to a public relations representative of the light-alloy industries to stir up what he perceived were their "mutual interests":

> In opinion of our Marine Corps public information specialists there is definite news value in a demonstration of a dome shaped helicopter hangar, lifted in the completely erected state and transported over miles of terrain by the helicopter it can house. The publicity attendant to such a demonstration would be of significant value to the Marine Corps and we believe also of substantial advertising value to those commercial interest associated with the project.[29]

Col. Lane was prepared to adjust the specifications of these light alloy domes to expedite the prototyping process. For example, instead of aluminum tubing and cast aluminum hubs, he was prepared to settle for channel extrusions of magnesium since it entailed no casting. This

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[27] J. Dixon, "Note: Telephone conversation between (Col.) Lane & Dixon," 5/22/54 in BFI-CR163.

[28] Memo.2/24/54 Director of Aviation to Assistant Chief of Staff," Purchase of geodesic dome personnel shelter for test" in BFI-CR163. This dome, fabricated at Cornell in June 1954, was billed the Mark-II dome (See "Cardboard Domes to Replace Tents?" *The Christian Science Monitor* (Boston), 4 June 1954; "Domes for the Army (Made of Cardboard, They Would take the place of tent)," *New York Times*, 18 June 1954 ; also "Senior Architects Organized to Study Cardboard shelter," *Cornell Student Daily*, 21 May 1954).

[29] Ltr. ca. Feb.'54 Col. H.C. Lane to J.S. Kirkpatrick (Brooks & Perkins, Inc., Mich.) in BFI-CR163.

prepared the way for the eventual BuAer Mark-III 50-footer magnesium dome, designed at MIT in August '54.[30]

Finally, Col. Lane was exceptionally skillful in convincing his superior command that with Fuller's geodesic structures, the Marines' own "three-phase shelter concept" would be eclipsed with strategic savings in man-hours, weight and costs.[31] He also explained that geodesic structures, as a "one-phase family of shelters," would be more significant for the advance bases rather than continental base use.[32] Col. Lane argued that despite its "initial" mobility and the traditionally acceptable "long stays at developed airfields," the present system of mix-and-match Marine shelter system of "47 types of shelters (with) over 2,900 entirely different materials" had many deficiencies and penalties. These were, he continued, "logistic loads" which caused "reduction in operating efficiency, mobility and flexibility of Marine Aviation" and "difficulty in disassembly and reerection." But most importantly, there were fundamental developments in new flight take-off and landing techniques which necessitated "shorter tenure at aircraft operating areas" and "greater mobility" [Fig.3.16a - b]. The shelters were as necessary as the best maintenance and advanced weapon systems of Marine Corps Aviation in any potential conflict areas. He summarized the meaning of the "grave logistic penalty" of all these considerations in one sentence:

> In fact, the handicap of inefficient shelter logistics tends to cancel out gains in flight technology; a case of the tail wagging the dog.[33]

Compare this observation of Col. Lane to Fuller's report to Walter Paepcke, President of Container Corporation of America (CCA), on the new air-power event, namely the turbo-prop fighters. Fuller suggested that while they would annul the necessity for landing strips, they would advance the necessity for housing of the technicians. Moreover, unless this new strategic edge was maintained, he warned that:

> the magnificent new flexibility and invulnerability permitted by the no landing field operations must be disastrously hobbled by the inadequacy of the housing technology... (that required) days and weeks.[34]

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[30]See also Col. H.C. Lane, "Final Report: A Study of Shelter Logistics For Marine Corps Aviation," USMC, 1955, pp.45-45. Henceforth as *Final Report.*

[31]Col. H.C. Lane, "Section IV: Marine Aviation's Evolutionary Solution of the Shelter Logistics Problems" in *Final Report*, pp.27-30.

[32]Col. H.C. Lane, "U.S. Marine Corps Light-weight Shelter Study" presented at Quantico Virginia (4 August 1954) in BFI-CR163

[33]Col. H.C. Lane, "Section IV: Marine Aviation's Evolutionary Solution of the Shelter Logistics Problems," in *Final Report*, p.29.

The congruence between Col. Lane's and Fuller's assessment of the logistic conditions was not accidental. Fuller had a more direct part beyond mere influence in shaping some of Col. Lane's conclusions. Col. Lane, while preparing the draft of his report between March and May '55, acknowledged and thanked him for his "comments and chop on the report."[35]

The "gains in flight technology" that Col. Lane mentioned in the form of "new flight take-off and landing techniques" included the Navy's Convair XFY-1 vertical-riser aircraft and a new arresting gear, also known as a "universal landing gear." The latter was a result of Navy experiments with water skis for planes[36] [Fig.3.13]. On the occasion of the airlift of the BuAer Mark-III magnesium dome at Quantico -Virginia in August, *The Washington Daily News* found it appropriate to feature the event alongside the Navy's new plane[37] [Fig.3.14]. This moment, Col. Lane offered, vindicated his promotion of Fuller's geodesics, even as Col. Lane denied access to these snippets of military intelligence:

> Note the coincidence that, although uncoordinated, the vertical riser aircraft and the hangar designed to match its mobility both flew for the first time on the same day. You will remember that it was this vertical riser and the catapult and arresting gear that prompted the visit to you in January.[38]

However, prior to the August event, and under the circumstances of urgency painted by Col. Lane, Fuller successfully repackaged a smorgasbord of experimental domes which he had earlier failed to convince Lawler to undertake. Thus, at Tulane University, the previously-rejected 90-ft Arctic hangar at MIT reemerged as a 108-ft hangar for six Douglas Skyray jet fighters, still using the idea of a rotating dome on wheels and a internally-suspended tent system[39] [Fig.3.11]. Simultaneously, it also built upon another line of dome experimentation established since the first at Yale University in Fall of 1952, namely, the use of paperboard. In the Tulane dome, a new geometrical sub-assembly of sixteen triangles was constituted as a parallelogram; but the fundamental problem of waterproofing that had plagued even "polyestered" paperboard remained unresolved.[40] The initiative for resolving this, whether it

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[34]Ltr. 3/19/54 RBF to Walter Paepcke in BFI-CR153.

[35]Ltr. (undated) Col. H.C. Lane (USMC) to RBF in BFI-CR161.

[36]_, "New Navy Landing Gear can Land on Snow, Ice and Water," *Quantico Sentry*, 5 August 1954, p.6.

[37]*The Washington Daily News*, 5 August 1954, front page.

[38]Ltr. 8/7/54 Col. H.C. Lane to RBF in BFI-CR163.

[39]The old problems associated with large opening in the geodesic dome reappeared here, as Krogsgard, an experimenter in the college dome program, reported on sagging of the structural member over the opening, causing awkward difficulties with the hangar doors (Ltr. 3/11/54 Russell Krogsgard to RBF in BFI-CR163).

[40]Ltr. 3/14/54 J.W. Fitzgibbon to RBF in BFI-CR162: with samples of penetrating waterproofing compound.

entailed waterproofing during the paperboard manufacture or sprayed on waterproofing afterwards, Fuller felt, should be taken by industry.

3.2.1.4. Industry, Fuller and the Marines

Because the participation of the Marines now provided an urgent edge to the dome enterprise which was previously missing, Fuller was emboldened to approach the materials industry more aggressively. After receiving two Marines official dispatches for the purchase of Fuller's domes, Col. Lane directed Fuller to attract the support of industry for his dome enterprises:

> Thought you might like to have this information in your requests to Forest Products Laboratory and Container Corporation etc. It might make them more receptive knowing of actual orders.[41]

As its own press release indicated, the public relations machinery of the Marines was no less enthusiastic in advancing the geodesic development. This claim was echoed:

> Geodesic domes for an entire Marine Aviation wing would weigh only 872,000 pounds costs $657.000 and takes 26,000 man-hours to assemble. Corresponding figures for the three-phase (tent, reinforced tents and Quonset huts) practice of today are 33,746,000 pounds, $5,102,000 and 961,000 man-hours.[42]

Reporting on the stakes and status of his dome enterprise with respect to the U.S. Marine Corps logistics requirements, Fuller appealed to W. Paepcke (CCA), in a more direct tone:

> (Col. H. C. Lane's Report) has been officially approved by the Commandant of the Marines, General Sheppard ... (and) dispatched ... with recommendations for further actions ... I am in a position of authority governing the license of manufactures as my patents are recognized by the U. S. Marine Corps.[43]

Fuller's strategy in enlisting industry in his project was by reassuring them that the geodesic structure was not a monopoly of any one building material industry, as a steel frame structure might be to steel or shell to concrete and steel. Geodesic structures "represented (a) mathematical system," he explained to the 40th Annual meeting of the Technical Association of Pulp and Paper Industry in New York in 1955. To an audience made up of industries which were the most unlikely builders in the traditional sense, Fuller sketched a potential market demand

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[41] Ltr. 5/13/54 Col. H.C. Lane to RBF in BFI-CR163.

[42] "Domes for the Army (Made of Cardboard, They Would take the place of tent)," *New York Times*, 18 June 1954.

exceeding their existing niche dreams. As he persuaded them to develop stronger, more durable waterproof paperboard, he also explained the economic stakes of his Marine Corps "disposable shelters." Beyond his immediate prototype contracts with the Armed Forces, Fuller enjoined them to his enterprise to produce dome-like newspaper, as many as three thousand in a paperboard factory [Fig.3.21]:

> If such lightweight structures do prove successful & useful, they will use a great deal of paper...
> This would be more millions of square feet per day than the building industry has ever dreamed of...
> It's an accelerating program that is running into many, many millions of dollars.[44]

Yet when the dome purchase inquiries poured in after the promotional and publicity blitz accompanying both the theatrical Marine dome-airlift and the cameo appearance of its two "sister" domes at the Milan Triennale, Fuller's dome enterprises were pressed to consider carefully their relationships to the industries' commercial initiatives. Of primary concern was managing the enterprise "the right way" by reining industries' own initiatives in prototyping activities and steering them towards Fuller's definition and vision of a "new industry." As Dixon reminded one of them rather paternalistically that Fuller was, being most experienced in this "geodesic art," still the quarterback of this metaphorical business game:

> Mr. Fuller has thrown an economic forward pass to CCA consisting of the potentials opened up by his public demonstrations of what could be done structurally and economically with geodesic domes of paperboard, and what would be necessary to make the dome commercially effective. You can now run the ball to the twenty-yard line through production chemistry and again throw the ball to Fuller so that he can run it further with the series of tests ... When geodesic domes have met every ratioed(sic) limit set by the Marine Corp's fundamental evaluation factors, final design for a prototype test dome will be return-passed by Mr. Fuller to the Container Corporation, who should then in two mass ground plays -- i.e., production tooling and distribution, be able to put over a real economic touchdown.[45]

3.2.1.5. BuAer Mark-II and Mark-III Dome, the Paperboard and the Magnesium Domes

In the geodesic dome prototyping, both Fuller and his associates were cognizant of the need to present their works as rational and systematic. Fitzgibbon explained that the nomenclature for prototyping adopted by Fullers' enterprises involved "three models and three stages," namely:

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[43]Ltr. 3/19/54 RBF to Walter Paepcke in BFI-CR153, p.1.

[44]R. Buckminster Fuller, "Paper and pulp structure," MSS 55.02.01, Feb. 22, '55. pp.12-31.

[45]Ltr. 12/13/54 J. Dixon to M.T. Hunsworth (Container Corporation of America) in BFI-CR157.

Mark I -- hand made mock up, for preliminary evaluation
Mark II -- improved (after evaluation) hand made unit
Mark III -- Final improved 'soft tool' unit, for terminal approval and production.[46]

While the Tulane and NCSC domes formed the experiments for the BuAer Mark-II dome, the VPI Dome [Fig.3.15] was a laboratory adaptation of the octet-truss "X-members" that Fuller had used on the Ford Rotunda Dome.[47] It was used to flesh out the new problems of jointing in a new dome conformation. The octet truss construction was, at this point, the only space-frame assemblage within Fuller's developing family of geodesic structures that possessed the essential thickness of shell and some extent of field tests. While the VPI dome was being prototyped in wood strips glued and bolted together, Fuller's enterprise at Raleigh was developing a full-scale contracted 36-ft dome magnesium frame of extruded sections, with view to welding rather than bolting the joints.[48] This was the subsequent Mark-III dome. The synchronized work was so impressive that by fall '54, Col. Lane advanced a new $19,000 contract for a 50-ft half-sphere of H-section magnesium frame. This work was fabricated by the MIT-Cambridge studio group, based on Fuller's "Southern enterprises" adaptation of the diamond conformation of the paperboard domes into magnesium extrusion diamond-shaped framework [Fig.3.15 & Fig.3.17a & b (III.194.1-2, 191.1-2)]. The initial use of bolts on the VPI dome and the proposed welding were altogether abandoned in place of rivets.[49] This hand-in-glove arrangement could not have been better orchestrated, as Col. Lane himself perceived of Fuller's dome design process:

> (T)he present arrangement is ideal. You and your university projects with only the blue sky as the limit on ideas. Then your *Fuller Enterprises* to pick them up and put those applicable to production for us, and work out certain details not possible in your school projects... (W)e can use almost everything you come up with that has mobility and is not designed for permanence[50](Itl., my emphasis).

Following from the MIT prototype, two more were prototyped, and the *Army, Navy and Air Force Times* of 1 January 1955 issue featured it as "one of the ten military highlights of

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[46]Ltr. 8/8/55 J.W. Fitzgibbon to Lt. Col. T.K. Pextond (Hdqr, Quartermasters, Nattick Mass.) in BFI-CR166.

[47]For technical details of the Mark-II Marine Dome, see "General Data on Fuller s-36 MK-II Storage Geodesic Dome," 5/4/54 in BFI-CR163.

[48]J. Dixon, "Notes: Phone conversation with (Col.) Lane," 4/12/54, in BFI-CR163.

[49]Ltr. 7/11/54 J.W. Fitzgibbon to RBF in BFI-CR162: highlighting the problems of the faulty fasteners. (See also J. Dixon, "Notes: Phone conversation with (Col.) Lane," 4/12/54, in BFI-CR163). See also Ltr. 12/10/54 J. Dixon to J. Cadwell in BFI-CR157, which compensated Fred Taylor & John Caldwell for the design on the Navy 50-footer magnesium geodesic prototype from March 8 '54 through Apr '54.

[50]Ltr. 5/28/54 Col. H.C. Lane to RBF in BFI-CR163.

1954."[51] With the successful prototyping and airlift of the MIT 50-ft magnesium dome at Quantico-Virginia, Col. Lane's confidence showed in his promise to place a further order for a hundred units of the dome. The order, Dixon observed, would produce "truly wealth-returning royalties" and amplify Fuller's original research and development."[52]

3.2.1.6. Managing the Marines. Shaping the Process from Prototyping to Production to Procurement

With Col. Lane's project promising the mass production of the geodesic dome, Fuller had to ensure that he still maintained control over this more lucrative aspect of the dome enterprise. The phenomenal success of the Geodesic Inc. (Cambridge, Mass.) and Lincoln Lab-MIT collaboration served as an ideal model for business. Besides controlling the front-end of the prototyping processes and developing the proprietary details, they were also better positioned to directly advise on the assembly process[53]. Thus, despite being guided by the precision and tolerance of tooling from the aircraft technology, Fuller felt that the specifications produced were better turned over as sub-contracts for local shops, rather than depending on large aircraft component manufacture shops. Besides, probably drawing from his direct experience at Beech Aircraft, he explained that the "soft tools" of aircraft industry "could not endure the mass formings of Class-A toolings" which existed in the Detroit area. The strategy he thus proposed was that:

> the appropriate evolution should be on prototypes assembled in (his) shops from components fabricated by machinists in local shops, translated through experience gained thereby into production drawings of the actual class A tools through staff employment of tool designers - whereby the production schedule could be immediately transferred to the mass-production vendors of the class A tooled industry.[54]

By Class-A tooling, Fuller was referring to a constructional breakthrough in his Ford Rotunda Dome which maintained a tolerance in the positioning and size of the rivet holes, close to 0.05 inch-diameter. He explained its significance:

> This is invisible increment to the unaided human eye. Maintaining this tolerance, produced a structure whose end-fixity strength was twice that it would have been had the tolerance been

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[51]Col. H.C. Lane, *Final Report*, pp.45-46.

[52]J. Dixon, "Notes of RBF's meeting with (Col.) Lane [Sept 15-17]," 9/15/54 in BFI-CR163, p.1. Ltr. 10/29/54 J. Dixon to R. Hamilton in BFI-HEv1.

[53]It was on this basis that Fuller found it fit to familiarize Col. Lane with Cambridge's work on the radome, particularly the testing of one of its 31-footer three-quarter radome on Mt. Washington (installed since 10/1/54) for its high wind and low temperature behavior (See Ltr. 2/17/55 RBF to John Vitale (MIT-Lincoln Lab) in BFI-CR164).

[54]J. Dixon, "Notes of RBF's meeting with (Col.) Lane [Sept 15-17],"9/15/54 in BFI-CR163, p.3.

slackened to dimensional variations of 0.01inch - which is the limit of human sensorial perceptivity. That is to say, that by taking advantage of the tools capability to operate at sub-visible tolerances, double the strength was attained and therefore the dome weighed one half as much as would a dome of equal strength - if the dimensioning had been accomplished within the limit of human visibility and hand indexed coordination.[55]

However, it was equally likely that Fuller was reacting to Col. Lane's intelligence that Intercontinental, an aircraft contractor, had solicited to take over the total design complex and fabricate the geodesic domes for USMC. Such an action, Dixon quickly pointed out, would compromise Fuller's "proprietorship through 'shop-rights'."[56]

Don Robertson, Fuller's patent lawyer, was also on hand to advise Fuller to waive his royalty for the production of an experimental dome for testing purposes, and to focus on the business potential in dome manufacture instead. Fitzgibbon reported that Robertson:

> suggest(ed) that the sale of 'kits' will probably become an ever-expanding part of (Geodesic Inc.) production operations. He suggests that ordinary business practice in the sale of kits does not specifically set up a royalty payment over and above the kit price, rather that in calculating the sales price of such a kit some increment be added into the price to cover such royalty and patent costs as proper. Robertson is primarily concerned with fortification of royalty and license position with the Government in respect to production items whether produced by commercial fabricators or as Lane once suggested in the field by Marines.[57]

In Robertson's own prognosis, Col. Lane's *Final Report* would "most certainly create a consuming interest in geodesic domes for shelter."[58] His strategy also proved worthwhile as the Armed Forces commissioned four sizes of domes (35, 42, 55 and 117-ft diameter) for use as "front-line" aviation shelters, confident that this would save $45 million as replacements for all its tents.[59]

In between moments of triumph, however, were minor but nonetheless "disquieting" disagreements over matters of royalties. For example, the Marines dissented over the prototyping costs, charging that their domes were "adaptations" of those previously offered in the public,

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[55] Ltr. 1/24/58 RBF to Brattinga in BFI-CR190.

[56] J. Dixon, "Notes of RBF's meeting with (Col.) Lane [Sept 15-17]," 9/15/54 in BFI-CR163.

[57] Ltr. 11/2/54 J.W. Fitzgibbon to RBF in BFI-CR162.

[58] Ltr. 7/6/55 D. Robertson to RBF in BFI-CR174, p.1. So convinced was Robertson of the potential business that he advised Fuller to acquire George Bryant Woods' patent for Spherical Structure (U.S. Patent # 2,711,181 issued on 21 June 1955). See Notes, "Rough outline worked out on basis of discussion between Brackley Shaw, Parkhurst, and Robertson June 29 and July 2, 1956" in BFI-CR178 as a basis of the final agreement on Fuller's acquisition of the Spheric patent.

[59] *Army, Navy, Air Force Journal*, 2 July 1955.

namely the Ford Rotunda & the Woods Hole Domes (1953)[60] [Fig.3.19]. The Navy assumed that it had "purchased drawings & manufacturing rights to the items in the drawings; and that (it) was giving a memorandum to the Patent Section requesting a reading of the patents."[61]

Over the issue of patent royalties, the more fundamental issue, Parkhurst pointed out, pertained to "what number of an article constitute a prototype and what constitutes production." Thus, he illustrated:

> The government might very conceivably insist that an order of twenty-five 50-footer is the number of prototypes they need to test the same out under various conditions of weather, terrain and other factors.[62]

Knowing that his work was indispensable, Fuller accommodated his patron by lowering the prices. The impetus, however, was because he reminded a long-time confidant, Brig. Gen. Harold Watson, that air advantage generally depended on the "organic fluidity of redeployment and re-dispersal." Ill-adaptability of conventional structures, he continued, was like being "inherently ill suited as are rooted trees to flee before a forest of fire." Thus, he concluded:

> As you know, I am thoroughly convinced that Geodesic structures will be of important strategic value to the Air Force. They have proved to be an integral function of maintaining air advantage.[63]

3.2.1.7. Prototyping in the Open

Fuller prototyped the Marine domes in the full view of the public. He also deployed them in non-military uses in ad-hoc fashion, as the opportunities arose. It will be shown that Fuller's domes for the use in international trade fairs were drawn from intermediate phases of these prototyping efforts for the military. For example, Fuller was developing a mock-up of a foldable magnesium dome for the Marines, presumably for its Mark-II magnesium dome series at Washington University in the Fall of '54 when the invitation for the Swedish Fair at Hälsingborg (H55 Fair) arrived.[64] Functionally, the exhibition requirements at Hälsingborg could have been

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[60]Ltr. (draft) 4/27/55 RBF to Col. H. C. Lane in BFI-CR165.

[61]Ltr. 4/27/55 W.M. Parkhurst to RBF in BFI-CR165.

[62]Ltr. 4/27/55 W.M. Parkhurst to RBF in BFI-CR165.

[63]Ltr. 4/11/55 RBF to Brig. Gen. Harold E. Watson in BFI-Hev6.

[64]Hälsingborg was slated as an "international exhibition of architecture, industrial design, home furnishings (and) craft" to be held in the South-west coast of Sweden from June-August 1954 (See Ltr. 11/13/54 Ake H. Huldt (Commissioner General, Hälsingborg 1955) to RBF).

fulfilled in the wood strut-cable dome.[65] In early February, however, Dixon reported that it was a 42-ft diameter Mark-II magnesium version that Fuller would send to Hälsingborg.[66] The Marines were aware of this development. Like the Milan Paperboard Dome, another dome project commissioned by the Marines, Fuller argued that the Hälsingborg project was to be undertaken "through private individual initiative by an industrial organization."[67]

This time the retinue of new industrial supporters included Dow (Magnesium Division) and DuPont donating the magnesium structuring and Orlon dome fabric respectively. The local industries provided the machining, and the finishing touch was to convince Cessna Aircraft Industry (Wichita, Kansas) to provide a helicopter to fly the assembled dome from the steamship port of Malmö to the exhibition site.[68] The dome would be self-erected by triggering fist-sized high-pressure gas flasks attached inwardly to the vertex of each tripod sub-assembly. Fuller proposed that these "pneumatically-actuated joints" be triggered by controls from a helicopter. The occasion, Fuller explained to Wallace, would constitute a "finer promotion" opportunity to demonstrate the potentials of Cessna's new light-passenger helicopter, the *CESSNA-CH1*.[69]

Mainly out of civic pride and prestige, the universities and local press echoed Fuller's boosterism and actively championed his work. Such was the case with the Washington University dome, billed a "Flying Seed Pod."[70] Undoubtedly a brainchild of Fuller, the Hälsingborg packaged dome contribution was called "The Follow-through Spirit of St. Louis." In addition, to dramatize its pregnant intent, it proposed that the dome be flown Hälsinborg on the twenty-eighth anniversary of Lindbergh's flight across the Atlantic[71] [Fig.3.17c & d].

Fuller openly admitted that the Mark-II magnesium dome was "very specifically developed for application to National Defense." It was to be "the next wave of structural

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[65] See Ltr. 11/14/54 J. Dixon to Ake H. Huldt in BFI-E series. Ltr. 6/4/55 J. Dixon to D.D. Canfield (Field Office, U.S. Dept. of Commerce) in BFI-CR165, p.1. For details of the first prototype, refer to"A Buckminster Fuller Research Project," Unpl. Report, School of Architecture, Washington University, undated, (ca. Spring 1955) in BFI-EJA Green.

[66] Ltr. 1/13/55 J. Dixon to RBF in BFI-HEv6.

[67] Ltr. 6/9/55 RBF to Dwane Wallace (Chairman, Cessna Aircraft, Wichita-Kans.)in BFI-CR165.

[68] Ltr. 6/9/55 RBF to D. Wallace in BFI-CR165.

[69] Ltr. 6/7/55 D. Wallace to RBF in BFI-CR161: Wallace declined for Fuller's request, explaining that the helicopter was still under CAA flight tests.

[70] See Washington University, St. Louis-Mo., Unpubl. mimeo "Major Goal - Present New Method of Building to World and 'Follow-thru' Spirit of St. Louis," undated, in BFI-E Series; also Lloyd Green's "St. Louis Envisioned as World Center of Global Air Routes," *Globe-Democrat Magazine*, 20 Feb. 1955: capitalizing on Fuller's prediction of St. Louis becoming the "Air Age Hub of North America."

[71] Ltr. 1/13/55 J. Dixon to Ake H. Huldt in BFI-HEv6.

advantage gain," where erection was done in "45 man-seconds."[72] The primary innovation was in a trigger mechanism that would erect both structure and skin of the geodesic dome simultaneously. The advance base project of the Marines had, by this time, sharpened Fuller's appreciation of the finer points of designing for "zero installation time." Winning or losing grand strategy operations, Fuller argued, depended on this factor.[73] Fuller openly used the military parlance of "hitting power factor" in describing the technical improvement.[74]

The Hälsingborg Project did not materialize. Unlike the paperboard dome which had at least two years of head start in prototyping; several features of the new dome created insurmountable problems, causing delays in getting the geodesic dome ready.[75] First, the universal joint design required more complex technical skills than the students could muster in the short time. In the course of the design, for example, a decision was taken to use a harder alloy of aluminum rather than soft magnesium.[76] Second, the foldability of the dome created new performance requirements on the fabric skin. It had to withstand severe abrasions which had caused severe water-proofing problems. Even Du Pont was hesitant to recommend its highly resistant-coated Orlon.[77] Third, there was confusion over the functional specifications of the skin, whether to put it on a track system, to act as a variable sun shield.[78] Finally, there was a "crisis of man-power" to mobilize the project close to the due date.[79]

3.2.1.8. Marine Domes -- An Assessment

The open and public prototyping of the Hälsingborg Dome, like the earlier Marine domes, posed numerous questions. Were the Marines concerned with any potential security breach of secrecy, given Fuller's claim that the project was specifically for "national defense"? On the other hand, did Fuller exaggerate the projects to give them the appearance of a national urgency, as he did with all his projects, in order to garner patriotic support from industry?

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[72]Ltr. 6/1/56 RBF to John Talbot in BFI-CR175.

[73]Ltr. 10/13/54 RBF to Col. H.C. Lane in BFI-CR163.

[74]Ltr. 11/15/54 RBF to Col. H.C. Lane in BFI-CR16.

[75]See Ltr. undated Messr Wilson's American Co. Inc. to B.L. Pickens (Dean, School of Arch., Washington Univ.) in BFI-E Series.

[76]See "R. Buckminster Fuller Research Project. A Report," in BFI-EJA Green; also Ltr. 4/13/55 B.L. Pickens to RBF in BFI-E Series.

[77]See Ltr. 7/1/55 B Shapiro to RBF in BFI-E Series; also Ltr. 4/14/55 R Fuller (Textile Fibers Dept-Du Pont) to RBF in BFI-E Series.

[78]Ltr. 3/1/55 J. Dixon to Bennett Shapiro in BFI-E Series.

[79]Ltr. 6/7/55 B.L. Pickens to RBF in BFI-E Series.

Fuller seemed undeterred by such risks and he publicly conducted and promoted these activities impetuously. The Marines also did not appear perturbed by his behavior. Rather, their own actions suggested that they, too, were openly responsible for fanning the industries' interests and commercial desires. In fact, the outstanding tension between Fuller and the Marines at this stage was over the issue of royalties and contractual agreements. Fuller even threatened to proceed with his research agenda with or without their support, even though he would "bring it to a tight focus on the M.C. (Marine Corps) Aviation needs." Fuller expressed his interests to Col. Lane in these terse terms:

> You know Hank that I am not kicking ... I was not going after the services business and that I clearly stated my requirements that my development equities must not be put in jeopardy. I would not and ever had any thought or willingness to sell my ideas outright - certainly not to lose them outright.[80]

There are two possible explications of Fuller's public prototyping of supposedly military-strategic ordnance. Ensuing from his letter above, one could propose that the Marines left him with few options. As much as the military armed forces initially provided him the stage and patronage to jump-start his enterprises, there was finally no firm or extended commitments for the work. With the new horizon of peaceful uses of the geodesic artifacts appearing in the trade fairs and possibly as rapidly-deployable shelters, the needs of the Marines became secondary.

A second reason one could suggest was that the military-strategic values of the geodesic artifacts were over-hyped. They were, in the end, low-priority military components.[81] This should be contrasted with the quiet mainstay of President Eisenhower's effort to prevent surprise attacks from the Russians -- the strategic ballistic missiles. Preventing a surprise thermonuclear attack rather than an outright offensive, McGeorge Bundy proposed, was the predominant strategy of the Eisenhower years.[82] He cited that the primary effects of the 1955 report, "Meeting the Threat of Surprise Attack" by The Technological Capabilities Panel (TCP), were in accelerating the development of ballistic missiles and the development of early warning systems. From a strategic point of view, ballistic missiles, albeit shorter-range ones, make redundant the necessity of advance bases. For this reason, the DEW-line radomes, unlike the Marine logistics-shelter domes, required a higher level of security clearance.

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[80] Ltr. (Draft) 4/27/55 RBF to Col. H.C. Lane in BFI-CR165.

[81] See the presentation of the Marine geodesic structures alongside the *The Corporal* (a guided surface-to-surface missile) and *James Forrestal* (the world's biggest 60,000-ton carrier) in "Military Highlights of 1954," in *Army Times Magazine* (Washington D.C.), 1 Jan. 1955, p.8.

Fuller's domes were readily and indeed, eventually replicated by the Russians with minimal technological-industrial mobilization. Perhaps because of the significant inaccuracy of ballistic missiles at this point, the public display of advance base capabilities in the lightweight logistics-shelters along with conventional firepower provided a degree of deterrence against potential Soviet aggression. As a way to test Soviet military and political intentions, the prospect of advance base would be considered, in military parlance, a "soft" tactic in the war of nerves. This was neither about containment nor about disarmament.

One could argue that the Marine dome project probably fulfilled many roles. Firstly, it augmented in a practical way the effectiveness of the conventional weapons. Second, it was also used as a carefully crafted smoke screen to disguise other tactical developments. Third, it enabled the Marines to hype its own contribution to the national defense endeavor, and to give it a high public profile. Competition among the different branches of the Armed Forces for prestige and allocations for defense funding was a primary motivation that Fuller clearly appreciated. Fuller proposed that the "anticipatory initiatives of the U.S. Marines gave them a 'three and one half year lead in the U.S.A. logistic initiative in respect to other branches of the National Defense."[83] While geodesic constructions did not stay in the military picture, it did "stir great activity in the several branches to design their own lightweight structures (non-geodesic)" as Fitzgibbon predicted.

The Marine-Fuller alignment sparked off the interest of the Department of Defense in logistics shelter, edging it towards "unifying building types and requirements for all services wherever possible."[84] The task to consolidate military research and develop building programs of all the branches of the Armed Forces (Army Engineers- Fort Belvoir, Army Quartermasters, Army Engineer Aviation, Navy Yards and Docks, Signal Corps, Rome Air Base-Griffiss Field, Air Force R & D and Marine Ground Corps & Marine Aviation) under one agency was openly contentious. Given their respective investments in research and development, inter-branch rivalry was expected. The Navy Yards and Docks opposed the use of geodesic structures; and the only other client that Geodesic Inc., managed to court was the Quartermaster (Nattick, Mass.). The Marine Corp, Fitzgibbon observed, despite its enthusiasm, was not empowered:

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[82]McGeorge Bundy, *Danger and Survival*, New York: Vintage Books, 1990, especially pp.325-327.

[83]See Ltr. 6/30/56 RBF to Maj. George J. King (Division of Public Information, Hdqrs. USMC, Washington D.C.) in BFI-CR178.

[84]See J.W. Fitzgibbon's "Memorandum: Defense Department Show," in BFI-CR163, which reported the Department of Defense sponsored Military Building Program Conference at Quantico, 10/11/55.

> The military shelter program, centered as it has been in the Marine Corps and by Secretary of Defense order kept out of the hands of the other services, has both benefited and suffered. It benefits by fairly adequate testing and evaluation and promise of procurement. It suffers because the Marines have no research and development money and the most limited budget of all the service units, and that has hit us hard.[85]

Finally, and most importantly, the presentation of the Marine dome project in the American media was for occasional public titillation and assurance. Public excitement over the logistics advantage made possible by the geodesic structuring fueled more fantastic speculations about the American military prowess. In one projection, the expanded advance base would contain platforms "to launch fighter planes and atomic bombers (and) guided missiles"[86] [Fig.3.45].

The heroic message was that America's power and position in the world political arena cannot be so readily relinquished, given the ever-vigilant extra-military initiatives of spontaneous individuals and private enterprises [Fig.3.46a & b]. Dixon articulated the political dimension of the Marine dome project as one that epitomized the individual function in democratic society. He recorded that the military was enthusiastic in Fuller's enterprises despite its small size and civilian constitution. These qualities, he surmised, fulfilled Eisenhower's ideology of private initiatives and the philosophy of the individual.[87]

These considerations aside, the military involvement in the projects and the heightened condition of the Cold War did not prevent some of Fuller's close collaborators of the prototyping activities from harboring fears of potential security leaks. For instance, even as Dean Pickens was preparing the Washington University dome for the Hälsingborg Fair, he questioned Fuller about its ominous consequences:

> view of the desire on part of the Armed Services to use geodesic structures, whether you would deem it wise to put this thing out for public display and possible pirating by designers from behind the Iron Curtain or elsewhere... We could not help but wonder whether your recent success with the military overshadows the importance of the Hälsingborg exhibit?[88]

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[85] Ltr. 3/27/56 J.W. Fitzgibbon to RBF in BFI-CR173.

[86] "Warm Bubble in the Arctic," *Boston Daily Globe*, 30 March 1955.

[87] See J. Dixon/RBF, Preparatory Notes "Strategy Talk," 7/29/55, Truro-Mass. in BFI-CR166.

[88] Ltr. 4/27/55 B.L. Pickens to RBF/J. Dixon in BFI-CR165.

The height of prototyping activity for Geodesics Inc. (Raleigh) was reached with the Marines escapade. Many prototype projects military domes were advanced[89] [Fig.3.23a - g]. However, only a few of these domes were realized or developed. The situation was exacerbated by the Marines' misconception of prototype as production-ready model, despite, Fitzgibbon explained, many unresolved details and dimensional errors in these prototypes. Further, he confessed:

> We have never made a prototype in which the savings effected in material reduction, part simplicity and general improvement have not resulted in potential savings far beyond the small sum involved in the prototype itself.[90]

The Marines purchased an undisclosed number of domes, but the geodesic structures did not form the staple element in the Marines' shelter-logistics which both Col. Lane and Fuller envisaged. T.C. Howard related an eyewitness account of the ironical fate of these domes. They were relegated to a series of underground bunkers along with other emergency supplies, to be used in the eventuality of a war. The domes, he proposed, were never for the Marines anyway; rather, "they were always intended to be part of the great buried vaults inventory." For T.C. Howard, the Marine project was a "good exercise but a very bad business venture" and he blamed Fuller's decision not to get directly into manufacturing domes.[91]

Over three years (1955-57), the account receivable of Geodesics Inc. (Cambridge) consistently showed a higher turnover than Raleigh, with radome business clearly exceeding the Marine domes.[92] In 1955 alone, Fuller received $4003.15 from Geodesic Inc.-Cambridge, representing 5% gross annual sales.[93] This study was not able to ascertain the total profit accrued in all military-related geodesic projects. By Fuller's projection, dome earnings was "approximately $3,000,000" based on the figure of one thousand geodesic domes of 42', 55' and 110' classes undertaken by his various dome enterprises.[94] These claims were probably exaggerated: the actual figure was considerably less. Robertson had haggled with the BuAEr

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[89] See "Rotating Geodesic Missile Shelter - Arctic," "Geodesic Dome Octet Truss Retractable Shelter," "Geodesic Dome Frame & Tent Shelter - Tropic," 2/20/56 in BFI-CR173.

[90] Ltr. 3/26/56 J.W. Fitzgibbon to RBF in BFI-CR173.

[91] Notes from Author's Interview with T.C. Howard, Raleigh-N.C., 4/26/95.

[92] See "Accounting Data for Synergetics & Geodesics" in BFI-Archive Box2.

[93] Ltr. 10/13/55 Geodesic Inc. to RBF in BFI-CR167.

[94] Ltr. 6/1/56 RBF to J. Talbot in BFI-CR175. See also Ltr. 7/19/56 RBF to Walter O'Malley in BFI-CR178: mentioned Marine's purchase of 600 42-footer, with bids in for 500 55-footers; also Ltr. 11/25/55 J.W. Fitzgibbon to RBF in BFI-CR168: mentioned of the rescheduling of Marine dome 55-foot orders from "800 units from 1956 to '57."

over royalty for mere twenty-eight geodesic dome aircraft shelters in 1955.[95] D. Blosser enumerated the procurement of the Marine Corps, Aviation Branch, ending in 1957 with: 26 (55-footers), 312 (42-footers of 2-frequency type), 36 (42-footers of 3-frequency type) 107 (57-footers); with accounts of outstanding dome problems threatening Marines' decision to "drop geodesics entirely."[96]

3.2.2. Geodesic Rigid Radomes (1953-64)

Like the Marine domes, the geodesic rigid radome was developed through the initiatives of Fuller's enterprise, this one based in Cambridge, Massachusetts. Radome, a contraction from radar-dome, referred to a class of dome structures developed initially by the Industrial Division at Cornell Aeronautical Laboratory (CAL) to house radar antennas.[97] CAL radome research directly benefited Rome Air Force Development Center (RAFDC, Griffiss Air Force Base at Rome, N.Y.); the latter subsequently offered the greatest resistance to the acceptance of geodesic rigid radomes. The pneumatic structure was the trademark of CAL. The developmental works started in 1946 and culminated in Walter W. Bird's inflatable rubber radome in 1955.[98] Ironically, this was despite CAL own conclusion that inflatable radomes were "not viable."[99]

Given the low reliability of guided missiles in the opening years of the Cold War, radomes were deemed significant tactical components to be deployed in the early-warning radar network around the periphery of the Soviet Union and its satellite states [Fig.3.31a]. Eventually, three lines of early warning systems were developed with American-Canadian cooperation: DEW (with over 50 radar stations completed by 1957; constructed and manned by U.S.); Mid-Canada (55th Parallel, Canadian) and Pinetree (Canadian-American). All three lines were tied to one combat operations headquarters of the joint command at Colorado Springs, Colorado when NORAD was formed in May 1958.[100]

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[95]See Ltr. 5/11/55 D.W.□ Robertson to Chief (BUAer) in BFI-CR172.

[96]Ltr. 11/29/57 D. Blosser to Geodesic, Inc. in BFI-CR191.

[97]"Cornell Aeronautical Lab (CAL) Inc.," Annual Report of the Cornell Aeronautical Laboratory, Buffalo-N.Y., 1951, p.16.

[98]See *Cornell Aeronautical Laboratory Inc. Buffalo: A Decade of Research, 1946-56*, Buffalo, N.Y., 1956 and CAL's *Design Manual for Spherical Air supported Radomes* (UB-664-D-1).

[99]See "Radome Shields Radar from the Weather," *Wave Guide* [Newsletter of Griffiss Air Force Base] Vol. 7, No.209, July 19, 1956, p.5.

[100]See also Richard Morenus, *Dew Line. Distance Early Warning, the Miracle of America's First Line of Defense*, New York: Rand McNally, 1957.

In the light of the burgeoning air defense budget, the radome was a sure-fire commercial proposition. However, the state of the art radomes in the early fifties were neoprene-coated fabric inflatable structures that were highly unsatisfactory because of cost as well as the high failure rates under extreme Arctic conditions [Fig.3.30a & b]. For this reason, Fuller himself actively promoted the geodesic solution when the Procurement Office, R & D Command at RAFDC, planned on a major acquisition of radomes.[101] Lindsay had similarly identified, early on, the radome application as a viable market for the geodesic structures. Operating from Canada and in close touch with the Canadian Air Force, Lindsay was aware of the radome development. In May 1952, he brought to Fuller's attention a feature on the radome in *Scientific American* (May 1952). More significantly, he provided a first-hand account of radome problems, based on his visit to "the largest radar station in North America":

> The radome (is) a three-quarter sphere balloon of fiberglass and neoprene seal inflated to 1 pound above outside atmospheric pressure... The affect was extraordinary. Men get dizzy (like notion sickness) inside because there is no apparent horizon. If the dome is lighted to 'daylight' intensity, it is like being in a '3rd degree chair'. The light penetrates horribly ... Six 6-inch potholes easily light the unit for general movement without straining the eyes.[102]

But it was through William Ahern, one of Fuller's former students at MIT, that the first venture in geodesic rigid radomes was undertaken[103] [Fig.3.31b].

From 1952-54, Ahern was an architect at the Building & Grounds division of Lincoln Lab-MIT, designing and constructing radar site buildings. Like CAL, Lincoln Lab was an applied research institution and a direct beneficiary of defense contracts spurred by the Korean War. Lincoln Lab was created in 1951 at the request of the Armed Forces for MIT "to improve United States Air defense capabilities in light of the growing threat of atomic attack."[104] In light of its developmental works on radar, the radome was a natural follow-through product.

John Vitale, Ahern's divisional head (at Operating Project Lincoln) was looking for an alternative solution to CAL's inflatable radome that would be rigid but still soft (with the least

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[101] See Ltr. 5/27/55 RBF to Procurement Office, R & D Command (RADC, Griffiss Air Force Base, Rome-N.Y.) in BFI-CR165: proposal to undertake Air Force Procurement Directive, No. 332050, 5/22/55.

[102] Ltr. 5/21/52 Jeffrey Lindsay to RBF in BFI-CR139.

[103] For bio-data of W. Ahern, see "Geometrics Inc.," *Architecture & Engineering News*, November 1964. Ahern had previously worked in Carl Koch's office, designing and developing prefrabricated building systems (See Robert L. Levy, "Builders Still Waiting For the Day of the Dome," *The Boston Globe*, 5 Nov. 1970, p.5).

[104] "Symposium on Rigid Radomes," Proceedings MIT-Lincoln Laboratory, 8-10 Sept. 1958, p.2. Besides the large radome, Lincoln Lab also developed huge transmitting/receiving system; Chipmunk (smallest of radars), TX-2 (transistorized experimental computing machine for data processing) and the miniature tube (Cyrotron, a superconductive computer component).

material) for radar penetration. Ahern brought this piece of intelligence to the attention of Fuller. Ahern contacted Fuller in January 1953, offering the potential of collaborative work on the radome project.[105] Ahern recognized the larger commercial scope beyond the geodesic radomes, and offered Fuller potential collaborative work on the octet-truss antenna tower, Arctic troop shelters and other novelty artifacts in his portfolio.[106]

Fuller, in turn, engaged William Wainright and John Williams, two of his students at MIT in 1952.[107] By February 1953 the first contract for an 18-ft geodesic radome test-section was secured.[108] Williams, Fuller's "technical representative," translated his earlier scheme of diamond interlocks into polyester resin bonded fiberglass mat sheets with reinforced edges and notches to be held together by non-plasticized poly vinyl chloride bolts.[109] After almost a year of design and testing on a 31-ft three-quarter spherical prototype[110] [Fig.3.33a & 3.33b], a full-fledged 55-ft seven-tenth geodesic radome prototype was assembled at Huntington, Rhode Island in August 1955. It established the record as the largest rigid plastic structure and it was assembled by eight workers in 288 man-hours[111] [Fig.3.32].

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105 Ltr. 1/8/53 W. Ahern to RBF in BFI-E Series.

106 See Ltr. 2/20/53 W. Ahern to RBF in BFI-E Series & Ltr. 3/18/53 RBF to W. Ahern in BFI-E Series.

107 Notes from Author's Interview with William Wainwright, Boston-MA., 4/19/95. Williams and Wainwright extended the fiberglass pan-type developed by Lindsay at ID-Chicago. Having studied at ID-Chicago under K. Wachsmann from 1949-52, Wainwright was probably familiar with Lindsay's experimental dome-work. Lindsay recorded that he had paid $500 for plastics for a "radome prototype which did not materialize" in 1949 (See Ltr. 3/24/61 J. Lindsay to W.M. Parkhurst in BFI-CR218).

For reasons unknown, Williams relinquished this prototyping to Wainwright and P. Floyd, who were conducting architectural Monsanto-sponsored research on plastics in housing for the Bemis Foundation. The first test section for a 18-foot geodesic radome was tested at Koch's Acorn work-site. Wainwright, Floyd and Kirschenbaum (Wainright's classmate at ID-Chicago) subsequently formed Geometrics Inc. to develop the 55-footer radomes (Notes from Author's Interview with B. Kirschenbaum, New York-N.Y., 10/5/94; Notes from Author's Interview with William Wainwright, Boston-MA., 4/19/95)

108 Ltr. 2/7/53 RBF to J.A. Vitale (MIT-Project Lincoln) in BFI-E Series, with price quote for supplying a test section of 18-foot dome (See also Lincoln Laboratory Purchase Order#16732, 2/9/53 in BFI-E Series). The report of the January 1953 test section was reported in "Quarterly Progress Report, Div. 7 Lincoln Lab, April 15, 1954" by the Engineering, Design & Drafting Group 71 comprising of William Ahern, C.A. Orne, Jr., P. Stetson (See copy in BFI-Archive Box2).

109 Ltr. 2/2/53 J. Williams to RBF in BFI-E Series.

110 The first was a 31-foot geodesic radome for the Signal Corps, Fort Monmouth-N.J. (See Ltr. 6/1/54 W. Wainwright to Signal Corps in BFI-G17.2).

111 Everett M. Smith, "Geodesic Dome of Lightweight Metal and Plastic Provides Quick Shelter. Sphere's Entire Strength Contained within surface," *The Christian Science Monitor*, 13 Jan. 1956, p.13.

3.2.2.1. Dome Works and the Division of Labor

Despite Fuller's interest in radomes, Wainwright observed that Fuller was neither technically competent to realize the prototype nor had he any insight about "dome-buckling." He noted that Fuller had just entered his Paperboard phase of his dome experimentation. This entailed making a dome out of flat and lightweight material like corrugated cardboard, and hence the name Paperboard. With the geodesic rigid radome project, Fuller tried to use fiberglass like paper by notching them together. Though conceptually elegant as a paper model, the technique was deeply impractical since it produced "many parts" and "funky joints" which resulted in leaks.[112] While this might be partly true in the early months of the prototyping, Fuller gradually showed interests in detailed aspects of the radome fabrication, especially in the production and structural implications of Wainwright's proposed die modification for the dome panels.[113] Fuller also contributed to the refinement of the radome by proposing the inclusion of circular openings at the joints to remove the crowding of the flanges that tended to create a "silhouette" for the radar equipment [Fig.3.32 c/f Fig.3.33a]. Further, capping this hole, he proposed, ensured water tightness.[114]

While most of Fuller's collaborators in his dome enterprise provided consistent accounts of his lack of technical finesse in the prototyping activities, the geodesic radome phase of Fuller's works singularly demonstrated their general independence from his influence. By Fuller's account, he implied that the geodesic radome development, though historically attributed to him, was abducted from his control. T.C. Howard recounted that on many occasions, Fuller accused "these guys (Wainwright, Williams and possibly, Floyd) at MIT" of "opening (his) mail."[115] On the other hand, Kirschenbaum offered that in the early prototyping phase Fuller was "not in the picture at all" despite the defense security rating and urgency of the radome after the Saturn rocket project.[116]

Like the other Fuller enterprises, the collaborators partially financed their respective prototyping activities, and in this case, Wainwright claimed that though this practice aroused Fuller's "suspicion," it did not translate into open objections.[117] The Cambridge operation was

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[112] Notes from Author's Interview with William Wainwright, Boston-Mass., 4/19/95.
[113] See Ltr. 11/21/54 W. Wainwright to RBF in BFI-CR256 & Ltr. 12/6/54 RBF to W. Wainwright in BFI-CR256.
[114] See Memo.20/12/54 RBF to W. Wainwright in BFI-CR256.
[115] Notes from Author's Interview with T.C. Howard, Raleigh-N.C., 4/26/95.
[116] Notes from Author's Interview with B. Kirschenbaum, New York-N.Y., 10/5/94.
[117] Notes from Author's Interview with William Wainwright, Boston-Mass., 4/19/95.

managed totally by Wainwright and Floyd, even at a point when Ahern suggested that "the radome possibilities" had reached a point requiring some rational corporate-business actions.[118]

To understand this curious relationship between Fuller and his associates, one had to locate the geodesic radome phase at a time when Fuller was in the midst of his other half-completed and more important conceptual dome pursuits. The Paperboard Dome project (1951) which he started at Yale was emblematic for his projected ephemeral shelter while the Minni-Earth Dome project (1955) at the University of Minnesota was a symbolic, pedagogical eyepiece. The Princeton Tensegrity Dome project (1953) promised the first demonstration of spherical tensegrity, further clarifying the geodesic principles of structure as energetic circuits. Finally, two high profile, yet incomplete public applications of the geodesic structures were straddled with problems. The foundation details and skinning solutions of Gunnar Peterson's restaurant dome at Woods' Hole were uncertain;[119] and Fuller's installation of the Ford Rotunda Dome was threatened by changes in the jig-assembly and labor strikes.[120] By the end of 1954, when the quotations for the prototype and mass production of the 31 3/4 foot spherical geodesic radome was issued to Lincoln Lab, Fuller had two other clients in waiting - the Marines and *Interiors* magazine.[121]

Fuller's ambivalence towards the initiatives taken by the employees, manifested as eagerness yet strange reluctance, could also be described and explained at several levels. It stemmed primarily from the division of labor in his dome enterprises. He remained suspicious of employees' intents and never adequately credited their often seminal roles in advancing his structural concepts, whether this entailed locating geodesic works in the context of architectural culture or in working out their respective technical issues of production and assemblage.[122] This reluctance in sharing credit had been attributed to the residual late-Victorian value of individualism which Fuller never totally purged, and Fuller's phobia from numerous experiences

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[118] Ltr. 4/26/54 W. Ahern to RBF in BFI-CR256 and Ltr. 4/29/54 RBF to W. Ahern in BFI-CR256.

[119] Telegram 4/22/53 E.G. Peterson (Falmouth-Mass.) to RBF in BFI-E Series. See also Ltr. 5/15/53 R. Hamilton to RBF in BFI-HEv4; Ltr. 10/18/53 W. Wainwright to E.G. Peterson in BFI-E Series; Ltr. 11/17/53 P. Floyd to RBF in BFI-CR155; and Ltr. 4/24/53 RBF to D. Stuart in BFI-CR147.

[120] Ltr. 3/9/53 RBF to William Groves in BFI-HEv6. See also Ltr 4/22/53 G.A. Welch to J.A. MacAlarney in BFI-CR162 regarding the strike of the American Federation of Labor Carpenters' Union.

[121] Ltr. 1/1/54 W. Wainwright to J.A. Vitale (Project Lincoln) in BFI-CR256. At this point, the Air Force had considered the rubber radome (of CAL) "not worth bothering with" (Ltr. 4/20/54 W. Wainwright to RBF in BFI-CR256).

[122] Recalling the momentous display of three geodesic structures (the radome, tensegrity mast and radome) at MoMA, most of Fuller's collaborators felt their contributions were generally unrecognized in his hour of triumph. Kirschenbaum felt that a grievous omission was that the DEW-line dome exhibited was not credited to him and

as a victim of "double-cross."[123] On the issue of attribution, Wainwright recalled Fuller's general discomfort with his initiatives:

> I know that (Fuller) told Bill Parkhurst once, 'I don't know if this is a Bill Wainwright radome or a Bucky Fuller radome or what it is.'[124]

Ironically, many of the important dome projects that had been historically attributed to or publicly identified with Fuller were realized despite him. While Fuller openly professed confidence in his structural artifacts and pontificated over the "failure mystique," he was, paradoxically, gripped by inaction when opportunities for the implementation of the structures arose. At several pivotal moments, his anxieties even prompted him to stop the projects.

Kirschenbaum recounted Fuller's fear in undertaking the first consignment of 55-ft radomes by Western Electric; and how he spent the wee hours of one morning at Forest Hill, New York "beat(ing) him down."[125] T.C. Howard similarly recounted that on the Union Tank Car Dome (UTLx) and the Climatron of the Missouri Botanical Garden (MBG), Fuller "almost had a nervous breakdown" and was scared out of his wits. On the Climatron which was executed primarily by Synergetics Inc. (Raleigh) after Fuller had relinquished his business share in the company, Fuller even bet with Pete Barnwell, one of the company's associate, that the dome would collapse within a year.[126]

While it was probably prudent for Fuller to be over-cautious in restraining the initiatives of his employees and associates; in most cases, it was ironically Fuller's own publicity hype that edged them along. Fuller's general fear of building was ironically not about the fear of the untried; rather it was about his fear of the real and practical realities of the built world. Clearly, in any act of building, there is a loss of innocence and this contributed to his anxiety to undertake works beyond the prototyping stage. Further, prototyping activities in architectural practices were rare. The uncertain and untested capacity of his architects-associates and the prospects of real projects naturally intensified his doubts about undertaking built projects.

Wainwright. Likewise, M. Fitzgibbon reported that the conception and installation of the octet truss was primarily T.C. Howard's efforts (Notes from Author's Interview with M. Fitzgibbon, St. Louis-Mo., 9/15/94).

[123]Notes from Author's Interview with J. Baldwin, Santa Barbara-Calif., 5/5/95.

[124]Notes from Author's Interview with William Wainwright, Boston-Mass., 4/19/95.

[125]Notes from Author's Interview with B. Kirschenbaum, New York-N.Y., 10/5/94

[126]Notes from Author's Interview with T.C. Howard, Raleigh-N.C., 4/26/95.

Fuller's geodesic enterprises were hardly peopled by mendacious prospectors or investors; in fact, they were mainly recent college graduates or young faculty members persuaded by Fuller's idealistic mission based on the technology of plenty and driven by the uncertainties of the untried. Otherwise, they and many others operated under the good faith of his licensing agreements. In this way, the Lindsay and the Brewer House episodes in the early years of the dome enterprise, along with Fuller's continual general distrust of and perceived need to control, added to what could justifiably be termed a pathological pattern of insecurity.

3.2.2.2. The Geodesic Rigid Radome -- An Assessment

The geodesic rigid radome proved to be the most profitable of Fuller's dome enterprises, primarily because it substantially out-performed the rubber radome with considerable cost reductions. It was a highly specialized but hardy instrument, capable of withstanding high Arctic winds and the unpredictable weight of ice built-up.[127] The challenge posed by the radome design aptly suited the potentialities of rigid, fiberglass geodesics. For a start, the operation of the radar necessitated a minimal enclosure that should not reduce the power of its signals. The 7/10 sphere provided an almost optimal configuration. Given that it enclosed equipment rather than humans, a radically low factor-of-safety for design was acceptable, allowing the extreme limits to be tested. In this way, and in its new use, the geodesic radome design circumvented the obstacles of building and safety codes.

Geodesic Inc. (Cambridge) radomes were made from vacuum-bag molded panels with gasketted flanges and held in place by phenolic-laminated fasteners. The 3/4 sphere, 31-ft rigid polyester fiberglass radome on Mt. Washington, installed since October 1954 for Lincoln Lab, weathered without any deflection with 182mph winds.[128] More importantly, the commercial impetus came directly from large defense contractors who prized the rigid radome as a technological edge that enabled the housing of larger radar equipment[129] [Fig.3.34].

The size of the radomes quickly moved from 31-footer to 50 to 55-footer after less than a year of prototyping activity. By January 1955, Geodesics Inc. was already procuring the contract to supply Western Electric, a subsidiary of the Bell Telephone System, with twenty-nine 50-

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[127]For structural performance of the radome, see Howard Simpson's "Report on the Structural Analysis of a 31' Diameter Radome," ca. Oct. 1954 in BFI-CR256.

[128]Ltr. 4/11/55 RBF to Brig. Gen. Harold E. Watson in BFI-HEv6.

[129]Ltr. 10/21/54 Bendix Radio to W. Ahern in BFI-CR256: Bendix was developing a group of "C" band sets of radar, using R.F. transmissions for Arctic installations even though Lincoln Lab radomes were tested on FPS-8 radar antenna of "L" & "S" band transmission. See aslo Ltr. 10/28/54 W. Ahern to Bendix Radio in BFI-CR256.

footer geodesic radomes.[130] Other prime defense contractors included Westinghouse Electric Corporation & RCA Victor.

For Fuller, Lincoln Lab, as a sanctioned and eminently-placed research center, provided the prestige for future recommendations of the geodesic rigid radome to various departments of defense and industries. Fuller was familiar with and congenial towards the role of Lincoln Lab as a "special corporate utility" within MIT.[131] Thus, under the existing arrangement of prototyping activities with Lincoln Lab, Fuller's enterprise in Cambridge, recently corporatized as Geodesics Inc. along with the Raleigh office, was a well-poised sub-contractor to larger, prime defense opportunities. Parkhurst, Fuller's legal counsel, appreciated this advantageous position, when he reported to Fuller the meaning of recent inquiries from industries:

> (I)t was most likely companies or contractors having prime contracts with the Government for the furnishing of radar defense mechanisms and the housing thereof would be most likely to approach us.[132]

Unlike the Marine dome prototyping activities, the relationship of Fuller's enterprise to the industries in the radome project was more direct because there was only one principal construction material, polyester resin fiberglass. Though Geodesic Inc.-Cambridge prototyped for the armed forces, its immediate clients were the prime defense contractors. This arrangement did not occur with Geodesics Inc. (Raleigh). It did not divorce its middle role as a professional consultant to the Armed Forces and this created tension points with the actual fabricators. While Raleigh kept viewing their works as prototypes, the fabricators constantly worried about their tool-up costs and assumed that they were executing a complete product. The dispute in the 117-ft Marine dome between Geodesics Inc. (Raleigh) and Washington Aluminum over dimensions and soundness of engineering, and production operation, illustrated one of many such instances.[133]

The geodesic radome fabricators did not have to incur research and development costs to develop better polyester resins, since they were already a large-volume industrial material undergoing accelerating improvements. The material industries assumed that role directly while the fabricators' primary capital cost lay in better equipment and processes to maintain a competitive edge. In the hub-strut and tent geodesic structures of Geodesics Inc. (Raleigh), the

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[130] See Ltr. 1/17/55 Geodesics Inc. to Western Electric in BFI-G17.2; also "Western Electric Named to Build Big Radar Net," *New York Telegraph and Sun*, 21 Feb. 1955, p.22.

[131] Ltr. 8/17/57 RBF to Frank Laucomer in BFI-CR188.

[132] Ltr. 11/2/54 W. Parkhurst to RBF in BFI-CR159.

[133] Ltr. 12/12/55 J.W. Fitzgibbon to RBF in BFI-CR171.

material combinations were more extensive and varied, and the cases of patent infringement were more frequent. For example, the uncertainty over the proprietorship of fabricator-derived innovations was vividly demonstrated in the case of the geodesic catenary tent. In the context of licensing Silva Tent & Awning Co. Inc., one of the main providers of Synergetics Inc. trade dome tents, Fuller evoked the "principle" of his geodesic patent to claim proprietary control over Silva's fabrication methods. He claimed that these tents as "geodesic tensile skins of high-frequency module complex" were complex "constructions" and that the separation of skin and structure were expedient categories of trade and technology.[134]

The geodesic rigid radome depended primarily on the uniqueness of the geodesic geometry, with technical sophistication and proprietary features more clearly established in the details of the flange design and gasketing. As a sub-contractor, Geodesic Inc. (Cambridge) could opt for fabricators of their satisfaction.[135] Thus, when Universal Moulded Products Corpn. planned to increase cost and refused to adjust its dies for the base parts of the geodesic radome fabrication, Geodesics Inc. readily opted for Lunn's advantages in fabrication: higher resin to glass ratio and higher tooling quality.[136] Other fabricators like Bigelow Reinforced Plastics assured even better quality using "pressure" rather than vacuum bag for manufacture.[137]

Even under this arrangement, there were occasions when one prime contractor, Western Electric, attempted to claim ownership of the tools, with the objective to undertake independent procurement in the future. This, Fuller's legal counsel, Parkhurst argued, was an infringement of his patents.[138] Such infringement was not confined to industries alone. At one point, Rome Air Force Development Center (RAFDC) procured copies of drawings & specifications for a 55-ft radome (5006-C rigid radome) of Western Electric Co. Inc., presumably from Lincoln Lab, with the intention either to produce its own specifications for rigid radomes or to speed up the procurement process.[139] Lincoln Lab, on the other hand, under the pressure of their own radome research initiatives to compete against and replace the inflatable and honeycomb core radome

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[134]Ltr. 12/9/55 RBF to D. Robertson in BFI-HEv2.

[135]Fuller's enterprise in turn sub-contracted the dome fabrication to various fiberglass fabricators (Universal Moulded Products Corpn.-Virginia; Lunn Laminates Inc.-Long Island; Goodyear Aircraft Corpn, Akron-Ohio, Bigelow Reinforced Plastics and Carl Beetle Co.) on a competitive basis. At one point, this included a pleasure boating fabricator; Beetle Boat Co., New Bedford-Mass. (See Ltr. n.d. Messr. Beetle Boat Co. to RBF/W. Wainwright in BFI-G17.2).

[136]Ltr. 3/2/55 W. Wainwright to RBF in BFI-CR256.

[137]Ltr. 11/21/55 Messr. Bigelow Reinforced Plastics to W. Wainwright in BFI-G17.2.

[138]Ltr. 4/26/56 W.M. Parkhurst to RBF in BFI-CR177.

[139]Ltr. 7/10/56 W. Wainwright to H. Fitzpatrick (Lincoln Lab) in BFI-CR177; Ltr. 12/5/56 S. McKittrick to W.M. Parkhurst in BFI-CR181.

structures promoted by RAFDC, altered the tools of Geodesic Inc. to produce their own version of "cut-down" radomes.[140] Lincoln Lab also tried to develop its own design of the 150-ft radome (publicly issued as bid #IFB 30-635-58-1 for 150' Rigid Radome CW-412), on a geodesic geometry based on a dodecahedron breakdown rather than an icosahedron one, in order to circumvent Fuller's patent.[141]

When geodesic radomes entered the production line in mid-year 1956, it became obvious to Fuller's collaborators in Cambridge that the enterprise's makeshift activities were unacceptable to corporate practices. Aside from the personal reasons that the collaborators offered for seceding from Geodesic Inc., it was also clear that the "research development and prototyping function" of Fuller's corporate instrument was partly restrictive.[142] More importantly, Fuller's first corporate client, Western Electric, then appointed the prime contractor of the first thirty-one radomes of the DEW-line, was seeking ways to by-pass the services and controls of Geodesics Inc. (Cambridge). Rather than attributing the difficulty of his business operation to the reluctance of the military establishment (Air Corps) to accept the conditions of his patent, Fuller opinioned that Western Electric was "detouring the question of their recognizing (his) patents by making (him) prime contractor with profits equal to royalty."[143] Forming Geometrics Inc. and operating as a licensee of Fuller enabled the collaborators to exploit the more lucrative role of a sub-contractor for Western Electric.

While Fuller claimed that he had no "proprietary interests,"[144] he nevertheless benefited from the royalties accruing to both these licensees - Western Electric in procuring the Fuller geodesic radomes, and Geometrics in adopting his patented design. Under this arrangement, Geometrics operated directly as a commercial front for Fuller's structural systems, enabling Fuller to act in a detached manner from the world of business. Though Wainwright intimated that Fuller was "hurt" by Geometrics' decision, he noted that it was financially beneficial to Fuller's mission:

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[140] Ltr. 6/6/57 W. Wainwright to RBF in BFI-CR187.

[141] Ltr. 7/19/57 P. Floyd to RBF in BFI-CR188; Ltr. 7/25/57 D.W. Robertson W.M. Parkhurst in BFI-CR188.

[142] Kirschenbaum explained that Geometrics Inc. was formed because of Fuller's reluctance to challenge Lincoln Lab's "proportion(ing) up the dimensions" of their (his and Wainwright's) 55-foot radome geodesic design. Wainwright offered that they wanted to pursue architectural work (Notes from Author's Interview with William Wainwright, Boston-Mass., 4/19/95; Notes from Author's Interview with B. Kirschenbaum, New York-N.Y., 10/5/94).

[143] See Ltr. 4/26/56 W.M. Parkhurst to RBF in BFI-CR177.

[144] Ltr. 10/11/56 RBF to Signals Corps Procurement Office (Washington D.C.) in BFI-CR180: see Fuller's distinction of the functions of Geodesics Inc. & Geometric Inc.

> We generated enough money so that he could go on being Bucky Fuller, which was a more useful function than designing radomes ... I believe that the radome program was by far the biggest money-maker in the geodesic world.[145]

The royalty on the geodesic rigid radome collected in one instance, from Zenith Plastics Co. (Gardena-Calif.), a 3-M subsidiary, offered a picture of the scope of the business. The annual production of radomes accredited to Geodesic Inc. (Cambridge) and Geometrics Inc. was approximately: 3 in 1954, 32 in 1955, 44 in 1956, 9 in 1957, 48 in 1958, 197 in 1959, 127 in 1960 and 90 in 1961; making a total of 550 geodesic rigid radomes spanning a period of six years. The staple radome type for the DEW-line was the AAF-396A 55-footer. In 1970, Ahern recounted that at least 500 domes were built by Geometrics Inc.[146] Fuller's royalties on the radome was pegged at 5% of the fabrication costs. The latter varied, depending on the specifications of the radome and the tenders of the contractors. In 1956, the royalty from twenty-five Western Electric radomes was $45,000.[147] In 1957, Universal Moulded Products Corporation paid him $7040.41 for four 50-ft. radomes at $140, 808.17.[148] In 1958, Zenith Plastics Co. (Gardena-Calif.) billed Rome Air Force Base for ten radomes at a net of $43,282.50 each and the royalty accrued on the gross ($432,825,00) was $21,541.25.[149] On average, the royalty per radome was approximately $2,000; and even at this conservative estimate, Fuller's royalty on the entire geodesic rigid radome program alone was no less than two million dollars.

In the early sixties, on the occasion of the MoMA retrospective exhibition on Fuller's work, *Three Structures by Buckminster Fuller* (1959), which witnessed a dragged-out bureaucratic process of assembling his structures, Fuller reiterated the 4D-Dymaxion theme, namely, the "inordinate shunting of social wealth" of the building trades skilled labor.[150] The radome, which had taken a nominal 14-hour assemblage by Eskimos and others unfamiliar with it, by contrast, took the American building trade union one-month to do. Avoiding an absolute maligning of American labor, Fuller implied that geodesic technology, along with enlightened labor which was willing to relinquish the "obsolete inefficiencies of building," would "bring industrial mass purchasing ability to all of humanity." While this point reminded his audience of

[145]Author's Transcript of Interview with W. Wainwright, 4/19/95, Boston.

[146]Robert L. Levy, "Builders Still Waiting For the Day of the Dome," *The Boston Globe*, Nov.5, 1970, p.5.

[147]Ltr. 8/22/56 McKittrick, S. to RBF in BFI-CR179.

[148]Report of Sales under Fuller License April-June 1957, with Universal Moulded Products Corpn. in BFI-CR188.

[149]Ltr 2/12/58 Zenith Plastics Co. (Gardena-Calif.) to W. Parkhurst in BFI-CR192.

[150]E.J. Applewhite, ed. "Radome" entry in *Synergetic Dictionary: The Mind of Buckminster Fuller*, Vol.III, New York: Garland, 1986, p.460.

the repro-shelter dimension of his geodesic project, another new role for Fuller's dome arose in a most unexpected quarter.

3.3. Geodesic Domes At the Trade Fairs Abroad (1955-59)

Fuller recognized very early, through the DDU and Dymaxion Wichita House projects, the potent significance of design in public life and national politics. This was especially so when the subject matter impinged on issues of national security. He understood the subtleties of design, especially through his domes, as political postures even before the State took notice of them or recognized their potency. The meaning of Fuller's Paperboard Dome project for the Milan Triennale attested to this most vividly.

3.3.1. A Military Ordnance Becomes an Object of Peace

The successful airlift display of the magnesium two-frequency 42 dome at the National Air Show in Philadelphia in September 1955 finally settled the legitimate place of geodesic structures in Marines logistics. Richard Witkin, the Aeronautical Editor for *The New York Times*, present at the event, reviewed the group scene of the U.S. Navy aircraft carrier *Ticonderoga*, the Marine Corps geodesic structure (air-delivered in a mock beachhead operation from the carrier), the Air Force bomber taking off over the geodesic dome:

> (It) provided a technically balanced group of highest priority science and technology applications integrated in a comprehensive and dynamic first-line of defense.[151]

With this imminent program sealing geodesic structures as a logistics requirement of the Armed Forces, Fuller's own liberal anxieties about war again emerged. Three weeks after the air show, Fuller wrote to Maj. King (Division of Public Information, Hdqr. U.S. Marine Corps, Washington D.C.) to remind him of the significance of a side-show which he might have missed amidst the phantasmagoria of military technology. It was true that his structures, as "integrate(d) flyable logistics," demonstrated a commonality in efficiency alongside the technologies of the Armed Forces. However, Fuller also proposed that it was also a major gain, a "technological beachhead," for serving "world society." Thus, he proposed:

> Here (at the National Air Show) the Marines officially recognized and celebrated the *second barrel found on their gun* [152](Itl., my emphasis).

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[151]R. Witkin, "Helicopters Star at U.S. Air Show," *New York Times*, 4 Sept. 1955.

The high-speed portability of his integrated environment control to any place on earth was deterrence against war. However, this "second barrel," Fuller offered, exceeded the bellicose intent of his geodesic structure. Paradoxically, it would eradicate the necessity of war. Fuller's intent was to suggest that the effective use of technology would create abundance and correct the false perception of inadequacy of world resources. For this reason, the geodesic structure was an infinitely more effective tool for propagandizing American technology and political ideology peacefully rather than aggressively. It would, he argued, directly and commonly advantage "the everyday ways of living" for all of humanity:

> (T)he Marines have unexpectedly developed their other gun-barrel for cold war. (It) means gaining the cold war advantage over our competitor in the historical struggle for world man's highest credit as his most effective leader in the speedy conversion of the worlds' scientific and industrial potentials to the greatest common advantage of man. This cold-barrel increment of the Marines' initiatives was also witnessed ... by our cold-war adversaries. *But most important of all, because it ... was witnessed by world-man ....*
> The fighting Marines are, then making a series of cold war, stepping stone beach-heads towards the most important comprehensive victory in the whole history of man: *The end of hot-wars*[153](Itl., my emphasis).

The larger context of this assertion was the pervasive rhetoric of Cold War. Rather than adopting a hawkish, direct assault on Communism and peddling the necessity to go to the brink of war, Fuller adopted a liberal initiative of rationalizing self-preservation and the occasional need to flex the nation's preparedness for war. This strategy of deterrence, as an aspect of the Cold War, was offered by him in this assessment:

> The Marines' initiative turns out to be an unexpected double-barreled weapon: one gun-barrel good for the hot war, and one gun-barrel good for the cold war. Their ready-for-hot battle barrel tends to postpone the moment of war because if the Marine's demonstration of formidable efficiency directly witnessed by our potential hot-war adversaries.... The Marines' formidable efficiency has gained through their ability to maintain scientific weapons at any advanced point by incorporating shelters in the form of geodesic domes as weapons thus making possible the aeronautical delivery of scientific environment controls simultaneous with advanced position landings. They are thus enabled to maintain scientific hitting weapons at advanced positions. Their integrated environment control weapons are all deliverable to any place within hours.[154]

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[152]Ltr. 9/26/55 RBF to Maj. George J. King (Division of Public Information, Hdqrs. USMC, Washington D.C.) in BF-CR167, p.6.
[153]Ibid., pp.4-5.
[154]Ibid., p.4.

For this reason, Fuller proposed that the Marines could proffer to "world-man" a taste of this peaceful ordnance, by assisting in the Indian-Pakistan flood. This humanitarian act would be a significant public relations coup.[155]

3.3.1.1. The Milan Paperboard Dome (1955)

Fuller's entire life project was fundamentally humanistic and humanitarian. The geodesic artifact in the corpus of his creative production was intended as an efficient structural shell and effective energy modulator. It was to be the thrust of his repro-shelter project. The success of his geodesic artifact as military ordnance however overtook and overshadowed this ambition. Publicly, it contradicted his peaceful intent. His effort to re-direct public attention towards this objective, however, was still cast in the rhetoric of Cold War. America would fight the Cold War through the "second barrel" or "cold-barrel". The occasion which gave rise to this opportunity, and one which Fuller skillfully capitalized, was the award of the coveted *Gran Premio* at 1954 Milan Triennale, for his Paperboard Dome contribution.

The process to craft the "cold-barrel" began around the same time the Marines solicited Fuller's participation in their logistics project in January 1954. Olga Gueft, editor of *Interiors*, was desperately seeking for American representation at the Tenth Triennale, Milan Design Exhibition (August-November 1954). As a doyenne of American design culture, Olga Gueft lamented the general lack of American design initiatives at the exhibition and the absence of public grants for projects of this nature. Even at the last Triennale, Gueft recounted that the U.S. pavilion was designed by Belgioiosi, Peressuti and Rogers, which while "superb" was a " tribute to Italian, not American genius."[156] Further, the theme of the Tenth Triennale, industrialization in shelter, suited Fuller aptly.

While Fuller probably viewed this as an opportunity to diffuse the bellicose aspect of his geodesic structure, it was not clear whether Col. Lane was fully informed of this parallel development or Fuller's intentions during these early stages. However, from Fuller's subsequent effort to realign the protocol for presentation of the *Gran Premio* award, it is clear that the Marines were slow at fully appreciating the sophistication of Fuller's publicity coup.[157]

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[155]Ibid., p.7.
[156]Ltr. 1/26/54 O. Gueft (Editor, *Interiors*) to RBF in BFI-CR156.
[157]Ltr. 2/17/55 RBF to Clare Booth Luce in BFI-CR165.

Gueft proposed that Fuller's geodesic dome would contribute "to the greater glory of the U.S. representation at the Triennale," fulfilling a "badly needed reassurance concerning American sympathy with their (Triennale) aims."[158] Fuller appreciated this consideration, particularly the ability of Gueft as a neutral party, to garner support from the material industries. More directly, as editor of one of the most influential purveyor of tastes on interior design, Gueft's ability to "expand her liaison and editorial support function" was invaluable.[159]

3.3.1.1.1. Previous Experimentations on the Paperboard Dome

In Fuller's stable of domes, the Paperboard Dome (sometimes known as Cardboard Dome) was clearly the best candidate for this new public relations exercise. It was the only dome-type that had undergone the test phase as a manufacturing prototype by exploiting the relatively low tooling cost of cutting dies. Most significantly, in appearance, it was a most unlike military ordnance and hence better suited to public acceptance. For instance, while it fitted the Marine Corps' bill of "one-phase concept" for military shelter, it was publicly reported that it "could provide semi-permanent shelter for disaster zones, camp sites or other situations."[160]

Before its initiation into the fold of military logistics, the paperboard dome epitomized Fuller's personal effort, quite independent from the dome initiatives of his enterprises or his franchisee-experimenters. It was emblematic of economy and ephemerality. In its projected application, the dome was also imagined to be "as ubiquitous as the standard packing crate."[161] Dixon enumerated the advantages of the paperboard dome: its inherent integrity as a ready-made formwork, its amenability to the high speed printing process and production and its compactness for transportation.[162]

As a semi-permanent, disposable shelter, the design proved to be responsive to improvements. In all the early developments of Mark-I paperboard domes beginning in Fall '52 at Yale University, Fuller had worked towards the reduction of wastage in production, better sub-assembly geometry, stronger and easier systems of fastening [Fig.3.22]. Fuller started exploring the dry strength of paperboard. The following year, a group of thesis-level students, constituting

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[158] Ltr. 1/26/54 O. Gueft to RBF in BFI-CR156.

[159] Ltr. 2/7/54 RBF to O. Gueft in BFI-CR156.

[160] "Cardboard Domes to Replace Tents?" *The Christian Science Monitor*, 4 June 1954.

[161] James Ward, *The Artifacts of R. Buckminster Fuller, Vol. III*, p.401. Fuller's Paperboard Dome (U.S. Patent #2,888,717) patent claims were filed in January 1955, the patent was awarded in April 1959.

[162] Ltr. 2/18/54 J. Dixon to R. Porter (Board Product Publishing Co., Chicago-Ill.) in BFI-Hev6.

themselves as the Fuller Study Group (FSG), much to the chagrin of George Howe (Chairman of Architecture Dept., Yale University), pursued detail studies on the all weather performance of new paperboard domes. They discovered that 20% phenol resin content would render the board stable against moisture and waterproof adhesives, thus producing a satisfactory all-weather enclosure without the necessity for any further enclosure protection treatment.[163] In Fall '53, FSG completed a 36-footer, 8-frequency dome in conjunction with similar work then undertaken at NCSC using polyester-coated corrugated cardboard of the V-series which was made up of diamond-shaped components.[164]

The bottleneck rested in the quest for better waterproofing to ensure durability of the paperboard strengths, then limited to paperboard coated with and strengthened by polyester resin.[165] However, with a coating of polyester fiberglass, a material with higher tensile strength, Fuller realized that the paperboard was acting as a formwork. Fuller enthusiastically reported this discovery:

> These cardboard forms are so cheap and expendable that they are not reclaimed but were left in the finished truss. This goes a long way towards solving one of the main difficulty of working with polyester plastics, that of separating it from the expensive dies that form it.[166]

The paperboard dome destined for the Milan Triennale, a Mark-III version, was a product of these experimentations. The staples gave way to snap pin fasteners, which produced a more accurate assembly. It also used stronger tape adhesives and new plastic surfaced weather tapes waterproofing the joints and laps.[167]

The paperboard dome presented by Fuller as a mass-produced personal shelter was a curious dream stuff of consumption in the context of America. It was a redefinition of the meaning of abundance in the land of plenty. Its ascetic image and agenda underpinned it as a throwaway artifact. Robert Marks echoed Fuller's claims that it would enable consumers "to

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[163] See R. Buckminster Fuller, "Transcript - Meeting of the Forest Products Research Society, Grand Rapids-Mich.," 5/7/54 in BFI-CR158.

[164] See also "Paper and pulp structure," BFI-MSS 55.02.01, Feb. 22' 55, p.16; "The Cardboard House," *Perspecta 2*, Yale Architectural Journal, Autumn 1953, pp.28-34.

[165] Ltr. 3/31/53 R.C. Ferguson (YSG, New Haven-Conn.) to RBF in BFI-E Series.

[166] Undated telegram (ca. March'54) in Ltr. 3/19/54 RBF to Walter Paepcke in BFI-CR153. See also Olga Gueft's "How to print a house and Why," *Interiors*, June 1954, pp.70-73.

[167] See Ltr. 2/5/55 J.W. Fitzgibbon to R. Mango in BFI-CR164.

enjoy high standard dwelling advantages at costs readily met out of a single year's income."[168] This dramatization echoed his earlier promotion of the 4D-House:

> (A) husband and wife could buy in five hundred light weight pieces of waterproof, high strength corrugated paper board, and could transport in one load in their car to a desirable, deep country site, thus securing for themselves an *immediate foothold* on the previously desirable but unavailable land.[169]

Fuller claimed that the paperboard dome would enable a "winning solution from out of an area of humble and plentiful resources" by making the "advanced (airframe) technology" available at the "local ten-cent store."[170] Despite its simplicity, he continued, it was "beyond the possible contrivance of field work craftsman."

3.3.1.1.2. Working Against the Odds of the State and MoMA

Gueft was neither alone in her enthusiastic support to feature Fuller's dome at the Triennale nor had she thought of this idea herself. It was likely that her choice was influenced by Roberto Mango, an Italian architect.[171] Mango was previously associated with George Nelson and *Interiors* during his short stay in New York in the early '50s. Both Gueft and Mango concurred that Fuller would be "an appropriate American genius" to build the American pavilion at the Triennale.[172] Fuller trusted Mango and was aware of Mango's value as "(his) spokesman in Italy."[173] Now, back in Italy, but still spiked by Fuller's "terrific enthusiasm," Mango unabatedly offered to promote Fuller's work, using Milan as a "door to Europe." The Milan Triennale dome, he proposed, was one of "many forms of propaganda" for creating "adequate and intelligent diffusion of (Fuller's) conceptions."[174]

However, the enthusiasm of Mango and Gueft met many insitutional and practical obstacles. Firstly, the State was reluctant to support or participate officially in the Triennale the same way as other countries. The reluctance was ideological. It was to avoid any misrepresentation of cultural homogeneity and autocracy. Nevertheless, Gueft lamented that its

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168 R.W. Marks, *The Dymaxion World*, p.58.

169 Ibid., p.30.

170 R. Buckminster Fuller, "The Cardboard House," p.28.

171 See Ltr. 2/17/55 RBF to Clare Booth Luce in BFI-CR165.

172 Ltr. 1/26/54 O. Gueft to RBF in BFI-CR156.

173 Ltr. 4/30/52 RBF to R. Hamilton in BFI-HEv10.

174 See Ltr. 7/10/54 R. Mango to RBF in BFI-CR156; also Ltr. 11/2/54 R. Mango to RBF in BFI-CR159.

"apparent indifference (had) caused unfavorable reactions."[175] Secondly, both Gueft and Mango had hoped MoMA would "fill the breach" and validate their initiative, was not forthcoming. Edgar Kaufmann Jr. then curator of MoMA's section on industrial design and who had spearheaded the American initiatives, in the Ninth Triennale, was unimpressed with their proposal and doubted the fitness of the dome for the exhibition.[176] Thirdly, the Triennale exhibition committee misread the intent of the paperboard dome, and slated it to be used as a flower show greenhouse with smatterings of interior furnishings. Of the last of these obstacles, Mango managed to avert the mis-representation of the paperboard dome by convincing the Triennale committee to adopt a second and larger dome.[177] It was this second dome that was presented as a minimalist shelter.

Fuller nevertheless turned the first two obstacles around to his advantage. His action sidelined both the State and the arbitrator of high modernist culture, MoMA. MoMA withdrew from the Triennale in July. By taking the initiative, Fuller would eventually claim the high ground of a truly American exhibit, achieved through unfettered private enterprise and industry. Ironically, the exhibit became more ideological without the participation of the State, and Fuller began to capitalize on this. The State's token participation, on the advice of Mrs. Clare Luce Booth (U.S. Ambassador to Italy), would have consisted of "dismembering the exhibit and dispersing it in the gigantic labyrinth of the Palazzo."[178] The fundamental differences between MoMA, Fuller and his promoters at *Interiors* were also instructive of what constituted the proper representation of American (industrial) design in the American Exhibition.

Kaufmann had intended to feature a recently curated MoMA-exhibition, *Built in USA*. Though a "worthy" exhibit, Gueft did not feel that it was "physically or informationally important enough to fill either the space or the honor inherent in this situation." Rather, she proposed Fuller's dome, in itself was "the most dramatic symbol of industrial design that any nation in the world can place on such an exposition."[179] For Gueft, the space and the technique of the geodesic not only "represent(ed) America in a more characteristic way," it was "a remarkable exhibition itself."[180] Further, she had intended to block the repetitive representations of the

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175 Ltr. 2/26/54 O. Gueft to Edgar Kaufmann Jr. (MoMA) in BFI-CR156.
176 Ibid.
177 Ltr. 2/19/54 Zane Yost, Roberto Mango (*Studio di architettura*, Napoli) to RBF in BFI-CR156.
178 Ltr. 2/26/54 O. Gueft to Edgar Kaufmann Jr. (MoMA) in BFI-CR156.
179 Ltr. 5/3/54 O. Gueft to Peter Muller-Munk Associates in BFI-CR156.
180 Ltr. 6/20/54 O. Gueft to R. Mango, T. Ferraris & M. Zanuso, p.4 in BFI-CR156.

Society of Industrial Designers and the poor quality of representations from those who offered their works "to represent American design."

Gueft also alluded to the "personal problem of jealousy" of the MoMA Director of Traveling Exhibitions with respect to *Built in USA* and implied that Fuller's project was an obstacle.[181] Towards the end, Gueft, in her final capacity as "official American" representative to the Triennale settled for Victor Gruen's *Shopping Centers of Tomorrow + Northland Sculpture = The Urban Center Outside the City*, a circulating exhibit sponsored by the American Federation of Arts. The works, based in Northland-Detroit, Southdale-Minneapolis, Bayfair-Oakland, was intended as a representation of a civilized and non-commercial America amidst a condition of plenty.[182]

Fuller initially offered to build, pack and ship two 36-ft diameter domes to Milan for $15,000, but this proposal fell through probably because it was exorbitant and due to the objection from MoMA.[183] He had piggy-backed the project on the impending dome contract from the Marines. The details of the respective financial arrangements, at the start, were probably unavailable to either Gueft or Col. Lane. Nevertheless, when the Marines became aware of this parallel project, they were not perturbed. In fact, Col. Lane's goodwill persisted to a point where he even tried to assist Fuller in conveying the Cornell paperboard dome to Milan; even considering "disguis(ing) the shipment as one for (the Marines)."[184] It confirmed that unlike the Mark-III magnesium dome, the paperboard dome did not pose a high-security problem. Nonetheless, they refused to relinquish the paperboard dome to the Triennale.[185]

Gueft personally accorded publicity for the geodesic dome in the May and June issues of *Interiors* and in its sister publication, *Industrial Design*. In the April issue of *Interiors*, she made a public appeal for U.S. participation in the Triennale. Privately, she solicited the participation of material industries in the Triennale, promising them good publicity since the magazine's unofficial sponsorship and coverage would reach some thirty odd thousand readers in the home furnishings and industrial design. She also articulated the political clout of the project:

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[181]Ltr. 5/24/54 O. Gueft to RBF/J. Dixon in BFI-CR156; see also Ltr. 6/6/54 Z. Yost to RBF in BFI-CR156.
[182]See Ltr. 6/20/54 O. Gueft to R. Mango, T. Ferraris & M. Zanuso in BFI-CR156.
[183]Ltr. 3/1/54 O. Gueft to RBF in BFI-CR156.
[184]Ltr. 5/28/54 Col. H.C. Lane to RBF in BFI-CR163.
[185]Ltr. 6/20/54 O. Gueft to R. Mango, T. Ferraris & M. Zanuso in BFI-CR156

> Buckminster Fuller is on the verge of making low-cost shelter another miraculous achievement of American industrial production. The geodesic may not be the average American's ideal home, but it represents a remarkable solution for the unhoused millions of the submerged countries of the world. *The fact that the United States Marine Corps backed the research will do the American no harm in the propaganda tug-of-war between East and West*[186] (Id., my emphasis).

While the U.S. Marines patronized the project, Fuller quietly opposed Gueft's perception that it had backed the research for the geodesic structures.

3.3.1.1.3. Industries Supported the Milan Paperboard Dome

By June, the material donors were firmly lined up - with 3000lbs of V-3 Kraft paperboard from the Container Corporation of America (CCA), 12,000-ft of fiberglass tapes from Parmacel Corporation (Johnson & Johnson); and translucent waterproof vinyl plastics from Bakelite Division (Union Carbide).[187] Because of the backing, Fuller characterized the effort as a representation of the "American industry enterprise." For this reason, he dramatized that the failure on the project caused by any assembly problems in Italy would be a potential "failure of American products and prestige."[188]

Of the corporate supporters, W. Paepcke (President of CCA), a patron of American corporate design, was most responsive to Fuller's personal request for assistance.[189] In July, he agreed to retool a the production line in one of his plants to manufacture three domes primarily, two sent to Milan, and the remaining one for Quantico for a dry-run assembly by Shoji Sadao. For Paepcke, the collaboration was mutually beneficial. The success of the project potentially positioned him well in terms of the eventual deluge of orders from the Marines' disposable domes, not to mention the civil market. Supporting Fuller's project was also a natural cause because it advanced his personal agenda to promote American design. He had spearheaded such a mission through the Aspen Design Forum since the early fifties.

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186 Ltr. 4/30/54 O. Gueft to RBF in BFI-CR156. (See also *Interiors*, April 1954 pp.70-73)

187 Ltr. 6/20/54 O. Gueft to R. Mango, T. Ferraris & M. Zanuso in BFI-CR156. Hugh de Pree (President of Herman Miller Furniture Co.) provided cash; Bostitch & Industrial Tape Corpn. provided industrial staples and tapes respectively (See "How to print a house and why" in *Interiors*, June 1954).

188 Ltr. 7/26/54 RBF to Ruth H. Shipley (U.S. Department of State, Washington D.C.) in BFI-CR156.

189 Ltr. 3/19/54 RBF to Walter Paepcke (Container Corporation of America- Philadelphia) in BFI-CR153: Seeking assistance in wider (10-foot) cardboard that would be of the "most water-proof, fungus-proof, fire-proof, high-grade kraft paper combined by waterproof gluing agents; strengths of 325psi." See also Ltr. 6/10/54 H. Bayer to RBF in BFI-CR156: confirming Paepcke's donation of cardboard, the plan to manufacture the cardboard as promised & shipped them to Genoa in July.

3.3.1.1.4. Realizing and Maintaining the Cause

Despite the numerous problems encountered in the fabrication and erection of the Milan Paperboard Dome, the project was finally considered "overwhelming" by the public, businesses, and building companies[190]. In January 1955, the project was awarded the *Gran Premio*, the highest prize for all country participants.[191] However, more importantly, Fuller informed Ambassador Clare Booth Luce, that the Italians were so impressed by the geodesic dome that they christened them "Architecture out of the Laboratory."[192] Not only was his "secret hope (of) the Triennale Dome Enterprise" fulfilled, he had also "tapped out" its hidden significance. It showed American initiatives on behalf of "world people" in "packaging up" a high standard shelter technology.[193]

Fuller's initiative was realized no less through the vigilance and dedication of Mango and Zane Yost, one of his former students at MIT. Yost's own interest was to realize the concept of autonomous dwelling, and believed that the geodesic structure was intricately tied to it.

The challenges that Mango outlined in implementing the Milan Paperboard Dome revolved around the issue of the general unfamiliarity with the geodesic artifacts. Both within and outside the Fair, the solutions required "knowledge of local people, some diplomacy and understanding."[194] Firstly, he had to contend with the big wheels of bureaucracy of the Triennale and to overcome their "continuous misinterpretations" which would have compromised Fuller's intention for the dome as a shelter. Yost reported that the Triennale committee was unfamiliar with Fuller and viewed the project "generally as a novelty."[195] In August, even after the erection of the dome, Sadao reported from Milan that the Triennale board merely viewed the dome as "a pretty shape for a 'flower exhibit.'"[196] Second, perhaps a more challenging task, was the "delicate job of presenting (Fuller's) house in the more convincing way to (the) unprepared public."[197]

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[190] Ltr. 11/2/54 R. Mango to RBF in BFI-CR159. See also reviews in *Collier* 26 Nov. 1954; *New York Times*, 28 Nov. & 5 Dec. 1954; *Industrial Design*, Nov. 1954; *Interiors* Nov. 1954 and *Fortune* Dec. 1954.

[191] Ltr. 1/26/55 R. Mango to RBF in BFI-CR165.

[192] Ltr. 2/17/55 RBF to Clare Booth Luce in BFI-CR165, p.2.

[193] Ltr. 1/26/55 R. Mango to RBF in BFI-CR165, p.2.

[194] Ltr. 7/10/54 R. Mango to RBF in BFI-CR156.

[195] Ltr. 7/27/54 Z. Yost to RBF in BFI-CR156.

[196] Ltr. 8/12/54 S. Sadao to RBF in BFI-CR156.

[197] Ltr. 7/10/54 R. Mango to RBF in BFI-CR156

Mango's anxieties over the reception of the dome design and his design for the interior of the second dome ironically betrayed the uncertain status of the paperboard dome. For an industrial object destined for the mass-market, he suggested that the aesthetics of geodesics was a higher order that should not be compromised by the vulgarity of the "street man." Later, Mango confided to Fuller that the strategy of familiarization had to be more gradual than anticipated because of the "Italian mentality and (their) lack of technical knowledge" and "the enormous weight of tradition."[198] To augment the asceticism of the dome and to distance it from any misreading as a novelty, Mango proposed that his interior plan was "'to suggest' rather than to complete what (was) inevitably missing" and to encourage visitors to "'touch' the whole by hand" and "'rest' his imagination for the more essential"[199] [Fig.3.14]. Both Mango and Yost tried faithfully to maintain Fuller's intent in using the geodesic structure as a component of a larger autonomous dwelling project. They reinforced this intention by making the flexibility of the floor grid a pivotal design element, a consideration largely missed by Fuller. Keeping with the portability of the dome, they proposed that a simple, highly flexible flooring system would enable a "minimal possible preparation of site," and eventually eradicate the "'tied to the ground' services" altogether.[200]

3.3.1.1.5. A Higher Stake than the Marines' Military Objectives

The accolades received for the Milan Paperboard Dome made it necessary for Fuller to engineer a portrayal of his work as a peaceful mission. This was to avert the Marines' potential coup on the credits, given the recent military publicity in the U.S. media, for which Fuller was actively responsible. The U.S. Marines had come to feel lately that they ought to receive the credit for the Milan project since they were primarily responsible for commissioning the prototype on which the domes were based. While Fuller acknowledged the sagacity of the Marines in sponsoring him and recognized that they had no intention of depriving him of credit or the limelight, Fuller privately suspected their "proprietary interest" in his work.[201] Thus Fuller felt the need to rework the protocol for receiving the award, which was initiated by the Marines. The award protocol in his mind, he explained to Mango, would illustrate a "typical U.S. enterprise action without any hint of official aid."[202]

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198 Ltr. 11/2/54 R. Mango to RBF in BFI-CR159.
199 Ltr. 7/10/54 R. Mango to RBF in BFI-CR156, p.2.
200 Ltr. 7/27/54 Z. Yost to RBF in BFI-CR156.
201 Ltr. 2/17/55 RBF to Clare Booth Luce in BFI-CR165.
202 Ltr. 2/21/55 RBF to R. Mango in BFI-CR164

According to Fuller, the Commandant of the U.S. Marines, having learned of the award, had asked that the presentation of the award be made to Fuller in his Washington office. The Marines would directly bestow the award on Fuller. Clearly under such a protocol, the Milan Dome would be publicly perceived as a Marine initiative, with Fuller merely receiving accolades for design excellence. Rather than sending this message, Fuller requested Ambassador Booth to route the award through "official channels" to be presented by the appropriate Italian representatives in the Office of the Commandant of the U.S. Marines Corps.[203] So instead of taking the limelight, the Marines would be seen merely as a supporter of the project.

Besides this publicity effort to re-engineer the image of the geodesic artifacts, the Milan Dome episode was historically significant with respect to cultural diplomacy. It illustrated the reluctance of the State, and hence its slowness, in coming around to appreciate the political dimension of design on the international scene. The missed opportunity, filled in by private sponsorships, serendipitously allowed them to find "high points" in cultural diplomacy [Fig.3.18]. Gueft reported the triumph of the private sector at the Triennale in this way:

> Many visitors regret that the U.S.A. has no official, juried exhibit this year. We have lost face by indicating that we are not enough impressed by our own design to match quality of the other exhibits by one all our own. Thanks to private sponsorship, the U.S.A has made one statement which helps compensate for this: the geodesic domes in the gardens, built only of paper and staples. The technical brilliance which conceived so simple a structure, and the industrial know-how which can produce so fast and so cheaply, have impressed visitors as much as any other display.[204]

For Fuller, the Milan Paperboard Dome enabled him symbolically to reinforce the meaning of individual initiatives in the face of bureaucratic obstacles. It epitomized an "American pattern of enterprise initiatives."[205] Truly, in Fuller's term, the presentation of the *Gran Premio* in the presence of the industry supporters was, despite the late assistance of Luce and in the Office of the Marine Commandant, a "public celebration of a Geodesic Birthday."[206]

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[203] Ltr. 2/17/55 RBF to Clare Booth Luce in BFI-CR165.

[204] Olga Gueft, "Tenth International Exhibition of Modern Decorative Arts, Industrial Design and Architecture," *Interiors*, November 1954.

[205] Ltr. 2/17/55 RBF to Clare Booth Luce in BFI-CR165.

[206] Ltr. 2/21/55 RBF to R. Mango in BFI-CR164.

3.3.2. Trade Fair Domes: Advancing the American Cause without Politics (1956-59)

In the wake of the Milan Paperboard Dome, Fuller successfully lined up the civil use of the dome in a series of international expositions in Frankfurt (March '55), Brussels (April '55), Paris (April '55), and Bangkok (Constitution Fair, December '56).[207] The Department of Commerce, through its European Trade Fair Programs, was quick to sense that the vehicle of the Fair and the dome-factor were effective in advancing the American political cause without the appearence of the State's interests. These twin items encapsulated American technology -- at one end, the geodesic dome highlighted the vitality in the American tradition of tinkering; on the other end, the mass consumer goods signified the technology of plenty. For this reason, Fuller's assistant, John Dixon, was quick to account for the dismal reception of the American entry at the Milan Triennale the following year.[208] Citing a *LIFE* report (9 May 1955, p. 59) of the small and lusterless U.S. entry which consisted of a section of a typical American home, Dixon exaggerated the general disappointment:

> (R)ich U.S. had made no effort, and a U.S. business man called the display, 'The corny thing you expect from the Russians.'[209]

More than an effort to solicit further commissions from the Department of Commerce, Dixon proposed this arresting, however far-fetched, political stratagem -- without the presence of Fuller's dome, the U.S. image abroad suffered a defeat:

> (D)espite our political statecraft of 1955 the Italian party favored by the U.S. had in the meantime lost control of Italy ...
> Though the 1954 vs. 1955 Milan Fair policies of U.S., private and public initiatives were obviously but two of a multitude of factors in the gaining and losing of international friendships, they do hold *key positions and constitute proven data* concerning positive and negative strategies[210](Itl., my emphasis).

Fuller's dome project, and its symbolic deployment in the international fair circuit, Dixon further argued, was "in direct line with National Policy." By "national policy," Dixon meant two

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[207]Ltr. 2/18/55 J. Dixon to Col. H.C. Lane in BFI-CR163. See also Ltr. 2/7/55 Peter G. Harnden (Director, European Trade Fair Program) to RBF in BFI-[?].

[208]Dixon was so attuned to the political dimension of the Fair that he eventually joined the USI from 1960-64, after coordinating the geodesic pavilion for American National Exhibition in Moscow (See "John Dixon" resume, ca. March 1968 in BFI-CR232).

[209]Ltr. 6/4/55 J. Dixon to J.D. Canfield (U.S. Dept. of Commerce) in BFI-CR165.

[210]Ltr. 6/4/55 J. Dixon to J.D. Canfield in BFI-CR165.

things: the observation of free enterprise and the promulgation of its corresponding value by the State in international development. He elaborated:

> (It) requires that the U.S. recognize the initiative of the individual as well as the initiative of corporations - when the initiating individual is backed by U.S. industry - as constituting the phenomena 'industry' as supported in foreign development by the 'U.S. Foreign Trade Fair' legislation of the U.S. Congress.[211]

In practical terms, there was no need for Dixon's hard sell. There were no portable environments that could compete with the geodesic dome in terms of cost, speed of assembly, and appearance. Further, Fuller's initiatives to act on behalf of the State to propagandize American technological ingenuity was opportune but natural. It was neither surprising nor contradictory. Rather, the hesitancy of the State to propagandize the national ideology in the setting of the fairs was closer to American political ethos. So as not to repeat the political tyranny of which America accused the USSR, individuals and private enterprises indeed were more legitimately positioned to advance the national-political cause.

Fuller's work, in a larger context, extending from the 4D-Dymaxion project to the geodesic artifacts, was emblematic of American technological optimism. With this sudden international exposure of the geodesic dome, not only was there a new avenue for his dome enterprises, but it also provided him a world-wide audience for his ideas. These ideas were generally congruent with the political motif of a free and democratic America. Dixon, no doubt echoing Fuller's intent, explained to a Trade Fair official that the Trade Fair arena as such could be used as a kind of barometer to gauge the "pulse of world response (of) world people" to American intent. This intent was Fuller's rendition of the American post-war destiny; namely the discovery of the identity and role of American technology as an "evolutionary process" by "world people."[212]

Fuller's idealism stemmed from a broad technological optimism. This optimism needed little augmentation before it was leavened with Cold War rhetoric within the next year when the geodesic dome appeared in Kabul, Afghanistan. The potency of American technology was no doubt dramatized by the mystique of the geodesic dome, especially in the theatrics of precision for making and assembling the dome. The trade fair dome was a direct demonstration of self-discipline in crystallizing and orchestrating an assemblage of some of America's best private

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[211] Ltr. 6/4/55 J. Dixon to D.D. Canfield in BFI-CR165.
[212] Ltr. 5/26/55 J. Dixon to D.D. Canfield in BFI-E Series.

industrial initiatives into a coherent statement with seeming effortlessness. Fuller described the new phase of geodesic art capability, the hub-strut-and skin domes, almost like a high precision art performance:

> If we do send Geodesic domes to European Trade Fairs each will be accompanied by a member of the respective team which engineered and processed them. The unusually high strengths of these air-frame type units depend on uniquely fine tolerances maintained at infra-visible levels, and high speed field assembly can be attained only through mathematically patterned practice routines. *In my latest university, Marine Corps, and Air Force projects, we carefully rehearse such routines in a manner not unlike the development of a ballet. It is a component part of the design that the public installation to be conducted in such a manner as to seem effortless*[213] (Id., my emphasis).

3.3.2.1. The Kabul Dome (1956) and Cold War at the Fairs.

The aborted Hälsingborg initiative, though a personal blow to Fuller, did not in any way diminish the gradual recognition by the Department of Commerce-Office of International Trade Fairs (OITF) of the ideological potency of Fuller's dome. In fact, the volume of inquiries on the non-military (commercial and civilian) use of the dome eventually led Fuller to establish Synergetics Inc. (Raleigh) in 1957 [Fig.3.26].

In June 1956, the power of Fuller's geodesic was again evoked at the International Trade Fair at Kabul. T.C. Howard, Fuller's subsequent collaborator at Synergetics Inc., suggested that Nelson Rockerfeller instigated the participation of the U.S. Department of Commerce at the Kabul Fair.[214] Then a special assistant to President Eisenhower, Rockerfeller was on a world tour when he chanced upon the massive preparations in Kabul for the Jeshyn International Trade Fair to be opened on August 1956. Rockerfeller was apparently vexed by the general nonchalance and dismissal of the Fair by the U.S. Embassy in Kabul. The U.S. Ambassador, in particular, was ambivalent about U.S. participation from the very beginning.[215]

Between the Milan Triennale (1955) and the Kabul Fair (1956), the fair activities of the American government were administered under the makeshift "Emergency Fund for International Affairs, Executive." The 84th Congress finally passed the "International Cultural Exchange and Trade Fair Participation Act of 1956" under Public Law 860 on 1 August 1956, which fundamentally pledged a permanent commitment of funds for broad cultural exchanges that

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213 Ltr. 2/21/55 RBF to R. Mango in BFI-CR164.

214 Interview with T.C. Howard, p.18.

215 Ltr. 9/7/56 J. Dixon to RBF in CR179, p.1.

included fair activities. One of the most significant provisions of the new act was the establishment of an "industry exhibit division." President Eisenhower waived the statutory restrictions that probably had stymied the Jeshyn Fair in Kabul, by his executive order on August 21 to the United States Information Agency (USIA).[216]

Given the late and short notice, the just-in-time success of the Milan Dome was sufficient to convince the Department of Commerce-USIA that Fuller's dome was the only design solution for Kabul. Fuller's enterprise immediately appropriated the 100-ft diameter dome slated for the Mid-America Jubilee celebration in St. Louis, Mo. [Fig.3.27a-b].

The dome and its dome-raising stunt created impressions exceeding all public and official expectations prompting John Dixon to characterize them as "smash hits."[217] Originally packed at Raleigh on 15 July 1956, the dome-kit arrived in Kabul four days later. The dome raising, accomplished in two-days, was magical. This was evident in the summary report of U.S. Embassy-Kabul: "On Thursday Two Specks in the Sky - On Sunday A Pavilion at the Fair."[218]

The fanfare of the dome-raising ended with the Afghan Minister of Mines and Industries, Dr. Mohammed Yusof, driving the final gold-plated pin into the dome's aluminum tubing. Kabul not only saw the "most dramatic structure ever presented at a Southeast Asia fair," the U.S. Embassy reported that the event also provided "an impressive demonstration of the technological know-how commonly attributed to the United States"[219] [Fig.3.28b]. The pure exhilaration of this ideological-public relation coup over the "Soviet Bloc" was also noticeable in this unclassified telegram of Department of Commerce-USIA:

> U.S. last of all participants Kabul Fair to begin erection and first to finish, Soviet, Chinese Communist, and Czech pavilions more than 50 percent complete prior to arrival dome.[220]

The account of the effortlessness in the dome raising was to contradistinguish the heavy-handed political machinery and methods which the Soviet bloc mobilized to raise their respective

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216 "Presidents' Special International Program, 1 July -31 Dec. 1956," copy in BFI-EJA Green.

217 Ltr. 7/26/56 J. Dixon to RBF in BFI-CR178, p.1. This letter provides the day-by-day accounts of the dome-raising process. Dixon reported that J. Masey and T. Miller (manager of the Fair), were "continually seeing more and more potential in the dome" (See Ltr. 8/8/56 J. Dixon to RBF in CR-178, p.2).

218 U.S. Embassy, Kabul-Afghanistan, "On Thursday Two Specks in the Sky - On Sunday A Pavilion at the Fair," *American News Bulletin*, July 23, '56 (copy in BFI-CR178), p.2.

219 Ibid., p.2.

pavilions. The ideological distinction was obvious: while America resorted to technical ingenuity of its private industries to save labor, and thus relegate the surplus labor to other creative endeavors, the Soviet bloc mustered brute force through its political will to rally its labor on the site [Fig.3.28a]. *The Architectural Forum* reported the remarkable achievement thus:

> At the Fair, Russian engineers kept busy with sketch pads at the U.S. exhibit, recording details of the American dome. In contrast with the dome, which was put up over a week-end by a four-man crew, the Russians built a more traditional structure, with a 200-man crew.[221]

Besides the impressive, fine-honed calisthenics in dome-assembly which stunned the Chinese and Czechs, Dixon also carefully noted the involvement of a team of multi-national erectors consisting of Afghans, Austrians, Germans and Americans and the relationship of the geodesic to the yurt. The yurt-geodesic connection was quickly pointed out to the Afghan Minister of Mines and Industries, Dr. Mohammed Yusof.[222] Marks remarked, several years later, that despite their initial unfamiliarity with the dome, the Afghans who worked on the dome proved to be "the most skilled craftsmen."[223] These observations were not merely intended to compliment; rather, they were to suggest not only the conviviality of American technology, but also its universalism. In other words, though appearing alien, American technology vis-a-vis the dome, was neither alien nor intrusive to the Afghan culture. The friendliness of American technology augmented OITF's strategy of only using Afghans during the Fair to explain the workings of American-made machines in the local language. These arrangements were not only pragmatic; they also effectively reinforced the ideology of familiar objects. Through sameness in difference, the two couplings: yurt-geodesic and local-Afghan/technological-American continuity provided evidence of the same road traveled, and perhaps even suggested common future destinies. The theme which collapsed the old world experiences into the new, and vice versa directly supported OITF's own strategies. In the reports of its Fall Fair series, OITF noted that the U.S. pavilion at St Erik's Fair, Stockholm-Sweden, in September '56, was designed by a Scandinavian-American while two unionists of Greek descent presented "the American philosophy of labor" at International Fair, Salonika-Greece, also in September '56.[224]

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[220]Telegram(copy) 7/23/56 Baldanza, Masey/Miller to Dept. of Commerce, et.al. in BFI-CR179. See also the attendance taken at the U.S., Soviet and Chinese pavilions, ascertaining the popularity of the U.S. Pavilion with the Fair visitors (Ltr. 9/7/56 J. Dixon to RBF in BFI-CR179).

[221]"Building Weight cut to 1lb. per sq.ft." *Architectural Forum*, Nov. 1956, pp.158-59.

[222]Ltr. 7/26/56 J. Dixon to RBF in BFI-CR178, p.2.

[223]R.W. Marks, *The Dymaxion World*, p.59.

[224]Operation Coordinating Board (OCB)/USIS, "President's Special International Program," 7/1/56, pp.8-10 (Copy in BFI-EJA Green). For the original copy see White House Office, National Security Council Staff: Papers, 1948-61 (OCB Central Files Series m) Box:16, Folder: OCB 117 [Cultural Activities] (File #5) (3) in Dwight D. Eisenhower Library, Washington D.C.

Finally, David Cort, Fuller's old associate from *Fortune* days, explained American technology in an essentialist way by linking the receptiveness of the Afghans to the geodesic structure. Their nomadic (implying frontier) life and their make-do spirit were congruent with the American tinkering tradition and spirit that created the geodesic structure:

> (The Afghans) are born to be mechanics of mobility. They are superb mechanics. They take a piece of junk and turn it into a beautiful rifle. They buy exhausted, third-hand American taxis and make them run with hand-made parts ...
> Its (the dome) materialization, immense and gleaming was stunning to the Afghans. Some came inside, fell on their knees and prayed. Others say that it was merely ancient Afghan architecture, for indeed it applies the same universal principles as the nomad's yurt, made of interlaced saplings and sheepskins.[225]

It was also important, one reporter noted, that Afghanistan and the United States were the only two non-Communist governments exhibiting in Kabul.[226]

Unlike Milan, Kabul was an emergent theater of political jostling in the Cold War. Cort lamented the lack of a concerted state effort to counter the Soviet propaganda. The fairs, David Cort perceptively observed, had become a "natural arena" of the "charm war" between Russia and USA. At the fairs, Cort proposed that:

> the local people can see for themselves what the two competing worlds have to offer ... Here is a working test of what our government thinks is charming about America, how charming our mass-produced merchandise is to other people, how capable Russia has become at duplicating it, what is America's real charm and power, what in general charms whom.[227]

Writing to Talbot, a former high-school classmate and supporter in St. Louis, Fuller reiterated a characterization of Kabul as "the hottest spot in the Cold War."[228] With the Kabul dome and the hugely successful installation of geodesic-radomes along the DEW-line, Fuller proudly paraphrased the multi-faceted meanings of this singular self-initiative offered by an MIT professor:

> Geodesics have been adopted by the National Defense for our defensive frontier and for our offensive frontier should we be attacked, and for our cold war frontier, as well as for the morale building of our home front.[229]

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225 D. Cort, "Darkness Under the Dome," *The Nation*, March 1 '58, p.2.
226 Joseph R. Slevin, "Plastic Dome Covers U.S. Exhibit at Kabul," *New York Herald Tribune*, 5 Aug. 1956.
227 D. Cort, "Darkness Under the Dome" *The Nation*, 1 March 1958, p.1.
228 Ltr. 6/1/56 RBF to John Talbot (St. Louis-Mo.) in BFI-CR175, p.1.
229 Ibid.

Fuller himself was wrapped up in the charm war. However, he also appreciated the strategic significance of Kabul in this extended re-presentation of the geopolitical significance of Afghanistan to the Marines. Applying the theory of the heartland of the English geographer, Sir Halfred Mackinder, Fuller spelt out the stakes:

> Theoretically, either the U.S.S.R or the U.S.A. have now plenty of controlled energy to unfreeze the vital organ and permit the integrating flow of world industrialization through the fundamental traffic and communication facility which Afghanistan represents. *The Soviets have seemingly beaten us to the start by bringing the first railroad to Afghanistan as well as paving the streets of Kabul so that its capital traffic may flow.*[230](Itl., my emphasis).

The point was that American diplomatic complacency ignored the national security interests in this heartland. The Soviets, on the other hand, had already established their physical presence and goodwill in technical infrastructural works thus undermining any potential American political interests. Cort observed the Soviet technical goodwill in these ominous terms:

> (T)he Russians have paved a good stretch of Kabul highway for the Afghan to race on. A little later, Russia was allowed to push its railway into Kabul; tomorrow India and the world. The slumber in Washington was still sweet and untroubled.[231]

Fortunately, Fuller explained that because of the "favorable reaction to the great modern geodesic yurt" by "world people" including the Royal Afghan Ambassador to U.S., no less than a Cornell engineering graduate, American esteem had been rescued and enhanced. Fuller further bombastically proposed that his initiatives momentarily dislodged the earlier Soviet tactical moves and discovery of the strategic potential of Afghanistan. Crediting the Marines' support, presumably in patronizing an earlier hub-strut and tent prototype which led to the 100-ft Kabul Dome, Fuller further stoked the Marines' pride:

> Though there are no U.S. Marines visible in Kabul, this Afghanistan event is a logistical Iwo Jima of the Corps.[232]

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[230] Ltr. 6/30/56 RBF to Maj. George J. King (Division of Public Information, Hdqr.,USMC Washington D.C.) in BFI-CR178, p.6.

[231] D. Cort, "Darkness Under the Dome," *The Nation*, March 1 '58, p.2.

[232] Ltr. 6/30/56 RBF to Maj. George J. King (Division of Public Information, Hdqrs., USMC, Washington D.C.) in BFI-CR178, p.8.

3.3.2.1.1. The State "Sitting up and Taking Notice"

The geodesic structure provided more than a practical enclosing solution. By enabling a quicker, larger and cheaper exhibition space, the structure substantially redirected available funds towards more effective actual exhibits than pavilion construction.[233] This feature was particularly cogent given the recurring anxieties reported by American fair officials, in the "President's Special International Program," of sheer advantages in size, area and extent of the exhibitions of the Soviet Bloc. For instance, at the Levant Fair in Bari-Italy (September '56), the Czechs had fifty-five freight-carloads of exhibits and goods against a miserly four U.S. carloads; at Zagreb, the Chinese and Russians had respectively eight to two and a half times more spaces than the Americans.[234] The report urged a move towards a prefabricated demountable pavilion to enable a "greater degree of flexibility and accounting for considerable savings in future budgets." The Kabul Dome was reused, in succession, at Bangkok, Tokyo and Surabaya.

In the larger context of America's strategic political posturing via the international fair activities, the role of the geodesic dome cannot be overstated. The domes successfully crystallized the policies of American exhibitions and highlighted their political objectives serendipitously. Particularly in the "undeveloped" areas from Kabul to Bangkok and Poznan to Salonika, Marks argued:

> The geodesics ... dramatized American ingenuity, vision and technological dynamism; as structures to house American trade exhibits they would be tangible symbols of progress. *Fuller's three-way grids were better propaganda* than double-meaning speeches broadcast to regions in which radios were scarce[235] (Id., my emphasis).

In OITF's series of Fall Fairs in 1956, the geodesic structure began to provide a backdrop for showing the United States as the greatest producer of peaceful goods for the service of mankind.[236] Ten fairs constituted the 1956 Fall Fairs (Izmir, Berlin, Stockholm, Salonika, Damascus, Zagreb, Bari, Vienna, Bogota & Bangkok). Possibly, because of the exemplar of private industrial initiatives of the Milan Dome, OITF came to recognize the value of industrial design and American industries in advancing its international political agenda.

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[233] Notes from Author's Interview with M. Fitzgibbon, St. Louis-Mo., 9/15/94, p.65.

[234] Operation Coordinating Board-USIS, "President's Special International Program, 1 July 1956- 31 Dec. 1956."

[235] R.W. Marks, *The Dymaxion World*, p.59.

[236] See policy criteria of the trade fairs in "President's Special International Program," p.3.

However, the strategy in exhibiting the abundance of American technology was not without anxieties. Cort, for instance, accused many American trade fair entries, particularly the one at Zagreb-Yugoslavia (September '56) of embodying the vulgar message of "gluttony" by revealing "the putative contents of the American belly" through the merchandise exhibits.[237] Cort's message in his essay, "Darkness Under the Dome," was that the ascetic quality of the geodesic was the best representation of the sublimated American technology. In demonstrating abundance, Fuller's geodesic dome contained humility and a "mark of brain, spirit abstraction or hope" in opposition to "corporate advertising works" and "the growing philosophy that miracles (were) produced by corporations":

> (The geodesic dome) is as typically and individually American as the first Model T Ford car - the simplest and the best way to a difficult thing ....
> Am I subversive if I say that America stands for something very different? We were once a masculine, ascetic, roving, adventurous people who created new solutions as fast as new problems arose. And in fact, that same personnel is still here, though in the shadow.[238]

After Kabul, neither Fuller nor his dome needed to be in "the shadow." Fuller became the premier spokesman of American technology; and the geodesic dome assumed a basic propaganda importance to warrant its repeat commission for the first official U.S. trade fair entry behind the Iron Curtain, the Poznan Fair-Poland (September 1957). On that occasion, Cort offered this analysis:

> In this political climate (after the Hungarian rebellion), the dome must have received some of Europe's faith in the continuous American revolution of fresh, untrammeled thinking.[239]

Finally, while preparing a retrospective on geodesic dome enterprises, Anne Fuller paraphrased the broad summary of active deployment of geodesic structuring as a first line of defense in existing fronts and new frontiers:

> Bucky says it is appropriate to point out that we are ... the first line of defense and also the bridge head operation of the swift retaliatory offensive with the Marines. The front line of this cold war with the domes at Poznan, Milan, Salonika, Istanbul, Casablanca, Tunis, Kabul, Madras, Rangoon, and Tokyo. The first line of scientific __ with the I.G.Y. (International Geophysical Year) Antarctic expedition. First line of agricultural offense with the Plydomes and Homasote domes for agricultural stockpiling and machine protection. First line of cultural offense with the municipal auditorium at Hawaii , Virginia Beach and Borgia, Texas. First line of economical space enclosure both in ... the small structures field (with on the Homasote) and ... with the largest clear span space in history (at UTLx). On the infantile

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[237] D. Cort, "Darkness Under the Dome" in *The Nation*, 1 March 1958 p.5.
[238] Ibid.
[239] Ibid.

frontier, cradle to grave coverage 'Playdomes'. On the educational frontiers in developing new engineers and scientists though our wide university invitation series. Another phase of scientific frontier is with the Minni-earth (possibly to be used at the Brussels Fair) and with our Planetariums for the Air Force and for Flint Michigan...
The whole curve of operation since 1927 ... is apparently a part of a single rising tide whose magnitude is of historical tidal wave propagation.[240]

3.3.2.2. Moscow Dome (1959)

The next major appearance of a geodesic dome in the fair circuit was in Moscow. USIA contracted Kaiser Aluminum to build a Fuller-licensed 200-ft gold-tinted aluminum dome in Moscow to be used as the American Pavilion at Sokolniki Park-Moscow during the summer of 1959.[241] The occasion was America's reciprocating exhibition, which stemmed from the US-USSR cultural exchange agreement of 1958. The $3.6 million project was spearheaded by Harold C. McClellan, a Los Angeles industrialist and former Assistant Secretary of Commerce for International Affairs[242] [Fig.3.29a].

It also represented the first American exhibition in Moscow in forty-years, conducted in tandem with an exhibition by the Soviets at the New York Coliseum-Columbus Circle in June. Fuller credited his instrumental role in inducing the Department of Commerce (OITF) to employ the Kaiser-made geodesic dome as an "ace card in the historically critical U.S. Exhibition."[243] Because of the successful track-record of geodesic dome pavilions at previous OITF exhibitions, it was not unlikely that the geodesic dome was pre-selected before Welton Beckett and George Nelson were appointed as the architect and the exhibition's overall designer respectively.

The Russian exhibition in America consisted primarily of first line objects of industrial progress, namely, tools of industries. The American Pavilion in Russia, on the other hand, contained an assemblage of three buildings, of which the 200-ft Kaiser-made dome was the primary feature. In it, and on the surface of the dome, was projected Ray and Charles Eames's multi-media *Life in America*. This presentation consisted of scenes of American life - shopping, school, transportation and Hollywood. Blake described it as a "highly sophisticated propaganda" in the form of a "latter-day Norman Rockwellian America."[244] The second pavilion housed objects naturally found in an American's lifestyle; the third, was a model American house.

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[240]Ltr. 9/26/57 A. Fuller to P. Floyd in BFI-CR189.

[241]Ltr. 1/8/59 J.W. Fitzgibbon to W.M. Parkhurst in BFI-CR196.

[242]Josephine Ripley, "Soviets to 'See' U.S.," *The Christian Science Monitor*, 6 April 1959.

[243]Ltr. 11/23/59 RBF to K. Fulmer in BFI-CR208.

[244]P. Blake, *No Place Like Utopia*, p.242.

Like its exhibition contents, the geodesic dome represented industrial refinement, effortlessness and gracefulness of life under democratic industrial capitalism. Unlike the Russian exhibits of tools, the tools of industrial life in America were mere means, rather than ends. Thus, one observer claimed that all these achievements were realized "without even a whisper of propaganda."[245]

The geodesic dome at the American National Exhibition in Moscow gave Fuller a high public profile and recognition. The Fuller-licensed dome achieved a national notoriety in upstaging the Soviets by visualizing the technological gulf between the two nations. In this Fair-exchange politics, one reporter observed that America overcame the tactical odds and came out ahead. While the Russian Fair in New York had the added advantage of moving into an existing building, the Americans had to construct their own under record time.[246] The discrepancy was especially heightened in the overtly publicized Khrushchev-Nixon exchange, dubbed the "Kitchen Debate"[247] [Fig.3.29b]. Peter Blake lamented that the Fair-exchange, rather than an "occasion of better understanding" became an opportunity for "political operators to practice their sleaze."[248]

The "Kitchen Debate" in the mock-up of a six-room, ranch-style house constructed under the dome, centered on what constituted good life. Nixon's definition was based on idealism of plenty and the accessibility of consumer goods in America. Khrushchev countered by arguing that such conveniences ought to be birth-rights rather than transacted objects.[249]

The debate probably posed Fuller with a moment of unresolved ideological tension. Despite his professed apolitical position, he would not have vehemently disagreed with Nixon's paradoxical summation that the Fair and its paraphernalia were evidence of America as "the ideal of prosperity for all in a classless society."[250] On the other hand, Khrushchev's positive reception of the dome convinced Fuller that the Soviets could readily identify with the essential transnational value of his geodesic project.

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[245]Josephine Ripley, "Soviets to 'See' U.S.," *The Christian Science Monitor*, 6 April 1959.

[246]See ATTICUS, "People and Things," *The Sunday Times*, 26 July 1959.

[247]For the context of this debate, see Nixon's recollection in "Khrushchev" in *Six Crises*, Garden City, New York: Doubleday & Co., 1962, pp.246-253.

[248]P. Blake, *No Place Like Utopia*, p.245.

[249]See also "The Amazing Doings in Moscow," *Newsweek*, 3 August 1959, pp.9-14; Stephen Whitfield, *The Culture of the Cold War*, Baltimore, Maryland: Hopkins University Press, 1991, p.73.

Khrushchev was probably impressed by the remarkable feat in the assembly of the dome. It was accomplished in less than two weeks; and accordingly, Khrushchev had singled out the dome, among several other American technological objects, for emulation by Russian engineers. Marks recorded that Khrushchev had authorized Vladimir Kucherenko (Chmr. State Committee on Bldg. & Arch) to emulate the geodesic project, and for Fuller to teach the Russian engineers.[251] The Russians were also interested in an IBM-RAMAC computer; but eventually only the dome and the other exhibition pavilions were purchased for $375,000.

Fuller probably shared Khrushchev's larger technological vision rather than Nixon's fetishism of commodities.[252] Perhaps even quietly, he might have agreed with Khrushchev's view that the relative strength of rockets had more to do with prosperity than the relative merits of washing machines. President Nixon came out of the "Kitchen debate" convinced that Soviet communism was one of "steel-like quality, a cold determination, a tough, amoral ruthlessness" that could only be met by a broad, aggressive frontal strategy.[253] Fuller probably saw an opportunity to reconcile with America's nemesis, whom Nixon had identified as the "enemies of freedom."

Fuller's own deep frustrations with the dome business, vis-a-vis the Kaiser operations,[254] partly contributed to his renewed interests in the potential Soviet patronage. On the occasion of a Rollins College's (Florida) convocation in February 1960, when Fuller received his fifth honorary doctorate, his curious boosterism of the Soviet social project went a little further to the dismay of many. He openly claimed that the "Russians (would) achieve the highest standard of living in the entire world by the 1970s."[255]

The warm reception by Khrushchev and the concomitant purchase of the dome structure by the Russians probably excited Fuller to imagine new prospects for his geodesic artifacts. Despite the heightened political tension, the Russians' interest prompted Fuller to believe that the geodesic project had a bigger role outside America and "could lead in good invention and

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[250]R.M. Nixon, *Six Crises*, p.258.

[251]R.W. Marks, *The Dymaxion World*, p.60, 86.

[252]For a liberal critique of the debilitating effect of affluence on American society, that is the cultural and moral contradictions of capitalism, see Kenneth Galbraith's *The Affluent Society*, New York: New American Library, 1958.

[253]R.M. Nixon, *Six Crises*, pp.282-83.

[254]Ltr. 11/23/59 RBF to K. Fulmer in BFI-CR208.

[255]See Ltr. 3/5/60 R.E. Philips to RBF in BFI-CR208.

technology."[256] Fuller perhaps imagined that the Soviets, despite its centralized industrial planning, would be able to advance the geodesic project, using the Kaiser dome as a prototype. Thus, he enthusiastically explained:

> They (the Russians) were not buying it blind. Their own workmen had erected the dome under the scrutiny of their architects and engineers. The young Communist party guide, assigned to me as my interpreter, said, as we parted, 'We are going to have your dome forever.'[257]

Writing to George Allen, Director of USIA, Fuller revealed his confidence in the Russians as a new ally for his technological project of plenty:

> The essence of my work and philosophy is that the scientific design initiatives, exercised through the industrial equation, can alone render the resources of earth adequate to a total enjoyment by its total people. In the effective realization of this philosophy, the competent individual, aided by competent individuals, takes the initiative and the massive political state and organization Man fall into complimentary but secondary functioning. Mr. Khrushchev, representative of the political initiative of the massive state, spontaneously and unwittingly yielded that initiative in his reported behavior and words at Soloniki Park.[258]

Further, as one of twelve private American citizens of "international reputation" specially appointed to represent America in a series of round-table discussions and seminars in conjunction with the Fair, Fuller was privately convinced that he had made a trans-political breakthrough against a background of heightened political tension.[259] Allen also deemed Fuller's presence "of very great value in helping the United States make the most of this unusual opportunity to reach the Russian people directly."[260] However, Allen's apparent hands-off policy which allowed Fuller "to present any particular line or any point of view" he so chose was not an innocuous act of goodwill. Rather, the decision was ideologically instilled. The underlying assumption was that personal representation captured best the political ethos of America. For this reason, Nixon confessed that he also rehearsed strategies for "get(ting) through to the Russian people as distinguished from the Communist hierarchy."[261]

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[256]Ltr. 11/23/59 RBF to K. Fulmer in BFI-CR208.

[257]Ltr. 11/23/59 RBF to K. Fulmer in BFI-CR208.

[258]Ltr. 5/5/59 RBF to G. Allen in BFI-CR202.

[259]Fuller's trip to Moscow took place between July 27-Aug. 1 1959; an occasion significant enough for Reyner Banham, the English architectural historian, to bestow his congratulations for his "mission" (See Ltr. 5/28/59 P. R. Banham to RBF in BFI-CR201).

[260]Ltr. 4/20/59 George Allen (Director, USIA) to RBF in BFI-CR201.

[261]See R.M. Nixon, "Khrushchev" in *Six Crises*, p.245.

After Moscow, Fuller was convinced that his geodesic artifact had entered a transnational phase. Thus his artifact and he himself as an exemplary "world man" were more effective as a message of goodwill transcending the quagmire of diplomacy. Fuller interpreted Khrushchev's enthusiasm and personal request for him ("Buckingham Fuller") to lecture to Soviet engineers in this way:

> Doesn't that prove that the 'individual' can function more effective(sic) than the massive state or corporation. For his remark is a 'cold war' admission of the engineering superiority at least in structures.[262]

Despite his excitement over Soviet interests, Fuller did not openly court them. However, he was privately concerned about avoiding any actions which might be misconstrued as aggressive to the Soviets which could jeopardize the potential viability of his geodesic project in Russia. An instance of this critical moment arose when Z.S. Makowski, a Polish expatriate and then editor of *Tchnika i Nauka* (The Journal of the Institution of Polish Engineers), approached him for technical information on methods of analysis and photographs of his geodesic works.[263] It warranted Fuller to seek cautionary advice or what he termed "an official scrutiny" from Ed Applewhite, a confidant from Wichita-days, then an operation officer with the Central Intelligence Agency (CIA).[264] Describing Makowski as a "red world's technician" on a "fishing trip," Fuller explained that he was thus hesitant to comply with his request lest he inadvertently divulge "tactically informative technical data." While his rather blasé attitude in publicly prototyping the Marine domes did not appear to bother him, privately he appeared to be more prudent over the issue of national security:

> In view of our (USA) present action and hope in respect to Poland (*New York Times*, pg.1 February 27, 1959) I would like to know to what technical extent I should answer (Makowski's) letter and if I should answer it in any cooperative manner at all. Firstly, I do not wish to communicate in a uniquely informative manner with our trans-ferrous -curtain political adversaries in either an illegal or immoral way. But I also do not want to be stupidly offensive, or irritatingly negative at a critical moment, when a Polish leaning in our direction, or at least away from its Moscow dominance, is in development.[265]

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[262]Ltr. 5/8/59 RBF to J. Talbot in BFI-CR200. See also the *New York Tribune* report, 5 May 1959.

[263]Ltr. 1/26/59 Z.S. Makowski to RBF in BFI-CR199.

[264]Ltr. 4/2/59 RBF to E.J. Applewhite in BFI-CR199.

[265]Ltr. 4/2/59 RBF to E.J. Applewhite in BFI-CR199.

In the end, Fuller answered Makowski tersely, saying that he "(did) not have an outright technical treatise for release."[266] The episode suggested how Fuller overvalued the Soviet's interest in his work and he did so intentionally to forge new urgency for his works.

This second point was particularly obvious when he tried to reveal the hidden agenda of the Soviets in purchasing the Kaiser-dome. He coupled their interests "to break through comprehension of his principles" with implications of the recent Soviet satellite technology (Sputnik I & II, Oct.-Nov.'57).[267] The rise of Soviet satellite technology with the Sputnik event, Fuller predicted, would render the function of its enormous aircraft industry obsolete. Fuller maintained an idealistic view that the Soviet political machinery was coming around to redeploy its armament industries into civilian-consumer goods; and that his geodesic artifacts, among his broad industrial principles, would point a way. The net result would be an unwittingly peaceful one in which everyone would acquiesce.

Likewise, rather than attributing over-production of the American aircraft industries as a reason for the mounting pressures for their diversification, Fuller reconstructed the participation of North American Aviation (NAA), the prime structural fabricator of the American Society of Metals (ASM) Dome as fall-out from Russian satellite technology. In an addendum to a presentation for the ASM Yearbook, on the occasion of the organization's recently completed headquarters in 1959, Fuller rendered the significance of the geodesic structure technology to the aluminum industries in the "post-Sputnik" era:

> The aircraft industry is looking for a sustaining non-weapons economic outlet for its enormous capability. Its economic capability is organized around the here-to-fore economic impossibility that change and advance are constant and normal....
> Tuplov, prime air craft designer of Russia, on arrival in New York ... for the opening of the Russian Exhibition on being asked what he would most like to see in U.S.A. stated (July 2) that he was most interested in aluminum in the building industry ... I take this to mean that the Russian area of the industry in aircraft is about to reorient its high performance capability to the building arts ... The Western world will have to meet the Russian competition.[268]

Fuller also explained the implication of this conversion of Russian's "business of death" to the "business of life" to the "free world":

> We may soon see the Russians delivering the buildings and building mechanics of a complete new city of 10,000 to remote arctic areas in one air-delivered and parachute dropped twenty-

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[266]Ltr. 4/1/59 RBF to Z.S. Makowski in BFI-CR199.
[267]Ltr. 3/5/60 A. Fuller to R.E. Philipe in BFI-CR208.
[268]Ltr. 7/5/59 RBF to Dr. R. Smith in BFI-204.

four hour installation. If the Russians lead off with the historically unprecedented production capability abundance, at the highest technical level, applying the abundance directly to men's living needs, *the rest of the world will have to follow suit in order to maintain its dynamic balance in world economics*[269] (Itl., my emphasis).

Rightly or wrongly, Fuller intended to use this appearance of Soviet interest as a wake-up call for the American public and authorities. It was to heighten their awareness to the urgency of the strategic stakes at hand, namely, America's potential loss of world leadership.

3.3.3. Cold War Warrior

> I don't have plans (of special projects) for areas. My plans always have to do with ... the world.[270]

The Milan and Hälsingborg projects opened in Fuller a deep appreciation for a new symbolic dimension of the geodesic dome; namely, its ideological and political role in affirming American technological ingenuity. However, Fuller did not fully relinquish his belief that his work was vital to military logistics, particularly in augmenting a strong and mobile air command. He agreed, quoting Gen. Otto F. Wayland (Chief, Tactical Air Command, USAF), with the military that its tactical initiatives were "the best insurance against brush-fire or limited type wars."[271]

Fuller's explanation of his work, which oscillated between objects of war and peace contained neither ambiguity nor contradictions. Like many Americans of his generation, he probably viewed WW II and Korea as "good wars."[272] There was neither social stigma nor ethical conundrum in supporting the cause of the military. Further, if tools were evolutionary, their development from evil to good was, in any case, unavoidable. It was evident in this vindication of "houses-by-air ideas," which grew out of military development:

> I have lived to see my houses-by-air progressively adopted in successive emergencies by our national defense first as the air deliverable geodesic radomes to the entire Arctic perimeter's Defense Early Warning system stretching from the Aleutians to Greenland and Scandinavia; and adopted for advance potentials hot-war's airborne bridgeheads by the United States

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269 Ltr. 10/19/59 RBF to J. Montgomery in BFI-CR204.

270 Quoted in F. Kutchin's "The Elite Feature Interview: Inquiring for Buckminster Fuller," *Chicago Elite*, Nov.-Dec. 1977, Vol.2, No.6.

271 Ltr. 6/30/56 RBF to Maj. George J. King (Division of Public Information, Hdqrs. USMC, Washington D.C.) in BFI-CR178. Fuller quoting Gen. Otto F. Wayland's (Chief, Tactical Air Command, USAF) report in the *New York Times* (16 June 1956) to the Senate Air Power Investigating Committee.

272 See Studs Terkel's *'The Good War' : An Oral History of World War Two*, London: H. Hamilton, 1985 for Fuller's generation impressions of WW II.

Marines Corps (should that terrible moment come); and adopted by our Department of Commerce for our cold war, world around, International Trade Fair.[273]

For Fuller, the best war to be fought was ultimately against war itself. Yet, this strategy was inadvertently transformed by Fuller into Cold War rhetoric. The rhetoric implicitly cast the Russians as the invisible enemy of the U.S. and the "world people." The contest in the new world arena was about securing a moral authority, and the geodesic artifacts equally qualify for the new demands:

> The probable historical decision governing the possible win-or-lose-all events in the new Airocean World phase of omni-dynamic history, will hinge upon the superior ability to airlift adequate environment controls into instantaneous occupyability(sic) - at any and every critical event- half-way around the world in any land occurring direction. The next war's beachhead operations must succeed in planting a seed crop of environment controls whose numbers may be progressively multiplied until thereby ultimate control of the whole world environment has been established. Totally controlled environment will constitute a sustainable world 'peace'. The side which has the superior fly-in-able environment controls will win the peace....
> General Wayland (Chief, Tactical Air Command, USAF) and the others will in time come to discover those *hot barrel facts*. What they may miss, however, being military men, is that the *cool barrel of the Geodesic structures weapons* - inadvertently adopted by the Marine Corps - is the barrel which can now hit directly, instantly and effectively at the heart of every peace-time economic pattern the world around *without unleashing hot war*. *And if we win the cool war first, then there will be no hot war....*
> (I)t is towards industrialization that peoples of the world now direct their war-detouring hopes of swift emancipation from all the fundamental physical disadvantages and lethal deficiencies which in turn lie at the bottom of all political unrest (Itl., my emphasis).[274]

In actions and ideology, Fuller was unwittingly a Cold War warrior. Whether one relegated Fuller's collaboration with the military on the DEW-line radomes and Marine advanced based domes as mere opportunism or as personal acts of patriotism, it is finally difficult to extricate the complicity of his actions with the military. He assisted in advancing technologies of containment or retaliation, albeit with varying degrees of success. Initially he saw national security as fundamentally a military issue, but later, he saw the threat of Russia as political rather than military one. Fuller recognized that realpolitik was immoral, yet by the closeness of his patronage and relationship to the military, he did little except to protest quietly. While he alluded to internationalist aspirations, the concerns of the intense period of national security reduced them to a murmur.

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[273]Ltr. 7/28/62 RBF to J.K. Delson (Energy Resources Panel, National Academy of Science) in BFI-CR234.

[274]Ltr. 6/30/56 RBF to Maj. George J. King (Division of Public Information, Hdqrs. USMC, Washington D.C.) in BFI-CR178, pp.2-4. Fuller also claimed that he had previously distributed the map to "approximately one hundred and fifty leaders of research of major U.S. industrial corporations or branches of the National Defense."

Ideologically, Fuller was clouded by his belief that it was America's destiny in redeeming "world's people" from the potential shackle of communism. Fuller's ideological role was in identifying aspects of his work that would assist in curbing Russian duplicity and expansionism. His demonstration of the progressive edge of "evolutionary" industrial capitalism would be a deterrent to the Soviet's avowal of world revolution. This is despite his portrayal of his project as more radical than political ideologies of Marx or capitalism.

Still, Fuller tacitly believed that faulty communication was at the heart of the U.S.-Soviet problem. A "unity" among men transcending earthly differences would ensue if such tools and communications were forged. In advancing such tools and communications, however, Fuller believed that the American varieties provided greater efficacy, autonomy and transcendence. In making American technology "universal," he turned technology into propaganda, purging it of its nationalistic strains. Fuller, closer to Roosevelt's liberal sensibilities, believed in the flexibility of the Soviet political system -- it could be reformed and persuaded by technology. This approach diffused the political conservatives' deep suspicion of the Soviets; but the soft approach continued to mask the American pursuit of power.

The geodesic artifacts at the trade fairs accomplished this power pursuit directly and indirectly. Directly, they supported the American cultural programs by representing the milieu of creativity under American democracy. The design in the geodesic dome thus became palpable evidence of progressive culture under capitalism. Indirectly, they heightened the awareness of the State in the role of design as an ideology, raising design from a marginal concern to a focal issue. Fuller was aware that force was inadequate and often ineffective in transmitting new things and ideas.

Fuller's private 'voluntarist' initiatives in the dome projects and his ensuing efforts to gain media mileage out of them were not matters of pure self-promotion. Sidestepping the support and appearance of the State was paradoxically and ultimately a direct affirmation of the core of American political ideology. While the State represented the will of the people in a mechanical sense, it could not possibly give expression to a nation's soul. Whereas reliance upon State control was characteristic of European methods and smacked of realpolitik, the American way, one political analyst of American culture explained, called for the primacy of private initiative.[275] Still, Fuller's cultural perspectives, though liberal, were still based on corporate industrial capitalism as an engine to drive the democratic processes.

3.4. The Business of Geodesic Domes

On the business front, the potentiality of a large, lightweight space enclosure that is efficient, demountable, industrially produced (that would involve fewer unions) was the dream stuff of large industrial corporations. It meant a new economical proposition befitting the changing scale of business. The feature of Fuller's geodesic structuring in *The Architectural Forum* (August 1951) was particularly pivotal in engendering the new desires. One knowledgeable observer of the modern supermarket design, for example, noted that new trends in merchandising had now expanded the range of food products. He projected excitedly the significance of geodesic structuring in this context:

> Nevertheless, the feeling of the industry is that too much money is being spent upon the construction of markets, many of which have to be rapidly changed within a short span of years in order to keep pace with the tremendous progress in the growth of new departments. Operators are primarily interested in merchandising, and would prefer to have less money tied up in building structures so that they have more cash on hand for purchasing and selling. The preset day operator wishes that he had accordion walls; he is constantly looking for more space, either within his own market or within new markets. The basic economy(sic) interest in the geodesic dome should provide an avenue that would free the operator from the expensive and harshly limiting confines of brick, stone, steel and lumber.... I venture to predict that when you get around to the construction of shopping centers that your first application would be in a supermarket.[276]

By 1958, with some seventy companies licensed to produce a wide variety of Fuller's geodesic dome, *Business Week* vindicated Fuller's twenty five years of "uncompromising iconoclasm in engineering and design" with a feature that was captioned: "R. Buckminster Fuller: From High Brow Theory, Low Cost Structures."[277] From children's jungle gyms to military shelters and Arctic radomes, the range of uses for the structure seemed quite endless. The geodesic structures were no longer, *Business Week* commented, "exercises for architecture students dreaming of the future." Rather, it was a real business proposition that "caught on at last." The evidence was that besides two significant industrial corporations, Kaiser Aluminum &

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[275] Frank A. Ninkovich, *The Diplomacy of Ideas : U.S. Foreign Policy and Cultural Relations, 1938-1950*, New York: Cambridge University Press, 1981, p.14.

[276] Ltr. 8/24/51 Nathaniel Schwartz (Asst. Ed., *Supermarket Merchandising*) to RBF in BFI-CR137.

[277] -, "Fuller's Domes Catch On at Last," *Business Week*, 10 May 1958, pp.112ff.

Chemical and Union Tank, among the seventy licensees, smaller ones stood anxiously in queue on an envisaged five million-dollar business with their respective trademark products.

Naturally, under these circumstances, the new publicity initiatives previously undertaken by Fuller were now more actively assumed by his eager licensees. It was under this context that *International Management Digest* confidently touted the popularity of the geodesic domes as "spreading like wild-fire across the U.S. industrial landscape."[278] The invention was, the magazine further proposed, "a novel and inexpensive way to roof anything." Publicly, the teething problem to industrially implement the invention appeared to be over, as the Kaiser Dome appear poised to "cover banks, service stations, airport terminals, perhaps even homes." Kaiser's marketing pitch was buoyed by the "shocker" publicity stunt of assembling Kaiser's Hawaiian project by a crew in one day [Fig.3.29c, d, e & f]. With a projected production capacity of 250 domes per year, each costing between 250 to 750 thousand dollars, inclusive of finishing, plumbing and interior details; and a constructional system which required no heavy buttresses or foundation cross-ties, Henry Kaiser himself predicted confidently that he could sell a dome to every U.S. small town that needed a community center.[279]

3.4.1. Geodesic Domes as Affordable Shelters

3.4.1.1. *Better Homes and Gardens* (*BHG*) Plydome (1956-57)

Of the list of Fuller's geodesic projects destined for use as shelters, his collaboration with Alvin Miller and Ken Olson on the plydome is worthy of examination. As a formal development from his "Garden of Eden" project (1949), which *Interior* magazine billed as midway between a "Chevrolet and a summer camp," the Plydome was based on off-the-rack stocks of plywood.[280]

Fuller explained the plydome as an "expedient" application of geodesic principles. For this reason, Fuller characterized the version of the plydome in which he lived at Carbondale-Ill., made by one of his licensees Pease, as his "private hotel." Instead, he preferred "the Garden of Eden":

> The geodesic dome for household use ... should be extended not only over the living quarters but over the entire lot, providing climate control for year-around cultivation of plants, swimming in weather such as we are now having and other sheltered amenities. The more

278_, *International Management Digest*, McGrawHill, July 1958, p.36.
279_, "Fuller's Domes Catch On at Last," *Business Week*, 10 May, 1958, p.115.
280 "Building & Housing -- Everyman's Eden," *Interiors*, June 1949, p.1.

confidential aspects of household life could take place ... within the confines of natural screens rather than within structural walls.[281]

However, because of its size and its ubiquitous base material, plywood, Fuller proposed that the plydome was "easily assembled and comparatively inexpensive" and hence its value:

I feel it is what people have been looking for, for a long time and a true means of solving shelter-problems in areas where there is a crying need.[282]

The plydome was described by Don Robertson as a "self-strutted dome." It was assembled primarily from uncut plywood panels consisting of strategically placed connecting holes, all lined up along the lines of the geodesic three-way grid. Because the plywood was used as in total, the approach was a conceptual break away from thinking in triangular panel forms. In an ironical twist of geometry, the static rectangularity of the carpenter's world which Fuller censured, is now reconfigured into a stressed-skin assemblage. Punning Louis Kahn's famous line, "What does the brick want to be?" Robertson poetically rendered the arrangements of the plywood sheets in plydome thus:

It was almost as though (Fuller) had only to suggest the plywood sheets that they were laid up icosahedrally, and that they had answered 'So we must fall into a full geodesic pattern.' Or, simply, 'We want to be geodesic.'[283]

Fuller's choice of 1/4-inch uncut plywood stock was prudent and timely since the development of high-strength water-proof corrugated cardboard for his Paperboard Dome was not forth-coming. The eclectic mix of materials on his latest aluminum-clad paperboard dome at McGill University during the fall of 1956 proved to be cumbersome [See Fig.3.35; also Fig.3.41]. Further, plywood was less shocking to the home-owners than paperboard because it offered a degree of longevity. By Fuller's account, the first plydome was undertaken at Washington University around November 1956.[284] This was around the time when Alvin Miller and Ken

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281George McCue, "Art Show, New Geodesic Dome at SIU" in *Sunday Post-Dispatch*, 28 Jan. 1962, p.5B. See Fuller's plan 100' diameter geodesic dome on Spruce Head Island (Ltr. 11/25/60 RBF to J.T. Kelly in BFI-CR216, Ltr. 9/22/66 RBF to Claude Stoller in BFI-[?]).

282Ltr. 3/9/57 RBF to R. Mango in BFI-CR192.

283D. Robertson, *The Mind's Eye*, pp.53-54.

284Entry for the year 1956 under "Memorandum of Activities-Richard Buckminster Fuller "in "Dymaxion Index" (edn.1953), p.19. See also the advice of Dean J. Passoneau (School of Architecture, Washington Univ., St. Louis) on ways to reduce the use of plywood, and erection using a central mast (Ltr. 2/24/57 J. Passoneau to RBF in BFI-CR184).

The prototyping exercise and laboratory-testing of the plydome which Fuller described as a "fundamental contribution to science and therefore ultimately to mankind," was also undertaken by the architectural fraternity at Univ. of Minnesota, with Plydome Inc. procuring material and providing templates for locating holes on respective plywood sheets (Ltr. 5/10/57 RBF to L. Anderson, (Alpha Rho Chi, Univ. Minn) in BFI-CR189; also Ltr. 8/22/57 L. Anderson to K. Olson in BFI-CR-189).

Olson, assistant editors at *Better Homes and Gardens* (*BHG*), approached him for a feature story for the journal.

Miller was following on the expressed interest of his building editor to undertake an interview with Fuller on "dynamic developments" that would be of "timely interest" to readers of *BHG*.[285] Instead, the planned interview led to an ambitious proposal by *BHG* to advance Fuller's paperboard dome as an economical geodesic shelter, an act that effectively domesticated its previous status as an army ordnance.

Seeing a potential big story in the making, *BHG* agreed to support the continuation of Fuller's paperboard dome project and in trying out a new system of dome fabrication. The implicit desire was to encourage its readers to purchase and to test out the dome units. With *BHG*'s wide rural, middle-class readership, numbering around 16 million, the projection of potential interests for 15,000 dome units did not appear far-fetched. Container Corporation of America (CCA) had provided invaluable technical support on the earlier paperboard dome prototypes and was, according to Fuller's dome-shelter plan, an eminently qualified licensee to produce, package, sell and distribute the corrugated cardboard geodesic dome build-it-yourself kits.[286]

For Fuller's civilian-project enterprise Synergetics Inc., this opportunity, though initially appearing as an entrepreneurial delight, had ominous and deeper implications. Fitzgibbon was rightly cautious. The new business would redefine its identity and the scope of services, even if the financial reward for operating in a technical supervisory service was staggering.[287] Given the "formidable task" and the fact that Synergetics had "no prototype experience with which to demonstrate the properties, longevity, and uses of paperboard geodesic domes," Fitzgibbon recommended that Fuller consider setting up a third corporation.[288] This corporation, he

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The Cornell Pine Cone, a later version of the plydome was, according to Fuller, "an improved version." The overlaps resolved the standing problems of waterproofing and also the locations of openings for light and ventilation (Ltr. 5/16/57 RBF to J. Lindsay in BFI-CR186).

285 Ltr. 12/6/55 A. Miller to RBF in BFI-12/6/55. Miller met Fuller in 1953 while he was a graduate student at Univ. of Oregon.

286 Ltr. 5/8/56 J.W. Fitzgibbon to RBF in BFI-CR173.

287 Ibid. Fitzgibbon reported that *BHG* publisher, Meredith Publishing Company, had assumed a 15,000 unit-order. At a dome unit cost of $790 ($300, cost of single dome structure in package at a container plant; $200, probable mark-up by the Container Company of America for distribution at 66% sales & profits; $150, secondary items; $20 as an average of 4% royalty on $500; and $120, technical service charge), the total business anticipated was $11.85 million. Fuller's royalty of $200,000 on the domes would be offset by the cost of such a national operation involving a nation-wide service organization of 240 men. Fitzgibbon concluded that, given this financial analysis, the project was untenable.

288 Ltr. 5/8/56 J.W. Fitzgibbon to RBF in BFI-CR173.

proposed, would be organized with the specific purpose to distribute, market, sell and probably service paperboard domes.

Fuller's proposed paperboard dome for *BHG* was a 39-ft diameter unit, three foot wider the Milan Dome design. The dimensional change required new tooling and new dies. Nonetheless, it was a worthwhile move since, as Fuller argued, it permitted "slightly better use of the paperboard as it comes off the rolls."[289] While the project initially excited all the parties concerned because of its tremendous publicity value, Fuller was unable to either get a firm commitment from *BHG* or convince CCA to advance the prototyping alterations. However, because of the envisaged publicity, Fuller, Miller and Olson decided to rechannel the momentum of the public interests to another dome project. The choice fell upon the plydome. Miller's own 39-ft plydome prototype in Van Meter-Iowa cautiously guarded during the process of fabrication, was intended to be the feature "scoop" in the June '57 issue of *BHG*[290] [Fig.3.37a & Fig.3.37b - d. Their feature on this dome as well as Fuller, "What do you know about Geodesic Domes?" was published in *Better Homes and Gardens*, June 1957, and reiterated Fuller's claim that the new structuring capacity meant that "as many as 30,000 to 40,000 domes in a day" could be produced.

3.4.1.2. Proselytizing the Plydome

Imagining that the plydome would have the same market impact as the paperboard dome, Fuller heeded Fitzgibbon's proposal to set up and bankroll a third corporation in February 1957, which he named Plydome Inc. It was initially incorporated as a private Fuller construction company for a market of do-it-yourself (DIY) domes for general uses. Charged up by their recent prototyping experience and in anticipation of a dome future, both Olson and Miller, upon completion of their feature story on Fuller, left *BHG* to undertake his third dome enterprise on a full-time basis.[291]

The corporate objective of Plydome Inc. was modeled after Fuller's other "design service" corporations. Besides its intention to encourage the mass-manufacture of domes, Plydome Inc. would contribute directly to Fuller's direct financial gain in the form of dome royalties. Licenses for plydomes fell under Fuller's general non-exclusive clauses, with respect to geographic areas and exclusive rights to a particular model. The primary focus of plydome

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[289] Ltr. 7/31/56 RBF to A. Miller in BFI-CR178.
[290] Ltr. 2/14/57 A. Miller & K. Olson to RBF in BFI-CR183.

was on industrially producible structures manufactured from flat sheet material. Royalty for Plydome Inc. was rated on a sliding scale of total sales, namely at 5% for the first $1-million sales, 4% for the second, and 3% thereafter.[292] Plydome Inc. provided standardized plans to licensees who, in turn, would carry out the sales and construction of the structures. Its basic services to licensees would include "up-to-the minute information on dome revisions, joint treatments, mechanical equipment, erection techniques."[293]

The licensees reciprocated by financing the prototyping of the dome and preparing the necessary publicity. The strategy of Plydome Inc. was "to initiate standardization through multiplicity of manufacturers," so that the final plydome cost would be lower.[294] As with the other dome enterprises, Fuller provided his own best and most skillful publicity. In the plydome phase, for example, Fuller secured a full feature on the "Exploration" program of Canadian Broadcasting Corporation (CBC)-Toronto through Ted Pope, a producer for Public Affairs-CBC, previously associated with FRF-Montreal.[295] Focusing on the theme of housing, Fuller advanced his new design for shelter in a 42- and 28-ft plydome. After the CBC-engagement, the 28-ft plydome was re-erected as a tractor store at Michigan State Univ. on the occasion of the Golden Anniversary Meeting of the American Society of Agricultural Engineers.[296]

Though proposing the plydome as "a new form of low-cost quality shelter to the consumer," Plydome Inc.'s marketing strategy was to avoid any kind of use that could be scrutinized as a conventional habitable space under the existing building codes. Even as one fabricator contemplated on the plydome as a "residential dome," Olson cautioned that the plydome was the stuff of "frontier land" and that the customer needed "a good bit of pioneering blood."[297] Olson also admitted that Plydome Inc. had not conducted any formal tests on the dome "that would prove universally satisfactory to all building commissions and pass all building codes."[298]

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[291]Ltr. 5/16/57 RBF to J. Lindsay in BFI-CR186.

[292]Ltr. 9/16/57 K. Olson to J.B. Cleary in BFI-CR189.

[293]Plydome Inc., "Shell Structures resume," 5/1/57 in BFI-CR186.

[294]Ltr. 6/24/57 K. Olson to Jim Solosky (Dow Chemical Co.) in BFI-CR187.

[295]Ltr. 1/17/57 T. Pope to RBF in BFI-CR187.

[296]Ltr. 5/7/57 K. Olson to D. Mortellito in BFI-CR186.

[297]Ltr. 7/30/57 K. Olson to E. Godfrey in BFI-CR188.

[298]Ltr. 9/17/57 K. Olson to Schneider Built Homes Inc. in BFI-CR189: Schneider was attempting to fend off the skepticism of its local building department whether the plydome was "substantial enough" for Long Island climate.

The structural efficacy of the geodesic dome, however, by this time, was not at issue, given the successful extreme circumstances under which it had been tested. Rather, the uncertainties over its thermal performance as a habitable space and its fire-safety became extenuating concerns for local authorities to deny building permits for the dome.[299] Thus, to avert the scrutiny of regulatory authorities, one licensee, Shell Structures (Denver-Colo.), proposed the use of the 24-ft plydome as "mountain vacation, ski huts, farm shelters," its 39-ft plydome as "storage domes" and "farm use"; and its 60-ft version as "privately owned aircraft hangars, office, and storage shelters, small auditoriums, club houses."[300] Others were destined for farm structure, vacation cabin, ski shelter, motel units, cabanas, mobile home annexes, etc.[301] Plydome Inc.'s own 29-ft prototype ended up as a car-wash [Fig.3.42a], its second 39-ft prototype, undertaken for the St. Columban Fathers' Foreign Mission Society of the Catholic Church (Bellevue-Nebr.) in July 1957, was used as a chapel overseas[302] [Fig.3.43].

In attempting to by-pass what he characterized as the quagmire of building trades, Fuller revisited the marketing strategy that he had developed in the DDM-Fuller House and 4D projects.[303] With plydome, Fuller proposed a more direct fabricator-consumer link. In one example, Fuller proposed plugging into the network of farm implement manufacturers and their dealers in order to reduce the cost of establishing marketing channels for domes on the farm front. The task was to enlist the support of the manufacturers of farm implements to commission their dealers in merchandising the dome packages as low-cost equipment shelter.[304] Other options explored included developing "responsible dealer-erector" or "fabricator-erector" relationships; creating "do-it-yourself" packages through Sears, Montgomery Ward and comparable companies dealing with mail-order houses; and lastly, marketing kits of parts or knocked-down units in local lumber yards.

Compared to Fuller's other domes, the plydome had several distinct features. Firstly, it was not portable despite its makeshift appearance.[305] The ground preparations for a concrete

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[299]Ltr. 9/9/57 M.J. Godfrey to K. Olson in BFI-CR189.

[300]Plydome Inc., "Shell Structures resume," 5/1/57 in BFI-CR186, p.1.

[301]Ltr. 5/10/57 Plydome Inc. to T. Pope in BFI-CR186.

[302]Ltr. 7/15/57 K. Olson to H.D. Grae in BFI-CR188; Ltr. 7/29/57 K. Olson to RBF in BFI-CR188; and Rev. Colm Murphy's "Geodesic Dome, the Structure of the Future," in *The Columban Fathers' Magazine*, November 1957, pp.1-3.

[303]See E.J. Applewhite, "Outline (of sales, promotion and distribution plans for Fuller House, and their allied products, from the time of manufacture to final occupancy), Fuller Houses Inc.," 2/1/46 in BFI-HEv6.

[304]Plydome Inc., "Shell Structures resume", 5/1/57 in BFI-CR186, p.2.

[305]Ltr. 7/2/57 K. Olson to The Rev. R.J. Welsh in BFI-CR187.

base ring and floor already established for plydome its permanent feature. The public perception of the plydome as a temporary structure was pervasive to the extent that Olson had to explain that despite the "radical structure" of the plydome, its longevity was on par with conventional construction.[306] Second, the rustic appearance of the plydome was at odds with the slick, precise hub-strut and skin dome system of Raleigh or the ascetic, geometrical rigor of Geometrics' radome. Yet, there was little doubt in Miller and Olson's mind that the plydome was an industrial object with a technological edge that would "touch every 'building' area -- from farm economy to human shelter." Their explanation to Robert Marks prefigured a significant message about personal control over technology. This would resurface in the late sixties with *The Whole Earth Catalogue* generation, when it faced Fuller's geodesic technology as hand-made domes:

> (Plydome) is so well tuned to present industrial technology. As a matter of fact, anyone interested in fabricating the structure could begin operations with no more equipment than a 1/2-inch hand drill and a pair of sawhorses. An oversimplification, but not too far afield of the basic technology that is entertained in plydome production...
> (I)t relieves the burden of saws, hammers, planes, measuring 'sticks', beams, columns, 2x4s and 'trims'. All you'd require would be a bucket of bolts and a wrench.[307]

With this explanation, Fuller's geodesic structural technology assumed an almost metaphorical lightness, transcending all the material strictures that had manifested its variations: in the paperboard dome, the radome, the hub-and-strut geodesic structure. More significantly, geodesic technology as "nature's technology" had no favored sons.

3.4.1.3. Pease Dome (1958-64) -- Geodesic Shelter As a Commercial Proposition, Promises and Problems

Despite the confident start, Plydome Inc. was inactivated in November 1957, less than nine months after its incorporation and its activities "consolidated" in the Raleigh operation. In total, no more than five plydomes were built.[308] Privately, Olson explained that the reason for closing down Plydome Inc. was financial, caused by Fuller's tightening up of his business overheads.[309] Its purpose to establish contact points for creating other dome agencies-fabricators fell short of the ambitious "fifteen dome market" zones which Fitzgibbon strategized for the paperboard domes. Only a handful of regional operations took on Plydome Inc.s' services -- Shell

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306 See Ltr. 10/18/57 K. Olson to Rev. Colm Murphy in BFI-CR191; also report of public concerns over acceptance by local building departments in H.D. Grae's "Plydome Exhibits Summary at the San Francisco Arts Festival, Sept. 24-29 1957" in BFI-CR190.

307 Ltr. 5/16/57 Plydomes Inc. to R.W. Marks in BFI-CR1[illegible]

308 Two 53-foot plydomes were subsequently built by one of Fuller's licensees, Riley Engineering (Hartford-Io.) for the order, and shipped to Korea (Ltr. 8/27/57 K. Olson to RBF in BFI-CR189).

309 Ltr. 11/1/57 K. Olson to M.J. Godfrey in BFI-CR191.

Structures (Denver-Colo.), Grae Contracting (San Francisco-Calif.), Pease Woodworking Co. (Hamilton-Oh.), Panel Bild System (Lynwood-Wash.), and Geoplex Enterprise (Anaheim-Calif.). Of this list of fabricators which Plydome Inc. enlisted in supporting its projected "vast and boundless picture" of dome shelter, the Home Division of Pease Woodworking Company (Hamilton-Oh.) was the only one successful in turning the plydome idea into a commodity proposition nationally, and maintaining a royalty payment to Fuller up till the mid-sixties [Fig.3.36a - b].

Upon the dissolution of Plydome Inc., Miller and Olson joined Pease to design and promote geodesic structures.[310] Pease was licensed by Fuller in 1957 and 1960.[311] Both Miller and Olson recognized that Pease's primary strengths in capital outlay, technical resources and marketing network were necessary to advance the plydome project.[312] Pease's long-standing history as one of the larger prefabricating companies for homes and miscellaneous structures in the East Central States was pivotal in its success as Fuller's geodesic patent licensee.[313] From the turn of the century, Pease developed its business and expertise in millwork and woodworking. Its first mail-order building material catalog was published in 1898; and this sector of business still accounts for a substantial amount of its materials business.[314]

Pease was able to muster resources to overcome obstacles posed by local building codes. Even as it raised its own 39-ft structure, it immediately underwent tests for equipping and accessorizing at its own plant sites.[315] Over the next six years, Pease's most significant tactical move, however, was to abandon the plydome altogether. Instead, through the work of Miller, Pease adapted a structure closer to the one that Synergetics Inc. developed for Homasote [Fig.3.44]. Pease's continued success was its ability to perfect its own line of non-geodesic domes from experiences it gained through prototyping Fuller's geodesic domes, with changes even at one point leading to charges of infringements by other dome inventors.[316]

Pease's experience in the mail-order business provided a network of sub-licensee manufacturers which facilitated the dissemination of domes in the domestic market. Though

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310Ltr. 1/17/58 W.M. Parkhurst to A. Miller in BFI-CR190.
311Ltr. 5/16/60 RBF to J. Pease in BFI-CR211
312Ltr. 6/26/57 K. Olson to RBF in BFI-CR187.
313Ltr. 6/24/57 K. Olson to J. Pease in BFI-CR187.
314For history of Pease Company, see: http://www.peasedoors.com/history.htm, 6/19/97.
315Ltr. 9/24/57 K. Olson to J.J. King in BFI-CR189.

Fuller's lawyer, William Parkhurst, received Pease's proposal for distributorship of their domes with trepidation, Pease gradually moved towards "assembling distributorship" in the mid-sixties[317] [Fig.3.36c & d]. Fuller expressed apprehension about how the Pease distributorship assembly could potentially compromise his idealized manufacturer-consumer link, particularly with respect to service. Because Pease "shipp(ed) their manufacturing dues to their distributors for local manufacture," customers did not properly receive Pease Woodworking's attention.[318]

Pease decided to phase out its production of Pease Domes in October 1964 but it was caught in a predicament of how to retrieve the developmental costs of its own dome variety.[319] Though it held its own patents on design and construction of Pease-type geodesic domes, Pease operated under a license agreement with Fuller and was "paying royalties for (his) mathematical patents" which barred Pease from licensing the assembling distributorship. Pease's proposal was that Fuller should license dealers to make Pease domes. This would enable them to save freight costs and gain in manufacturing mark-up, with both parties, Pease & Fuller, collecting royalty revenues. Though Fuller was dissatisfied with the arrangements and was of the opinion that the Pease Patent was "not worth much," he subsequently accommodated this licensing arrangement.[320] This was because the arrangement was probably the most realistic way of enlisting capable and responsible manufacturers as fabricators and sales outlets for dome shelters.

The Pease-Fuller association, more forcefully than any of the Fuller's other dome enterprises, highlighted the issues pertaining to dome business, royalty and patent rights. For instance, over the issue of royalty, Pease assembler-distributors argued that, despite the use of the same dome structure, there was a wide fluctuation in dome prices and in the way royalty was established. Given the vagaries of ancillary items like fenestration types, doors and other accessories, the royalty, they argued, would be more accurately calculated on the basis of the area of floor covered rather than the volume dollar of sale from each completed component.[321]

The issue of what constituted geodesic accessories was a standing problem, and not confined to Pease alone. It stemmed from the fact that Fuller's geodesic patent was overtly

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[316]Ltr. 10/9/62 D. Robertson to Stanley R. Foster in BFI-CR236: over the Pease's infringement of Gelsavage U.S. Patent #2,918,992.

[317]Ltr. 7/21/61 W.M. Parkhurst to RBF in BFI-CR222.

[318]In Ltr. undated (ca. Sept '64) RBF to Hon. G. Lewis in BFI-CR262.

[319]Ltr. 11/1/63 J. Pease to RBF in BFI-CR249.

[320]Ltr. 11/18/63 RBF to W.M. Parkhurst in BFI-CR249.

[321]Ltr. 1/27/66 J. Pease to W.M. Parkhurst in BFI-CR279.

general; and in one instance, a licensee arguing over royalties due for the inner and outer vent covers for the dome.[322] In the end, the geodesic shelter was merely a proposition for a shell and it represented a small portion of the final assemblage that the American public considered a livable shelter. Excluding the cost of land, and even at $3400, Fuller's own Pease dome, his "private motel" in Carbondale-Illinois, designed by Al Miller, formed less than ten percent of the house construction costs[323] [Fig.3.40a & b, Fig.IV 32.1, 34.1].

3.4.2. The Union Tank Car Dome, Baton Rouge-Louisiana (1957-58) & Corporate Ambitions

The plydome and the paperboard domes, seen as ephemerals and self-help, tested the low-end use of the geodesic structure. They raised doubts about their tenability as shelters. The other imagined deployment of the geodesic structure for commercial exploitation was a specialized industry. Both illustrated a similar mix of technological optimism and hype [Fig.3.05a & b]. The dome undertaking of Union Tank Car Company illustrates the folly of one such specialized dome enterprises.

Union Tank Car Company was a key lessor of all-steel train-cars in U.S. In 1958, it consolidated its industrial activities with Phoenix Mfg. Co. and Graver Tank & Mfg. Co. to form Union-Graver. As the world's largest lessor of tank cars, with some 56,000 cars serving railroads and shipper in the U.S. and Canada, the new business activities under Union Tank Car Companies integrated their overall services. Phoenix Mfg. Co. (Joliet-Ill.) operated a steel mill which produced a wide range of steel products including tank flanges; while Graver Tank & Mfg. Co. (East Chicago-Ind.) manufactured tanks for Union Tank besides being a leading plate fabricator and erector of steel.[324]

By several accounts, the engineers of Union Tank Car Company (UTCC) initiated the research into the use of the dome form for its car rebuilding and reconditioning plant.[325] They

[322] Ltr. 3/15/57 W.M. Parkhurst to Magnesium Products of Milwaukee in BFI-CR185.

[323] Ltr. 3/15/62 Parrish Const. Co. to RBF in BFI-CR229.

[324] See A.M. Kidder & Co., "Stocks & Markets - A Weekly Report," ca.1958 on Union Tank Car Co. (NYSE34 1/2); "The History of Union Tank Car Co.," (In-house News of Union Tank Car Companies by The Public Relations Board-Chicago) 5/5/61.

[325] Notes from Author's Interview with T.C. Howard, Raleigh-N.C., 4/26/95. See also "Fuller's Domes Catch On at Last," *Business Week*, May 10, 1958, p.115.

More directly, Graves & Lehr, two engineers at Union Tank studied and suggested the possibility in using the dome as a car repair shop (Ltr. 12/4/56 D.C. Graves & R.A. Lehr to RBF in BFI-CR191). Their follow-up letter were probably instigated by Fuller. Fuller had visited UTCC earlier in fall '56 probably at the invitation of Edwin Locke, the President of UTCC.[326] Locke, also a Harvard graduate, was acquainted with Fuller while serving on the War Production Board in Washington D.C. As a trustee of Fuller Research Foundation (FRF) in the late forties, Locke augmented Fuller's efforts to seek research funding in Washington D.C. At the start of the DDM project, Locke used his position in Washington to promote Fuller's application for research funds.[327] In 1956, Locke needed little evidence to be convinced of Fuller's vision of a world of mass-produced domes.

After an in-house study of their operational procedures, UTCC's engineers concluded that with a large enough dome, it was possible to automate, with minimum effort, the different inspections and maintenance stages of the tank cars as they move off the tracks into merry-go-round-style stations. Between mid- to end of 1956, UTCC engineers envisaged their schematics of tank-maintenance in a dome segment of 200' diameter [Fig.3.01a & b]. Because of this considerable reduction in working floor area and the appearance of centralized work efficiency, Locke himself was no less enthusiastic about its adoption.

The layout efficiency, however, would eventually be offset by the high temperatures, reaching 120°F on occasions; and the humidity caused failures of air-conditioning equipment, affecting cars and workers in the dome.[328] Despite these problems, the imagined work efficiency in terms of "increased mobility and smoother work flow," "concentration of activity," " more efficient materials storage," "reduction in movement of men" and the promise of "no idle repair spots," remained key features in the company's public relations campaign.[329]

While Locke's initial enthusiasm for the project might have been driven by his own sense of experimentation and the novelty of the geodesic dome, its potential as a prototype for mass-production of storage-maintenance facility quickly became attractive to him. Despite the initial hiatus on the prototyping process and numerous fabrication and on-site problems, the project, assembled in Baton Rouge, known as Union Tank Car Dome-Louisiana (UTLx Dome), was unequivocally stunning in appearance and in engineering terms.

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suggested the significance of Fuller's textile mill project at NCSC (1951) in shaping the Union Tank Car Dome project (Ltr. 12/11/56 D.C. Graves & R.A. Lehr to RBF in BFI-CR191).

[326]See J.W. Fitzgibbon's "The Design History of the Baton Rouge Dome," ca. March 1957 in BFI-CR196.

[327]See Ltr. 1/2/47 Ely Hutchinson (Chief, Industrial Research & Development Division) to Edwin A. Locke (Special Asst. to the President) in BFI-CR133.

[328]Ltr. 6/4/59 D.C. Graves (Union Tank Car Co.) to RBF in BFI-CR201).

[329]See report on Graver Tank-Wood River dome in The Public Relation Board (Chicago), "News from Union Tank Car Companies," 5/5/61.

Besides its 385-ft free span which immediately established its fame as the largest dome upon completion in March 1958, the entire bill of materials for the building included only eight items, using two ounces of structure for every cubic foot of enclosed space and costing less than $10 per sq. ft.[330] From start to end, the erection of the dome took a mere five months. The shop drawings were prepared in April '57 with 320 panels fabricated over a period of six months. The dome raising started in October '57 and was completed by March '58.[331]

At the end of 1957, even before the completion of the dome, Locke reported that the iron geodesic dome "look(ed) like a good product to sell others."[332] He convinced UTCC to expand its field outside the tank car leasing by acquiring Phoenix Mfg. Co. and Graver Tank & Mfg. Co. and integrating their manufacturing operations. The long-term plan was towards establishing a dome department to investigate the market for domes as tank-car maintenance plants and other "extremely economical" industrial buildings, including shopping centers, sports arenas and civic auditoriums.[333] One securities analyst proposed that these expansion activities promised prospective advantages of the company in longer-term appreciations.[334] Further, as the pioneer of the all-steel car, the proposition to be the first steel dome manufacturer needed little persuasion. The new venture would, in modern day parlance, augment the core capabilities of UTCC.

3.4.2.1. Coming Around to UTCC's Agenda

The UTLx Dome was fundamentally a new generation of geodesic structuring. It consisted of welded plates and a trussed pipe geodesic framework. Synergetics Inc. initially assumed that the primary challenge in the UTCC assignment was to adapt its geodesic arts based on aircraft design standards to building structures standards. Given the stringent dimensional and fabrication tolerances in aircraft technology and critical logistical requirements in weight, this crossover seemed unproblematic.[335] The task proved not to be the case and the technological translation was not as straightforward as it appeared.

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330 _, "Domes Catch On at Last," *Business Week*, 10 May 1958, p.115.

331 See Ltr. 2/9/59 J.W. Fitzgibbon (Synergetics Inc.) to RBF in BFI-CR206.

332 -, "Fuller's Domes Catch On at Last," *Business Week*, May 10 1958, p.115.

333 Ibid. See also similar promises in The Public Relations Board (Chicago), "The Future of Big Domes" (In-house News of Union Tank Car Companies), 5/5/61.

334 A.M. Kidder & Co. "Stocks & Markets - A Weekly Report," ca.1958 on Union Tank Car Co. (NYSE34 1/2).

The design process, or rather, the structural system selection, began with a magnified version of the plydome. Fuller probably suggested to the UTCC engineers that the plydome could fulfill its idea of a minimum cost shop dome. The fundamental engineering on the plydome was developed by Synergetics Inc. when the UTCC project was first proposed.[336] The preliminary plywood investigation in single and double domeboard unit was financed by UTCC.[337] The prototype, made of 4-ft by 8-ft sheets of Baltimore plywood, failed miserably under its own weight in test sections in February 1957 [Fig.3.04a & b]. The dimpling of the prototype section resulted from dome buckling because of the thinness of the plywood panel with respect to the dome size. T.C. Howard recalled:

> At any rate, Eddie(Locke) said, 'Bucky, let's forget the wood ... I don't want to mess with wood. We are not wood people, we are steel people.'[338]

To increase the effective depth of the structure, a "double dome-board array with spreaders in between the surfaces" was developed.[339] This was effectively a stressed truss unit, but still configured like the plydome with one section slipped under the other and fastened by bolts. The strength of the section, it was proposed, could be progressively increased by changing the thickness of the plywood from 1/4" to 5/8"[340] [Fig.3.03a]. Because of the dome size, the risks in numerous uncertainty factors such as buckling of its surface and objections from Locke himself, Synergetics Inc. deemed it prudent to move towards a dome form of a deeper structure.[341] For this reason, alongside the testing of the "double dome (plywood) array," a third structural strategy of truss-frame of aluminum tubes configured in a hexagon-pentagon pattern with 48" deep stainless steel tension members was developed in tandem.[342]

This third scheme was illustrated in a dome segment of 200' diameter consisting of a truss-frame structure with a suspended inner weather cover of geon-coated nylon fabric [Fig.3.02a & b]. The stressed truss of "double dome (plywood) array" was substituted by stressed

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335 Ltr. 12/13/56 J.W. Fitzgibbon to B. Damiani (Union Tank Car Co.) in BFI-CR181.

336 Notes from Author's Interview with T.C. Howard, Raleigh-N.C., 4/26/95, p.50.

337 See Ltr. 2/27/57 J.W. Fitzgibbon to R.A. Lehr (Union Tank Car Co.) in BFI-CR185.

338 Notes from Author's Interview with T.C. Howard, Raleigh-N.C., 4/26/95, p.24. Fitzgibbon also mentioned this phase of test-work in "The Design History of the Baton Rouge Dome," ca. March 1957 in BFI-CR196; and Ltr. 6/14/57 J.W. Fitzgibbon to R.A. Lehr (Union Tank Car Co.) in BFI-CR185.

339 Ltr. 2/27/57 J.W. Fitzgibbon to R.A. Lehr (Union Tank Car Co.) in BFI-CR185.

340 Ltr. 2/28/57 J.W. Fitzgibbon to D. Robertson in BFI-CR185; also Ltr. 2/27/57 J.W. Fitzgibbon to RBF in BFI-CR185.

341 Notes from Author's Interview with T.C. Howard, Raleigh-N.C., 4/26/95,p.22.

342 Ltr. 12/29/56 J.W. Fitzgibbon to RBF in BFI-CR184.

welded steel plates. This eventually gave way, by June 1956, to a geodesic space truss erected as an assemblage from pipe framework (of compressive struts and the connecting tension rods) and the hexagonal steel plates configured in an octahedron.[343] These subassemblies integrated and stabilized another with each successive ring of erection [Fig.3.03a]. The steel plates, besides acting as bottom tension members, also resolved skinning requirements of a hardy environment simultaneously. With the final design, the vestiges of lightweight aircraft technology were completely expunged. In other words, the final design became a total steel dome. The choice of steel was entirely a UTCC decision, since the company had "good steel purchasing contracts and steel fabrication experience, and had experience in the painting and maintenance of steel structures."[344]

The significance of the UTCC-prototyping process is twofold. It highlighted broad uncertainties and practical problems of changing the dome material from one medium to another, while retaining the geodesic geometry - in this case, the plydome. It also highlighted particular problems in manufacturing big domes. Despite the elaborate jig-assembly and prefabrication processes, the overall process was more akin to building. Partly, this was because the large dome presented new base-load problems, expansion characteristics and base connection requirements not encountered previously. For example, openings and tunnel in the dome necessitated a whole range of modifications to the standard parts.[345]

One could say that from the start of the project, UTCC's proposal to produce steel domes was a strange and lethal mix - an industrial tank car manufacturer employing an inadequately field-tested adaptation of aircraft technology; executed in the manner of a building industry. While the ambition to manufacture the dome was industrially motivated, the work procedures remained quintessentially architectural. There were whole hosts of participants on site: Union Tank acted as the main contractor, a general construction contractor (Nichols) and the supervising engineers (Battey-Childs, Chicago). Discrepancies showed up in the field operations, jig

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[343]For results of structural testing of a prototypical panel (one hex-shaped unit comprised of steel sheets and fittings), see "Preliminary Report No.1 on a Proposed Loading Test for Geodesic Dome for Union tank Car Company, Chicago-Ill.," ca. April 1957 in BFI-[?]. See also "Memorandum for agreement between Union Tank Car Co., Chicago-Ill., and Synergetics, Inc. of Raleigh-N.C.," 6/15/57 in BFI-CR187 which defined the scope of work to be undertaken by Synergetics Inc.: to "design, calculate and prepare the necessary drawings and details for the fabrication of a 375-foot diameter steel, octahedron truss, one-quarter geodesic dome with paint shop tunnel."

[344]J.W. Fitzgibbon, "The Design History of the Baton Rouge Dome," ca. March 1957, in BFI-CR196, pp.3-4.

[345]Ltr. 7/3/57 C. David Sides (Synergetics Inc.) to R.A. Lehr (Union Tank Car Co.) in BFI-CR187.

assembly and office drawings.[346] Another problem was UTCC's quiet ambition to go alone on the project, fast-tracking and cost-cutting, and doing without the technical support of the "geodesic engineers" of Synergetics Inc.[347] UTCC assumed that dome drawings were adequate as manufacturing specifications, requiring no specialized work to "interpret drawings, aid in jig fabrication and assembly and check out (the) results."[348] For example, T.C. Howard recalled how, at one point, UTCC failed to tighten the tension members of the dome and compromised its stiffness, leading to instability.[349] Similarly, though claiming that "these geodesic domes are simple and the fabrication and erection job should proceed with simplicity and dispatch," Fitzgibbon nevertheless suggested that it was more beneficial for work to proceed under the supervision of someone with experience with geodesic domes.[350]

Despite these on-site problems and delays in the dome fabrication at Baton Rouge, Locke advanced UTCC's business ambitions with full confidence in the geodesic dome:

> We have completed arrangements to expand our construction facilities significantly, and this has turned my mind once more to the possibility of our erecting Fuller Geodesic domes made of steel, *not only for some of our shops, but for other companies*. The question arises whether such an undertaking would be economically sound. Our feeling is that if we were only one of several licensees, it would not be sound for us to put much capital or effort into the marketing of the dome ... I wonder whether from your standpoint there is not a good deal to be said for giving an exclusive license for the marketing of the steel dome to a single strong corporation which would be in the position to do, and would have an adequate incentive for doing, the extensive promotional and technical work required[351] (Itl., my emphasis).

The opening of UTLx-Dome in 1958 occasioned what the UTCC public relations described as "a mightily-detailed, precision-planned program ... to structure the new image of a fast-moving American corporation: Union Tank Car Company"[352] [Fig.3.07]. Its public relations campaign had geared UTCC to a wide spectrum of interests - business, architecture and the tank car repair industry. It pointed out that the July 1958 *Fortune* issue suggested that with the dome,

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[346]Ltr. 8/2/57 J.W. Fitzgibbon to R.A. Lehr in BFI-CR188; also J.W. Fitzgibbon, "Memorandum regarding phone call from D Sides in Baton Rouge to Fitzgibbon in Raleigh & status of Union Tank Car Co. job in Baton Rouge," 7/9/57, in BFI-CR188.

[347]For evidence of delays and cost-cutting measures by Union Tank, refer to Battey-Childs' In-house Memoranda (RE#595 A-1, 11/30/57 & RE#595-4, 12/9/57), Lloyd G. Botts (Battey-Childs, Baton Rouge-La.) to J.H. Wilson (Battey-Childs, Chicago-Ill.) in BFI-CR191 and BFI-CR190 respectively.

[348]J.W. Fitzgibbon, "Memorandum regarding phone call from D. Sides in Baton Rouge to Fitzgibbon in Raleigh & status of Union Tank Car Co. job in Baton Rouge,"7/9/57, in BFI-CR188.

[349]Notes from Author's Interview with T.C. Howard, Raleigh-N.C., 4/26/95, p.26.

[350]Ltr. 7/9/57 J.W. Fitzgibbon (Synergetics Inc.) to R.A. Lehr (Union Tank Car Co.) in BFI-CR188.

[351]Ltr. 7/10/57 Edwin A. Locke Jr. (President, Union Tank Car Co.) to RBF in BFI-G-76 S. Sadao (Geodesic, Inc.).

[352]The Public Relation Board (Chicago), "Union Tank Car Company"(flyer), ca. August 1958. See also The Public Relation Board (Chicago) "News from Union Tank Car Companies," 5/5/61.

UTCC became "an aggressive, progressive dynamo in a traditionally conservative industry" while *The Architectural Forum* reported its "original, far-sighted approach to its particular construction problem." Thus, rather than "facing extinction," as Martin Pawley characterized the economic situations faced by UTCC and Ford Company, their respective dome projects were well-timed strategies to enliven or resuscitate their jaded public images respectively.[353] On the other hand, the UTLx-Dome was equally beneficial to the dome enterprise. Because of its unconventional use and its low public safety hazard, it circumvented the complications that would arise from stringent building regulation codes and zoning. Nevertheless, the unorthodoxy also created high public profile for the domes in the media, while their controversies were gradually worked into public acceptance.

Despite the publicity blitz, UTCC, through its subsidiary of Graver Tank, managed to build only one other welded steel-plated dome at Wood-River Illinois, using a similar geodesic configuration. The effort in making this second dome highlighted the problematic role of Fuller's corporate entities as they sought to exert their identities in relation to UTCC's business ambitions, and the dome industries in general.

3.4.2.2. Graver Tank's UTCC Mark-II Dome (1958-61) -- Working Around Fuller's Patent and System

UTCC's ambitions to expand its tank car maintenance interests into steel dome manufacturing highlighted the uncertain role of Synergetics Inc. in dome prototyping activities. In particular, it showed the serious contradictions between UTCC's corporate ambitions and Synergetics' mission. Several letters of exchange between Synergetics Inc. and Graver Tank attested to this tension. While Locke was attempting to win over Fuller's concession of an exclusive licensee, D.C. Graves, then Chairman of the Board of UTCC, sought to control the dome design by arguing that it was legally their prototype design.[354]

It was in Fuller's interest to get as many of his geodesic domes prototyped. In the early years, he had depended on non-exclusive licensees issued to structural experimenters, from which he collected a nominal royalty. These one-off projects were easily handled since the client was

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[353] K. Simon & K. Goodman, Transcript of Interview with M. Pawley (for a PBS documentary "Thinking Out loud"), New York, ca.1995, p.24.

[354] Union Tank's proprietary claim of the dome design was implied in the "Memorandum for Agreement" between Union Tank Car Co. and Synergetics Inc. (Ltr. 6/28/57 D.C. Graves to J.W. Fitzgibbon, under "The Scope of Work"). Though I was not able to locate this letter, it was directly referred to in two other letters, Ltr. 7/15/57 & 7/11/57 J.W.

often prepared to foot the bill and assume the risks. This practice assisted in expanding public reception of a broad range of geodesic structures. The large costs incurred in prototyping for manufacture, on the other hand, meant that Fuller had to find some other arrangements that would benefit him as well as his sponsors.

The primary confusion revolved around the identity of Fuller's corporate entity and its place in the commercial-speculative ventures, vis-a-vis UTCC's own corporate ambitions. UTCC assumed that Synergetics Inc., like Geodesics Inc., were promotional fronts of Fuller's larger geodesic enterprises, albeit their self-characterization as providing engineering and prototyping services. Hence, UTCC assumed that the prototyping services rendered by Synergetics Inc. was part of the licensing process, and the fruits of the design activity would be limited to a single licensee, namely themselves. The status of the drawings and the mathematical data associated with the dome also added further confusion. While UTCC treated them as trade secrets of research and development, and hence "items of commerce," Synergetics Inc. proclaimed that they were "instruments of professional service."[355] Further, the design development work was paid out of Fuller's investment on a dome "designed for a previous client," which though not employed subsequently, was "at hand for consideration and use on the Baton Rouge project."[356] From the point of view of Synergetics Inc., the distinctive dome design already advantaged UTCC, making it "difficult for competitors to counter." UTCC, on the other hand, treated the licensing agreement and royalties as payments, in principle, of the prototype. In this way, Synergetics Inc., rather than acting in a professional consultation capacity, was momentarily by the act of licensing, an extended research and development component of UTCC. UTCC logically viewed that the prototyping entailed specifications towards manufacture and hence demanded control over the dissemination of the dome design. Synergetics Inc., however, viewed its own work as merely design and detailing since each job and site often produce different dome configurations anyway.

Ensuing from the entangled issue of ownership of dome design and the ambition to make the UTLx-Dome, also known as UTCC Mark-I Dome, a commercial success, Graver Tank decided to modify its design for the company's new operations at Wood River, Illinois, 25 miles north of St. Louis, Missouri. Billed as UTCC Mark-II dome, the new design strategy simplified

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Fitzgibbon to D.C. Graves in BFI-CR188. Further, a revised two-page "Memorandum for Agreement" was drafted on 9/19/57, in BFI-CR189.

[355]Ltr. 7/11/57 J.W. Fitzgibbon (Synergetics Inc.) to D.C. Graves (Union Tank Car Co., Ill.) in BFI-CR188. For a revised, less harsh version see Ltr. 7/15/57 J.W. Fitzgibbon (Synergetics Inc.) to D.C. Graves (Union Tank Car Co.) in BFI-CR188.

the truss work by substituting single pipe sections for the array of pipe and tension members in the UTLx-Dome. It also simplified the field inspection process, and moved the fabrication process closer to the industrial capacity and expertise of Graver Tank. Also, by opting for a single-layer stressed-skin system, reducing truss depth from 48" to 26," the new design used a lighter gauge steel and more points of support. With this new system, a new structural erection process using pneumatic bags, that is, erecting the tension ring at ground level and pneumatically lifting the skin, also replaced altogether the almost trademark tower or mast systems used at Baton Rouge. This unique feature, the first "top-to-bottom erection technique ever attempted for so large a structure" would become Graver Tank's own contribution to the geodesic art.[357]

Graver Tank clearly intended to effect a fundamental geodesic design change to escape the strictures of Fuller's patent. Despite the indignation Locke exhibited for the new system because of its perceived structural risks, it was highly unlikely that he did not know about this move.[358] The royalties for the domes were pegged to the cost of the dome rather than its potential in a mass-market. At Wood River, Graver Tank acted as the primary contractors, hiring local steel workers and material suppliers. Its further tactic to reduce the cost of the dome, and hence royalties accrued to using Fuller's design, was by reducing the amount of steel used and by quickening the assemblage procedure.[359]

The move towards a geodesic structure of stressed skin and truss elements (or skin-truss geodesic) in the new Graver Tank Dome at Wood River was not motivated by business considerations alone. Despite trepidations over the new structural design, Graver Tank was more concerned with producing a product with an image of greater technical sophistication. In this case, precision measured in terms of constructional and dimensional tolerances of the dome structural members was a quality that was increasingly revered. Naturally, Graver Tank took great offense to Fitzgibbon's explanation of why the skin-truss type geodesic unit was not pursued in the first place. In relation to the light-formed stressed sheet designs of the aircraft company, Fitzgibbon suggested that UTCC's operation was nothing more than "refined blacksmithing":

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[356]Ltr. 7/11/57 J.W. Fitzgibbon to D.C. Graves (Union Tank Car Co.) in BFI-CR188.

[357]The Public Relations Board (Chicago), "Wood River Dome Fact Sheet," In-house News of Union Tank Car Companies, 5/5/61.

[358]J.W. Fitzgibbon, "Memorandum: Meeting with Locke-Graver 4/10/58, Chicago," in BFI-CR195.

[359]See Ltr. 10/8/58 Clark Root (Graver Tank & Mfg. Co., Inc.) to J.W. Fitzgibbon in BFI-CR197: provided a discussion over the projected new generations of steel domes, the Mark-III series.

> (I)n analyzing Graver industrial situation, we (Synergetics Inc.) felt that it was appropriate to design structures that fit their shops, craftsmen, union, attitude, experience, facilities, background, skills and that in general these add up to a requirement for a very simple building in which tolerances were loosely held and in which ironsmithing techniques were employed and in which iron workers and boilermakers could be advantageously employed, that such a design would sacrifice an increment of weight saving and gain a kind of crude quick simplicity of construction.[360]

Locke's objection to this tactical design decision, Fitzgibbon recounted, was that UTCC did not intend to "down-grade design" to its present facilities; rather, it was "primarily interested in upgrading (its) techniques to the higher potentials of geodesic design."[361] This objection was understandable. UTCC prided itself with many engineering and mechanical innovations, including the "Hot Dog" (HD) tank car that eliminated both the under-frame and dome of conventional tank cars and tank car of the largest capacity known.[362] Nevertheless, Fitzgibbon reiterated his doubts of Graver Tank's technical capacity to design a most advanced, high technique, lightweight dome structure. Instead, he underscored UTCC's potential success in creating a niche for "useful low-cost somewhat standard dome series."[363] After all, this was along the line that Kaiser Aluminum, another corporation with greater technical sophistication, took despite its advantage as a widespread sales organization and its specific tie-in with building through their special building product line.

Graver Tank's modification of its Mark-II Wood River Dome was driven by its commercial motivations. The design was dismal because the repercussions of the changes in terms of engineering-construction methods and operations, Fitzgibbon explained, were not considered adequately or comprehensively in terms of the whole system.[364] Despite reducing the steel weight of the structure, there was more than three times as many type of panels used than the UTLx Dome. The mix of erection systems of jacks-scaffolding and pneumatic bag failed to quicken the assemblage procedure. Finally, the sub-assemblies of panels used were small and the redesign did not consider the use of fast action fasteners [Fig.3.08]. Thus, though started in August 1958, Mark-II was only "dedicated" in May 1961.

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[360] J.W. Fitzgibbon, "Memorandum: Meeting with Graver Tank & Manufacturing East Chicago, Illinois," 24 April 1958.

[361] Ibid., p.2.

[362] The Public Relations Board (Chicago), "The History of Union Tank Car Co.," In-house News of Union Tank Car Companies, 5/5/61.

[363] Ltr. 2/12/59 J.W. Fitzgibbon to RBF in BFI-CR206.

[364] Ltr. 2/9/59 J.W. Fitzgibbon (Synergetics Inc.) to RBF in BFI-CR206, p.2 (Also known as "Baton-Rouge Wood River Dome Memorandum"). The letter was written in an effort to salvage the commercial viability of the "dome program" by persuading Union Tank to seriously consider a total redesign undertaking. Fitzgibbon subsequently followed up with an abbreviated version which Fuller redirected to Locke for his attention (Ltr. 2/12/59 J.W. Fitzgibbon to RBF in BFI-CR206).

It became increasingly obvious that there was deep confusion on the part of UTCC's reading of what the two experimental domes meant. While the UTLx Dome started off merely to fulfill UTCC's own expansion program and internal needs for operational efficiency, the Wood River project was beginning to fill its corporate ambitions for business diversification. Graver Tank's primary sales business in car tanks dived drastically from $50-million in 1956 to $35-million in 1957, making the dome market attractive as an alternative area for business development.[365] However, UTCC had neither a corporate framework for assessing what a dome business entailed nor the engineering methods to determine what Fitzgibbon characterized "the cost problems and cost potentials of dome buildings."[366] Graver Tank tried to monopolize a multitudinous level of the dome business - design, building, fabricating to selling - all of which it subsequently demonstrated sparse competence. The episode highlighted succinctly and directly indicted the flaw in Fuller's hyped confidence for industry to take over building-trades. Fitzgibbon described the follies of UTCC's "invasion of the building world" in this manner:

> (UTCC) has a distinct weakness in that they have no present system of contacts or experience in the building business, and no extended sales organization. Tank construction and sales are not really a substitute because it has no relationship to such realities as architects, engineers, building codes, building commissions, building contractors, planners, etc.
> This problem is also serious with the aircraft people (North America Aviation) who are trying to get into building buildings and they are earnestly lacing their sales and technical staff groups with building people, and are developing direct contacts with architects, engineers and contractors.[367]

In the end, the UTCC-Fuller-Synergetics experience grew to be marginally beneficial to all the parties concerned, even as the UTLx Dome assumed a significant architectural-structure benchmark in history[368] [Fig.3.05a & b]. Synergetics Inc. agreed to protect the investments of UTCC in developing the dome. It backed away from large-scale steel domes in deference to UTCC, though deeply aware of its own effort to develop its geodesic design operations almost single-handedly.[369] UTCC occasionally agreed either to the manufacture of or to the contract to

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365 Ltr. 2/12/59 J.W. Fitzgibbon (Synergetics Inc.) to RBF in BFI-CR206

366 Ibid.

367 Ibid.

368 Ltr. 11/24/57 Cranston Jones (Assoc. Editor, *TIMES*) to Edwin Locke Jr., in BFI-CR196: proposing that Fuller's work should constitute a section in an architectural show, co-sponsored with the American Federation of Arts (AFA), to be called "Form-Givers at Mid-Century." The show was opened as part of the AFA's 50th anniversary at the Concoran Gallery, Washington D.C., 23 Apr. 1959, with exhibits drawn from works of the three masters - Mies van der Rohe, Le Corbusier, F.L. Wright, and presumably, a second generation of modern American architects including Eero Saarinen, Wallace K. Harrison, Edward D. Stone.

369 J.W. Fitzgibbon, "Memorandum: Meeting with Graver Tank & Manufacturing East Chicago, Ill.," 4/24/58.

build steel domes, with Synergetics Inc. providing the geodesic engineering and costing.[370] Under these arrangements, Fuller was able indirectly to front his enterprises through UTCC's capabilities. His proposal for UTCC to undertake the developer, Bill Zeckendorf's fantastic, 24-frequency, 1500-ft diameter dome represented such an instance[371] [Fig.3.06]. Synergetics Inc. also took the initiative to develop designs for a cornucopia of improved off-the-shelf domes designs (ranging from 200-400 foot. in 50-ft increments), for instance, the Mark-III *A & B* all steel geodesic dome, for UTCC consideration.[372] While UTCC invested substantially in the specialized dome business and gained a public image of an progressive corporation, the dome business it anticipated did not materialize. Locke eventually cut off the dome royalty by steering Graver Tank domes away from geodesic form.[373]

3.4.3. The Issues of Patent Rights, Licenses, Royalty and Publicity

Fuller was idealistic regarding the efficacy of the patent. He saw it as a way to advance an egalitarian agenda based on material abundance. It was also a means to protect his intellectual rights. In 1938, encoded in a little known prognostication in *Nine Chains to the Moon*, Fuller had proposed that industrial democracies would benefit humanity from a reduction in the active tenure of patents.[374] Yet, the episodes of UTCC, Pease and several corporations showed that the fundamental difficulties lay not in the tenure of the patent but rather the day-to-day implementations of his ideas. In the course of the geodesic enterprises, not only did his idealism wavered, but his general inability and reluctance to accommodate the new demands of the market place openly jeopardized his enterprises.

In the mid-fifties, Fuller and his legal counsel began to give considerable thought to the strategic aspects of his dome enterprises, especially on ways to build the recognition of the patents. By 1957, around 30 to 40 companies were licensed by Fuller to manufacture, fabricate and sell the geodesic domes.[375] Implementing Fuller's patent in the industrial-business setting produced new sets of problems previously not anticipated. Even the fundamental question as to

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[370]Ltr. 8/5/57 J.W. Fitzgibbon to R.A. Lehr in BFI-CR188.

[371]Ltr. 10/6/58 E. A. Locke to RBF in BFI-CR197.

[372]Ltr. 6/6/58 J.W. Fitzgibbon to Clark Roote (Graver Tank & Mfg. Co.) in BFI-CR195: the Mark-III series domes would contain internal frames and reduced tolerance requirements for the sheet metal covering. These improvements eliminated the need for field welding.

[373]Ltr. 2/25/62 J. Lindsay to RBF in BFI-CR228. See also Ltr. 3/17/62 J. Lindsay to E. Locke in BFI-CR228, attempting to regain Locke's confidence to underwrite a new phase of Lindsay-Fuller dome design for a mega-dome project in Houston.

[374]R. Buckminster Fuller, *Nine Chains* (prognostications), loose sheet.

who the royalty payment was due, proved complicated. In the military domes, the issue was whether to license Magnesium Products of Milwaukee (MPM), a prime manufacturer-fabricator of the Marine domes or the government. Because of the initial piecemeal approach towards the issue of royalty, Fuller's patent lawyer admitted to his legal counsel:

> (I)t would be helpful to project our over-all licensing plans as far as possible since this would have a bearing on 'future licensing plans and success.'[376]

Robertson counseled Fuller that queries on the dome business represented two types of prospects - those who wanted exclusive rights versus those who wanted a mere license to secure access to dome mathematics for construction.[377] In this regard, Robertson concluded that Fuller could sell the patent line, technical data and engineering service - all of which he eventually did through his dome enterprises. Fuller also had the option either of offering the rights to the use of his patents as an exclusive or as a non-exclusive license. The former would only be tenable if he could establish a royalty high enough financially to brace himself for the eventuality of infringement charges by a third party. Exclusive license came with a reciprocal commitment on the part of the licenser to act in the interest of his licensee to legally challenge potential infringers. For example, as Homasote, in Trenton New Jersey, finalized its commitment to develop "domasote," a dome type using principally wood framing and Homasote boards, it demanded that its contract and license agreement be "held harmless in the event a suit is brought against them for infringement of patents of others."[378] In practice, even the non-exclusive licensees sought protection from claims of infringement by a third party. The infringement charges by Gelsavage and Martin Wagner against Pease and the Marines respectively represented two known instances.[379] In such instances, all the profits developed through the royalty revenue could be expended in expensive litigation processes; though in Fuller's dome enterprises, this misfortune did not occur.

As Jeffrey Lindsay's own dome enterprise evidenced, the dome patents were "generally not worth the expenditure because of the rate of development" and the tremendous costs required to underwrite the expenditure.[380] Unlike Lindsay, Fuller managed to sustain the legal

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[375]Ltr. 7/3/57 Dale A. Blosser to W.M. Parkhurst in BFI-CR187.
[376]Ltr 7/5/55 D.W. Robertson to W.M. Parkhurst in BFI-CR174.
[377]Ltr. 9/24/54 D.W. Roberston to RBF in BFI-CR172.
[378]Ltr. 1[illegible]/57 W.M. Parkhurst to RBF in BFI-CR1[illegible]0.
[379]See Ltr. 11/15/54 M. Wagner to Aviation Division, Marine Corps in BFI-CR163: regarding Wagner's U.S. Patent #2,278,956; Ltr. 10/9/62 D.W. Robertson to S.R. Foster in BFI-CR236: regarding Gelsavage U.S. Patent #2,918,992.
[380]Ltr. undated (ca. Jan 1959) J. Lindsay to J.W. Fitzgibbon in BFI-CR196.

instruments of his patents primarily from fees collected on his lecture circuit, which, by the mid-fifties, had almost developed its own small industry, complete with schedules and programs worked to a tee for every and any occasion. While, as Lindsay proposed, big business indeed were "looking hard for safe untried products," Fuller's interests in courting them was contradicted by his archaic belief in the efficacy of the American patent system to further enterprise rather than concentrate business and industrial oligarchies.

Fuller's lawyer William Parkhurst, who had characterized himself as the "'eyes and ears' and feelers of the Geodesic pulse," was generally ineffective. His plan for a "skilled organization involving considerable expense to tailor (Fuller's) product for the market and individual applications" never fully transpired.[381] Many decisions requiring his legal expertise and counsel often exceeded either anticipation or planning. The unfolding of the UTCC projects provided an illustration of the complexity of the crossover of an innovation into the commercial realm.

The dome prototyping activities in the military phase, though impeded by bureaucratic pressures, were advantaged by the absence of site and immediate commercial value. An abstract site enabled tests for a limited battery of performance tests but it did not entail adaptations that were costly. The financing of the dome as an ordnance, though passing through bureaucratic red tapes, was in the end readily justified under national security. In the commercial settings of the UTCC, Fuller's corporate entities operated with heightened difficulties over their identities and roles with respect to the industries. Even the mundane issue on the referrals of inquiries for the geodesic dome, ensuing from the publicity on the UTCC domes, was a subject of considerable tension. Though most of the inquiries were directed to UTCC, Synergetics Inc. argued that it was poorly informed on the evolving geodesic arts. Arguing that it was in a better position to access initial design works, Synergetics Inc. offered that it would relieve UTCC of developmental and promotional costs, presumably to make the cost of the dome more competitive.[382] For UTCC, it was deemed foolish, business-wise to relinquish such a control over prospective clients.

In 1968, Pease assigned its own patent rights and Fuller's license to a third party, Geodesic Dome Manufacturing Co. Inc. (later as Cadco, in Plattsburgh-N.Y.), which subsequently set up a fabricating franchise to license others beyond the scope of Fuller's standard

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[381]Ltr. 6/23/56 W.M. Parkhurst to M. Fitzgibbon in M. Fitzgibbon's Private Collection of Letters.
[382]Ltr. (draft) 7/29/58 J.W. Fitzgibbon to Edwin A. Locke Jr. in BFI-CR195.

agreement with his licensees.[383] By themselves, the issues of the scope of power of the licensee and patent rights are commonplace in many legal suits. What is more symptomatic of Fuller's objection to the excesses of this particular licensee at such a late stage of the dome enterprise, was his idealistic view of the legal instrumentalities of his patent and their capacities to control over the fabricators and other manufacturers.[384] Clearly, Cadco operated outside what would be commonly held up as nominal practice of legal agency. However, Cadco claimed that its rights to issue fabricating and assembling franchises was based on its financial commitment; and this in itself qualified Cadco as a free agent and not one of Fuller's.[385] The "risks" to geodesic arts was not an issue at this point, since, as early as 1959, Lindsay recounted that Fuller was fully confident that the advanced stage geodesic structuring had been reached.[386]

An exclusive license would more likely encourage the licensee to take on all aspects of the dome enterprise from manufacture and sale to assembly and other combinations of activities thereof. However, Fuller believed that his geodesic patents would be best developed if the rights to their use were issued as non-exclusive licenses. This would create unfettered competition and publicity without the appearance of promotion:

> (F)rom Bucky's point of view as licensor, the ideal situation would be to have a large number of licensees competing in the fields without restriction, for this would be almost certain to develop the maximum business - provided only that the idea take hold without the need of a big promotion.[387]

A non-exclusive license to use Fuller's patent rights, Robertson explained, did not "reserve to any individual or business rights to a particular geodesic design or territorial rights or representation."[388] This immediately annulled the need for policing exclusive arrangements which would tax Fuller's limited financial resources. Fuller's preference was, perhaps, also conditioned by his abhorrence of venture capitalism and his suspicion that any form of monopoly would undermine his publicly-rendered project for humanity. Fuller indirectly implied that his non-exclusive license was a type of "only-universe-issued license."[389] Further, Parkhurst

[383]The context for the creation of the "fabricating franchise" owned by Carl Getman is outlined in Ltr. 6/14/69 Carl B. Getman (Cadco) to "Sirs" in BFI-EJA Sub.

[384]Ltr. 12/8/69 D. Klaus to C.B. Getman in BFI-EJA Sub. For Fuller's objections to Getman's illegal agency, see Ltr. 2/24/69 RBF to W.M. Parkhurst in BFI-CR339.

[385]See Ltr. 12/19/69 C.B. Getman to D. Klaus in BFI-EJA Sub.

[386]Ltr. (ca. Jan. 1959) J. Lindsay to J.W. Fitzgibbon in BFI-CR196.

[387]Ltr. 7/5/55 D.W. Robertson to W.M. Parkhurst in BFI-CR174.

[388]Ltr. 2/21/57 D.W. Robertson to James E. Toomey (Counselor-Patent, Kaiser Aluminum, Washington D.C.) in BFI-CR183.

[389]Ltr. 9/1/59 RBF to P. Reps in BFI-CR203

explained that the non-exclusive licensing program was to maintain equality and uniformity of licenses.[390] The non-exclusive license would enfranchise licensees from wider technical capacities and resources while ensuring that patents would not remain idle and locked up in any one licensee. A wider range of dome proliferation would inevitably advance the geodesic art and business.

The non-exclusive and limited licenses were useful during the experimental stages of the dome enterprise, evolving as they did from the graduate students' "single structure licenses" or experimenter licensees. Though the royalties for these groups of license were based on what Fuller deemed "appropriate" and their estimates were entirely within licensee's own discretion, Fuller guarded the conditions for license-re-application closely to avoid "discrediting types of use."[391] In the business world, however, these licenses were risky for both the small entrepreneurs and large industries. For this reason, it was almost reflexive for licensees, big and small, to endeavor features in their own works they could claim their own. Pease Domes represented one among many of such examples. Another licensee, Paramount Rubber Co., Michigan, even as it secured a non-exclusive license to fabricate and sell sub-components of general assemblies of foldable cardboard structural forms, it filed its own patent application relating to paperboard forms.[392]

Fuller's sixty licensees in 1958 varied in size and technical capacity, ranging from lone entrepreneurs and local contractors to manufacturing conglomerates and material industries. Even with the technical services and support of Fuller's enterprises to make improvements available to all licensees, licensees with a horizontal network of resources were clearly advantaged. Kaiser Aluminum and Chemical Sales Inc., Union Tank Car Company (UTCC), North American Aviation Aircraft (NAA), Container Corporation of America (CCA), Magnesium Products of Milwaukee Inc. (MPM) and Pease either had an existing marketing network or a unique technical edge that the majority of Fuller's licensees lacked. For small enterprises, too few to be counted among Fuller's licensees except in the plydome phase, the non-exclusive license was advantageous as long as the scale of business remained small. Yet the scale of dome proliferation envisioned by Fuller could only materialize under a degree of capital and resource concentration mustered readily by these large fabricators-manufacturers. In other words, the moment small enterprises opted for a larger production capacity requiring considerable

[390] Ltr. 1/20/58 W.M. Parkhurst to A.J. Piot in BFI-CR190.
[391] See Ltr. 2/11/55 RBF to T. Miake in BFI-CR164; also Ltr. 7/7/55 W.M. Parkhurst to RBF in BFI-CR174.
[392] See Ltr. 9/8/54 D.W. Robertson to RBF in BFI-CR172.

investments in tooling, manufacturing and marketing; they have entered an uneven, competitive field. Further, they faced difficulties obtaining working capital under the short-term, non-exclusive though renewable licenses.[393] Thus, the prospects of patent protection sought by licensees planning on undertakings such as expansion schemes were reasonable expectations.[394] However, this did not mean that large operations were naturally advantaged. The case of North American Aviation (NAA) illustrated the point clearly.

NAA was the fabricator for the American Society of Metals (ASM) Dome (1959) and the St. Louis Climatron (1958-60). Plagued by the decline in airplane business, NAA entered the aluminum dome fabrication business in the late fifties with full confidence that their precision tooling experiences would not only meet the high dimensional tolerances required by Fuller's geodesic structuring but they would also outride the sloppy building industries.[395] However, geodesic domes did not attain the scale of production which would justify their highly-paid aircraft mechanics, forcing them instead to hire journeymen, thus changing the their core expertise in the process. Instead, in venturing into curtain wall business, NAA was burnt by the ensuing "frantic" competition in what they eventually characterized as a "cut-throat business." As a result, NAA resorted to a whole host of protections from Fuller, which included outright purchase of his patents to give themselves a bidding advantage by discounting royalties to their own customers.[396]

Exclusive licenses, often granted with conditions of limited time or area of dome manufacture, were, nevertheless, unattractive. For instance, exclusive licenses with limited but renewable terms like the one given to MPM, a fabricator of the Marine domes, was rejected by Zenith Plastics, a subsidiary of 3M Corporation and a prime manufacturer of geodesic radome. Zenith Plastics sought license agreements extending into the life of the patent, largely because its project entailed substantial commitments for research, tooling, materials and contracts. The reason for Fuller's reluctance to accede to such conditions was perhaps, as Parkhurst observed,

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[393]Ltr. 3/6/58 C.E. Stryker to W.M. Parkhurst in BFI-CR192.

[394]See Fitzgibbon's report on the anxiety of one such licensees, Gilmore Olson Co. (Cleveland-Ohio), seeking assurance of protection in his manufacture of Fuller's Octet structural system (Ltr. 8/18/58 J.W. Fitzgibbon to D.W. Robertson in BFI-CR193).

[395]"Interview with Harry Richman, Paul Londe, Jim Fitzgibbon & Gene Mackay III," 10/16/80 in Missouri Botanical Garden (MBG) Oral History 2-83-0015, p.10. This is a 29-page transcript of an interview moderated by D. Daley, J. Schuster and S. Frowine (all of MBG) on 10/6/80 to mark the occasion of the twentieth anniversary of the Climatron.

[396]J.W. Fitzgibbon, "Mtg. Transcript: North American Aviation Inc.," in BFI-CR198.

because of the "tremendous strides" in the development of geodesic structures which might quickly outmode the scope of the existing patents.[397]

While small operations saw non-exclusive licenses as advantageous to the large corporations, large industrial manufacturers like UTCC, MPM &B NAA viewed non-exclusive licenses a nuisance to the dome enterprises as a whole. The free-for-all market implied in non-exclusive licensing, UTCC argued, was injurious rather than beneficial to them because it diluted their specialized edge.[398] In other words, Fuller's publicity and promotion, which proselytized the general advantages of geodesic structuring, effectively advantaged the non-exclusive licensees rather than exclusive licensees undertaking particular makes of geodesic structures [Fig.3.48]. Fuller was implicitly bound by the principle of his non-exclusive license agreements, to promote all parties yet to no particular ones. Despite this condition, Fuller still maintained that his work was "completely independent of any promotional activities":

> Having no particular structural system to sell, I was free to explore for generalized principles governing nature's most economical structuring system.
> In order to free myself economically, I have licensed industrial establishment in respect to discoveries and inventions according to my research.[399]

Not surprisingly, MPM thus argued that the issuance of a large number of non-exclusive licenses left them "without assurance of having exclusive rights in (their) field of interest for a long enough time to enable (them) to recover the costs of development and promotional activities." In the process, other licensees were able to "take advantages of (their) efforts without cost to them or (Fuller)."[400]

In February 1957, however, to the amazement of his more idealistic believers in the free-spirited American entrepreneurial system, Fuller made an exception to his non-exclusive licensee practice. While not acceding to the Kaiser Aluminum & Chemical Corporation's request for an exclusive license to develop aluminum geodesic domes, Fuller nevertheless created conditions conducive for Kaiser to operate with almost exclusivity. In this move, which Robertson characterized as an "act of goodwill," general licenses of twelve other potential licensees for the

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[397]Ltr. 1/23/57 W.M. Parkhurst to Zenith Plastics in BFI-CR184.
[398]Ltr. 7/10/57 E.A. Locke Jr. to RBF in BFI-CR188.
[399]Ltr. 10/28/58 RBF to H. Cohen in BFI-CR197.
[400]Ltr. 10/23/58 P.B. Craighead to RBF in BFI-CR197.

metal domes were withdrawn.[401] Under the Kaiser-Fuller license agreement, Kaiser paid Fuller the $25,000 minimum annual royalty; but Kaiser circumvented Fuller's royalty on net sales by calculating panel components sold in incomplete form.[402]

For Kaiser, Fuller's concession was a commercial coup, giving it a strategic edge exceeding the standard license agreement which it obtained in November 1956, and under which the Hawaiian Dome was realized, a year later [Fig.3.38 & Fig.3.29d]. In February, Kaiser reciprocated the "goodwill" by undertaking a two-page advertisement "splurge" in the *Wall Street Journal* and a concurrent hour-long television feature on the raising of the Hawaiian Dome.

The Hawaiian Dome (1956), built at Henry Kaiser's Hawaiian Village Hotel-Waikiki Beach, was significant in several respects. The 150-ft dome was a new class of geodesic structures executed completely in a stressed skin of aluminum. The contractual arrangement under which it was produced was also unique. Synergetics Inc. provided the "design engineering" on a contractual basis as a professional service. This service entailed geometrical and structural analysis to strain gauge test on a big section; and it was executed in tandem with the UTLx-Dome.[403] Because of this contractual arrangement, Synergetics Inc. could not claim proprietary rights for the innovation and improvement to Kaiser's dome. The dome was based on the "surface truss principles" of Kaiser's engineer, Don Richter, Fuller's former student from ID-Chicago. Instead, the product belong solely to Kaiser which could exercise the option either to mass-produce the dome under a licensing agreement with Fuller or to proceed no further beyond the prototype.

The Hawaiian Dome was also a media hype par excellence. It was raised and occupied within twenty-four hours after the components were flown in from Oakland, California.[404] After the 22-nd hour concert by the Hawaiian Symphony Orchestra, Kaiser was quick to line up the interest of Mike Todd, the movie producer of "Around the World in 80 Days," and appropriately world-premiered the movie in the dome. The prospects of girdling the globe with aluminum dome theater-auditorium, each with a seating capacity of two thousand, readily-erected in twenty

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[401]Ltr. 2/21/57 D.W. Roberston to J.E. Toomey (Counselor-Patent, Kaiser Aluminum, Washington D.C.) in BFI-CR183. Hughes Aircraft Co. (Culver City-Calif.), one of the twelve companies affected by Fuller's license withholding, almost immediately demanded a review of the license to see its pertinence to Hughes' plans (Ltr. 2/28/57 Hughes Aircraft to W.M. Parkhurst in BFI-CR185).

[402]Ltr. 6/2/61 D.W. Robertson to W.M. Parkhurst in BFI-CR221.

[403]Ltr. 8/20/56 D.L. Richter to RBF in BFI-CR179; also Notes from Author's Interview with T.C. Howard, Raleigh-N.C., 4/26/95, p.22.

[404]R.W. Marks, *The Dymaxion World*, p.218.

working days, at four dollars a square foot, to show "Todd films to good advantage," was an offer Todd himself could not refuse[405] [Fig.3.49]. Todd subsequently formed Dome Enterprises Inc. in December 1957 on equal partnership with H. Kaiser and S. Weaver.[406] The short-lived enterprise even appointed Frank Lloyd Wright as a principal holding the title of "master architect."[407] The stated business mission was to offer the Kaiser dome "anywhere in the world as a solution for auditorium problems."[408]

Despite the illustrious start and the favorable concessions, Kaiser's dome business did not reach the volume hyped in its own publicity and Fuller's. Privately, Fuller echoed his frustrations with Kaiser's "snowballing costs" and its cost of installations which caused the geodesic structure to slip into the category of a "glamour product":

> (E)ach Kaiser dome contractor, when he is asked to furnish figures (of cost) for others, automatically adds a safety factor to his figures, purposing the avoidance of any misleading information in respect to the other fellows risk. These is also an inherent urge, on part of each contractor, to up, if he can, the safe margins - not only in respect to minimums but also to maximums ... These experiences have persuaded contractors that they could get a premium.[409]

Kaiser was able to sell only five domes in total. By 1962, their dome sales trickled to a level to unprofitable for maintaining the minimum royalty stipulated in exclusive license.[410] Richter explained that the Kaiser dome business failed because too much was spent on promotion and that there were few people at Kaiser who knew how exactly to build the dome. More significantly, he claimed that Kaiser signed on all kinds of people to manufacture domes; its business in "selling tonnage" of aluminum grossly contradicted the fundamental tenet of geodesic arts, namely the reduction of structural weight through higher performance.[411]

The problems of Fuller's enterprises stemmed primarily from their uncertain identities and often contradictory purposes vis-a-vis the ambitions of industries and the day-to-day demands of an increasing retinue of licensees, exclusive and non-exclusive. Being populated by architects

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405. "Todd Eyes Global Domes for Films," *The Honolulu Advertiser*, 1 Nov. 1957.

406. "Kaiser, Todd & Weaver's New Show Biz Venture; Aluminum Theater Domes," *Variety*, 6 Nov. 1957. See also "Weaver Kaiser, Todd take a New Venture," *Broadcasting Magazine*, 11 Nov. 1957.

407. "Auditorium Designed by Wright," *Entertainment*, 5 Jan. 1958.

408. "Trio to Dot World with Domes," *The Honolulu Advertiser*, 5 Nov. 1957.

409. Ltr. 11/23/59 RBF to K. Fulmer in BFI-CR208.

410. Ltr. 12/4/57 A.N. Washburn to RBF in BFI-CR191. Since the first year of Kaisers' exclusive license, only one 145-foot dome was sold, earning Fuller $2,104 on his 5% royalty.

411. Notes from Author's Interview with Don Richter, Singapore, 11/12/97.

and working under the rubric of traditional architectural services, Fuller's enterprises were unprepared for and ineffective in the business of manufacturing geodesic structures. In providing consulting services for prototyping, his enterprises entered a quagmire of interests promulgated by the various licenses and created competitions among Fuller's corporate licensees from which they were unable to extricate.[412] Fuller's own idealistic view of the patent and his general reluctance to enter into manufacturing himself exacerbated the problems.[413] Ironically, the success of Fuller's publicity exercises and promotions created new administrative pressures that his organizations could neither manage nor capitalize.

As large as Fuller imagined the business prospects of his geodesic structure invention could be, he was also shackled by the constant indecisions about the necessary business strategies to adopt -- whether to go into manufacture, to provide consultancy services or to remain in "anticipatory design." These indecisions continuously created uncertainties over the issue of control, quality and purpose of his undertaking.

3.5. Seeking Alternatives

The rigid geodesic radomes were indeed, as Robertson claimed, "instrumental in spreading interest in geodesic structures across a wide spectrum of U.S. industry."[414] However, by the early sixties, there were clear signals that the wide spectrum of his dome enterprises were not producing tangible results on the scale that Fuller had envisioned. It is difficult to ascertain exactly how many geodesic domes for public, private and military uses were produced. In 1961, Fuller recorded that there were 2000 geodesic structures in forty countries.[415] This was the same figure that Marks recorded for the period extending from 1948-59.[416] Ten years later, in 1969, the number of domes expanded to 5,000 domes.[417]

While the military domes accounted for the primary earnings in the mid-fifties, their demands dropped almost overnight over a period of two years. Two of Fuller's most successful licensees, Tremcor Inc. and Cathedralite Inc. (Capitola-Calif.) recorded progressive sales of

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[412]Ltr. 1/19/59 J.W. Fitzgibbon to RBF in BFI-CR196.

[413]Ltr. 2/27/57 A. Fuller to P. Reps in BFI-CR183. Anne explained that in return for a "very good royalty arrangement," Fuller granted Kaiser an exclusive license. Further, the arrangement suited Fuller since he wanted to "keep entirely in research and not go into manufacture himself."

[414]D. Robertson, *The Mind's Eye*, p.48.

[415]"SIU Basketry Tensegrity," ca. 1961, (Southern Illinois University Fact Sheet for Press Release) in BFI-CR232.

[416]R.W. Marks, *The Dymaxion World*, p.58.

[417]Fed Warshofsky, "Meet Bucky, Ambassador From Tommorrow," *Reader's Digest*, November 1969, pp.199-214.

geodesic structures from the mid-seventies to the early eighties.[418] However, even the sales of these industries did not reach the scale of success that Fuller envisaged. Alternative markets were explored aggressively.

Within Fuller's circle, the grim prospects of the dome business surfaced early, exacerbated by limited financial resources of the enterprises and the ironical success of Fuller's dome promotions. With the military dome income dwindling to zero but public interests running high, Fitzgibbon highlighted the running costs of the enterprise:

> The return from these geodesic loaves cast upon the waters is pretty slim to date but it is absolutely necessary that these responses (to dome enquiries) be made and no complaint. They do add up to a labor and overhead cost, however that has become serious with time.[419]

By the end of 1961, Fuller himself acknowledged that the geodesic dome frenzy had quietened, and offered this reason:

> Inquiries become fewer and fewer, probably because of the number of licensees as well as the pick-up competition of what was at one time our exclusive field plus a general slowing down in the unique building undertakings.[420]

While the dome business ebbed, Fuller began to assume a growing stature in reputation, exceeding the confines of America and in achievements, exceeding the tinkering activities closely associated with him. By appointing Fuller as the Charles Eliot Norton Professor in 1962, Harvard University reinstated her prodigal son, thus enabling Fuller to vindicate whatever excesses he was accused of or had self-created in his public discourses. The Department of Commerce and USIA trade domes had produced strategic publicity for him in far reaches unavailable to most architects. The "Buckminster Fuller Recognition Day" celebration at the World Affairs Conference at the University of Colorado-Boulder testified, at least, to its liberal "world" forum, his unfledged belief in a new world order since 1956. With well-placed appointments, consultancies and public appearances both in America and abroad, he was drawn into the orbits of influential private and

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[418] Tremcor Inc. reported earnings, from 1974-82:
'74 ($0.86mil); '75 ($0.824mil); '76 ($1.13mil); '77 ($1.84mil); '78 ($2.89mil); '79 ($3.84mil); '80 ($5.09mil); '81 ($6.92mil); '82 ($8.22mil).
Cathedralite Inc. reported gross profits, from 1976-82:
'76 ($130k); '77 ($166k); '78 ($686k); '79 ($783k); '80 ($1.35mil); '81 ($1.30mil); '82 ($1.47mil). Both items in BFI-CR76.

[419] Ltr. 3/27/56 J.W. Fitzgibbon to W.H. Wainwright in BFI-CR173.

[420] Ltr. 11/20/61 RBF to J.W. Fitzgibbon in BFI-CR225. Fuller sold Synergetics Inc. to the Raleigh group in June 1959 (See Ltr. 10/6/59 RBF to R. Beverly in BFI-CR204).

public people.[421] Even then, the "corpus" of primary research on Energetic-Synergetic Geometry, Fuller explained to his publisher, was "now adequate."[422] Finally, he had established a foothold on a transnational architectural forum, the UIA (International Union of Architects), at its Biennial World Congress in 1961. Using the resources at Southern Illinois University (SIU, Carbondale-Ill.) where he had been appointed a distinguished Research Professor since 1959, he rallied his ambitious World Design Science Decades' strategy package which included an "Inventory of World Resources, Human Trends and Needs." It was at this point that Fuller privately contemplated a different route for his stable of dome patents.

In the late sixties through the seventies, Fuller imagined that his work had a place in the burgeoning space-astronautical program, accelerated and expanded under the President Kennedy's administration. His mile-wide floating spherical tensegrity colony, "Cloud Nine," was presented as a mechanically activated "moon house"[423] [Fig.3.47a &b]. On his own, Fuller continued to forge new business associations overseas, and offered more exclusive licenses for ambitious projects, not unlike those imagined by Kaiser.[424] For example, he licensed Monsanto Chemical Co. (St. Louis-Mo.) to produce a new-line of plastic "Geospace" shelter domes with a view to the Indian market.[425] In February 1963, an entertainment entrepreneur, Nicholas Reisini, announced his plan to build six hundred Cinerama Geodesic Dome Theaters all over the world. However, only one 165-ft hemispherical theater of reinforced concrete "geo-hex" was subsequently built in Hollywood California.[426] Fuller nevertheless established prior art in the monohex geodesic through the Cinerama-Hollywood project, and secured a new patent (U.S. Patent #3,197,297). The tactical significance of monohex construction, though paradoxically executed in concrete, a material Fuller had eschewed, was to capitalize on a practical condition in

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[421]Constantin Doxiadis finally invited Fuller to the Symposium Conference on Science of Human Settlement. Fuller also shared common discussion platforms with distinguished scientists like Oppenheimer.

[422]Ltr. 5/20/63 to P.V. Ritner (Macmillan Company, N.Y.) in BFI-CR239, p.2.

[423]Loreba D. Jean, "'Moon House' Designed for U.S. Astronauts," *St. Louis Post Dispatch*, 24 June 1973 (previously published as "City of the Future," *Playboy*, Vol.15, No.1, January 1968).

[424]Ltr. 6/29/62 RBF to W.M. Parkhurst in BFI-CR233: proposing the coordination of "geodesic partnership functions" of four other parties to advance Gira Sarabhai's (a member of an influential Indian mill-owner family & patron of Le Corbusier) proposal to fabricate & distribute geodesic domes. It would involve the Design Institute at Ahmedabad in the scientific research on geodesic structures, Aluminum Institute of India and Monsanto Chemical Co. of India in the production engineering and prime negotiations for major geodesic dome undertakings; and the architect, Charles Correa in the design of specific particular applications of geodesic domes.

[425]See the licensing of Monsanto Chemical Co. license to produce "Geospace" in "Memorandum of Activities-Richard Buckminster Fuller," 1/26/61 in BFI-Archives, p.2.

[426]Entry for 1963, "Memorandum of Activities-Richard Buckminster Fuller," in BFI-Archives, p.2.

many countries where cement was plentiful and steel scarce[427] [Fig.3.69]. However, these initiatives, in total, produced no tangible consequences.

3.5.1. Reality Check

In 1962, Lindsay bleakly but accurately summarized the state of Fuller's geodesic art and business:

> Radomes are no longer geodesic. Kaiser is out of the dome business; Mahon (fabricator of Kaiser domes) is closing. Fitzgibbon and Wainwright are architecturally oriented. Pease woodworking is an overpriced product.[428]

As Lindsay's study of markets relative to geodesics structures showed, Fuller's licensees were "switching away from geodesics."[429] Others, like Pease and Kaiser, were developing their own line of structures to avoid the cumbersome legal strictures of Fuller's patent rights. Even the non-exclusive licensees which had previously been effective in proliferating Fuller's dome now developed into a large interest block, and posed an obstacle to others who were interested in Fuller's domes, albeit on a do-it-yourself basis[430] [Fig.3.48]. Besides the standing issues with the mechanics of licensing and royalty charges, there were the hidden costs of dome business -- expenses in undertaking testing programs to satisfy local building codes, marketing and tooling costs.[431]

Given the dismal state of the geodesic business, Lindsay advised that the redeeming market for geodesic domes was the specialized huge-span structures, citing Fuller's ambitious 800-ft dome (Yomiuri Dome,1961-63) for Matsutaro Shoriki. Personally, there was his own 640-ft Houston dome and potential "urban monuments" in the "real estate wheeler-dealer" William Zeckendorf's 50-acre speculative real estate, Freedomland Development in Bronx, New York[432]

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427 Stacy Jones, "New version of Geodesic Dome is Patented," *New York Times*, 6 August 1965.

428 Ltr. 2/25/62 J. Lindsay to RBF in BFI-CR228.

429 Ltr. 3/6/62 J. Lindsay to A. Fuller in BFI-CR229.

430 Ltr. 12/27/65 D.W. Robertson to R.P. Stevenson in BFI-CR282: cautioning Stevenson, editor of Home & Shop Group (New York) which published *Popular Science Monthly* against the publication of an article "encouraging the use of (Fuller's) inventions by persons not licensed to do so."

431 Ltr. 8/22/57 P. Floyd to C. Stodder in BFI-CR189: highlighting the institutional obstacle to geodesic building, resulting in higher insurance premiums.

432 Though Zeckendorf never realized a single project using Fuller's geodesic dome, he maintained a continual interest in Fuller's mega-projects. When Fuller's "umbrella-city" (Old Man River Project) appeared in the national press; Zeckendorf requested details which, in his words, would be "helpful" to promulgate his "efforts for a major horticultural dome to cover an entire city" (Ltr. 11/24/71 W. Zeckendorf to J.W. Fitzgibbon, cited in J.W. Fitzgibbon's self-published "The Notebooks. Old Man River Project," p.21).

[Fig.3.51]. The primary attraction of these " low cost big spans" project was, Lindsay proposed, that they could be undertaken "without being underwritten by a big corporation."[433]

Except for the Yomiuri Dome and the Ford Rotunda Dome, the overall results of Fuller's personal leads on high-profile large-span domes were, generally, dismal. In these high-profile projects, Fuller had offered geodesic structuring as a singular, customized solution to the clients' requirements, differing from the industrial "mass-production" solutions of the other domes. Under these circumstances, Fuller's enterprises acted as professional consulting firms rather than as research and development fronts. Rather than royalty revenue that he ordinarily obtained from the industrial prototype, Fuller requested a retainer's fee, with Synergetics Inc. acting as a prime contractor.[434]

Fuller had long appreciated that the value of the big-dome upon completion of the Ford Rotunda Dome was not so much in the economic terms cast by Lindsay but rather in their publicity and promotional value, sited amidst new patterns of consumption. Even in the late fifties, evidence of the dismal reality of the geodesic business neither dampened the media nor the business community's reception of the dome nor their projection of its potentials. The assessments of *Business Week* and *Fortune* on the geodesic enterprise based on the success of Union Tank, Fitzgibbon noted, were overtly "bullish."

> Big business has picked up Fuller and the geodesic idea as an important item in the post-Sputnik world, and the sky is the limit.[435]

The prospect of a building system which considerably reduced capital costs both in terms of the enclosure and the foundation was attractive to real estate speculations. One such speculator, convinced that Fuller's geodesic dome had been adequately "popularized," not only proposed an ambitious 525-ft "shopperville" but also sought a franchise to create similar commercial developments throughout North America[436] [Fig.3.50]. The idea of an all-weather break was the dream of all vendors of services catering to a burgeoning consumer population. As

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Zeckendorf was recoiling from his personal bankruptcy. As a come-back project, he had also proposed to use HUD funds for a 1000-foot high dome to enclose 500-1000 acres of pineland in southern New Jersey (Hackensack Meadowland), a project dubbed as the eventual "horticultural Center of North America." The project, though never materialized, was timed for the 1976 bicentennial celebration. It prompted the press to report that Zeckendorf's larger ambition was the installation of "ecological bubbles across the urban frontier."

433 Ltr. 2/25/62 J. Lindsay to RBF in BFI-CR228.

434 Ltr. 8/31/55 RBF to J.W. Fitzgibbon in BFI-CR166.

435 Ltr. 5/13/58 J.W. Fitzgibbon to W.M. Parkhurst in BFI-CR195.

vast shopping centers became a norm, the idea of an encased plastic dome to overcome the last "customer-inhibitor" was a logical step. A UTCC public relation statement quipped:

> Think of it. No more rained-out Dollar Days.[437]

For another business quarter, the big-dome speculator also claimed that this hermetically-sealed environment provided an added advantage of effortless surveillance, vital in modern factory management:

> The use of a high central structure inside the dome, either manned or equipped with closed-circuit television, gives supervisory personnel visual range of the entire operation from a single vantage point.[438]

3.5.2. Big Dome Dreams and Desires: O'Malley-Fuller Dome (1955)

It was partly on the prospect of an all-weather dome to increase the number of game-days that Walter O'Malley, the owner of the baseball franchise, Brooklyn Dodgers, had initially approached Fuller in 1955[439] [Fig.5.09c(2)]. O'Malley came across Fuller's proposal for a stadium for the Minnesota Twins in *American Fabric*, Spring 1953. Fuller was previously approached by Bob Howsam, manager of Denver Bears, to readapt Col. Lane's light magnesium frame hangar for a stadium cover against rain. At that time, he proposed that he could install an 800-ft diameter domical structure costing around $750,000.00; but nothing came out of this proposal.[440]

The Dodgers had planned to abandon their home-field at Ebbets Field in Brooklyn after the '57 season, claiming that its old, cramped quarters was reeling in only a fraction of the projected stake of 200,000 fans. Fuller's solution, a 30-story, 750-ft aluminum geodesic truss dome enclosure, emerging from his studio project at Princeton Architectural Laboratory, was

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[436]Ltr. 1/7/58 D. Landers to RBF in BFI-CR193. The project destined for Montreal began in 1958. It stretched into the early sixties; during which, its sheer scale attracted speculative interests from many of Fuller's big licensees, including Kaiser and Union Tank.

[437]The Public Relations Board (Chicago), "The Future of Big Domes" (In-house News of Union Tank Car Companies), 5/5/61.

[438]Ibid.

[439]Ltr. 5/26/55 W. O'Malley to RBF in BFI-CR165.

[440]Ltr 8/12/54 RBF to B. Howsam in BFI-CR154.

immediately posed as a "panacea" to stadium design in general.[441] For O'Malley, the stadium design would "keep the Dodgers well in the black."

Fuller proposed that under the cover of a proposed thin plastic geodesic dome, air currents circulating beneath it would naturally air-condition the space and the game would be played under diffused light and sound. Even if the completion of the Ford Rotunda and rigid radomes had emboldened his geodesic arts, the dimension of the new undertaking was, for all intentions and purposes, neither achievable by his dome enterprises nor was it within the technical capacities of the industries. Nevertheless, within a year, Fuller proffered his new dome solution as "far more economical" than those he had proffered in his students' projects at Princeton."[442]

Fuller's design projection and claims, as far-fetched as they were at this point, nevertheless aroused new optimism in the baseball franchisees and their host-communities alike. What O'Malley had characterized as Fuller's "substantial contribution to the stadium concept," was a preview to the "all-year round, all-weather sports palace."[443] This idea was eventually raised by Ford Frick, Commissioner of Baseball, as a way to save major-league baseball[444] [Fig.3.55a & b]. Hit by dwindling spectatorship and the relocation of clubs, the prospect of a stadium sitting capacity of up to 90,000 people, containing diversified but centralized related amenities like car-parks, offices, community centers, stores, restaurant, theater, hotel, was a pipe dream for clubs and communities alike [Fig.3.55b]. The fans, one dome enthusiast proposed, should be equally thrilled by filtered sunlight and being tanned without getting burnt.[445]

O'Malley, fired by his entrepreneurial sense, was quick to line up interests around what he called a "program of civic import."[446] Skeptics of the project however cautioned against it

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441 Twenty-five students worked on the first design in November (Press release, School of Architecture-Princeton, 9/26/55, copy in BFI-CR167). A second proposal was advanced independently by Bill Kleinsasser (See B. Kleinsasser, "The Joint (A Municipal Stadium for Brooklyn Dodgers)," Princeton Thesis Design Thesis), ca. Nov. 1955, copy in BFI-CR168; see also "Student Designs a Stadium for Dodgers; Princetonian's Idea May Affect Blueprint" in *New York Times*, 22 January 1956.

442 Ltr. 7/19/56 RBF to W. O'Malley in BFI-CR178.

443 See Walter O'Malley's enthusiastic response in "Dodger Head Hails Studies Made for Domed Stadium," *New York Times*, 23 Nov. 1955.

444 Al Hirshberg, "Super-Stadiums Can Save Baseball," *This Week Magazine*, 4 May 1958, pp.8-9.

445 James Sweeney "Under the Sun's Bonnet. Will We All Live in Domes?" *Cambridge Chronicle* (Mass.), 17 June 1956.

446 See "New Stadium Lauded by O'Malley. He Calls Program of Civic Import," *New York Herald Tribune*, 6 Feb. 1956, p.1.

and portrayed O'Malley's threat as that of an "Artful Dodger ... maneuvering cleverly."[447] This was because in August 1955, even before Fuller's dome entered the picture, O'Malley had threatened to play seven of the club's season games in Roosevelt Stadium-Jersey City, New Jersey. The move was clearly to pressure John Cashmore (Brooklyn Burrough's President), Mayor Wagner and Robert Moses (then, Commissioner and City Construction Coordinator of New York City) to acquire land for a new stadium, using the condemnation powers, under Title I. This program, touted as slum clearance, was meant for new housing grants from the federal government; but in O'Malley's scheme, the club would pay for the land and the construction of the stadium under a 30-year bond issue.

The new O'Malley-Fuller project would have been located on a 500-acre tract at Atlantic-Flatbush and Fourth Avenue in Brooklyn, land previously owned by Long Island Railroad. The bill for the $30-million "World of Tomorrow" Sports Center, if it had passed, would have been a windfall for the railroad holdings and the baseball franchisee.[448] However, the Fuller-O'Malley project was embroiled in local, state and federal government politics from which it was unable to extricate.[449] Local supporters including Robert Moses, who projected it as "a potential financial success," were not able to counter objections that it was a subsidy given to a private profit-making enterprise. Despite its doubtful constitutionality, the Fuller-O'Malley project fired up local interests over ways to revitalize a part of the city's economic life [Fig.3.55c].

As a result of the O'Malley-Fuller project, a semi-independent city agency, the Sports Center Authority conceived by Robert Moses, was set up in July 1956 to accept land, employ city personnel for an eventual City Sports Center.[450] The tension ensuing from local, state federal authority over such a project revolved around the issues of curtailing local jurisdiction and the higher cost of services. Had the state, through the auspices of the Port of New York Authority, assumed control, the project would have deprived the city of taxes. Although the legislative draft made no mention of the Dodgers, the center was designed on the premise that Dodgers would be the possible tenants, to ensure minimizing the potential deficit on such a project.

O'Malley was equally opportunistic as he rode on the notoriety of Fuller's geodesic project. For a start, the growing prestige and imageability of the geodesic dome had already

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447 *New York Time's* "Pie-in-the-Sky?" 9 Feb. 1956.
448 "Plan Sports Center to Keep Dodgers in Land of Faithful," *Newsday*, 6 Feb. 1956.
449 "State to Bar Sports Hub in Brooklyn," *New York Times*, 7 Feb. 1956.
450 "Stadium," *New York Herald Tribune*, August 1956, p.1; and "Big and Bold," (Editorial) *Journal American*, 7 Feb. 1956.

proven effective in dulling the request of another baseball franchise, the N.Y. Giants, then making a similar request for a new municipally built stadium. O'Malley had never intended Fuller to build the dome. Instead, he had kept close consultation with his personal engineers, Praeger and Kananaugh, who had the final say on Fuller's scheme.[451] Fuller, on the other hand, assumed that O'Malley authorized him to undertake "an informal study" of a theoretical new Dodgers stadium in the form of a geodesic dome, and that the work was fundamentally "Walter O'Malley's show."[452] Despite their differences on this matter of initiatives, O'Malley appreciated the publicity that Fuller's project created for his cause, even if it upset some of the Club's stockholders. As he explained to Fuller:

> (I am) fully aware of the publicity possibilities ... and anxious to have (you) and the Dodgers receive as much favorable publicity as possible but I do not want to transpose that interest to anything that might be construed to be a legal obligation until formal authorization could be given.[453]

O'Malley did not build his all-weather dome but provided Fuller a valuable lead to Matsutaro Shoriki, one of the most influential man in Post-war Japan. Shoriki amassed his fortune primarily through the success of *Yomiuri Shimbun*, one of the largest newspaper circulations in Japan. He expanded his financial empire to include racetracks, the Nippon Television Network and the baseball franchise Tokyo (Yomiuri) Giants. Shoriki was then planning a stadium for the Yomiuri Giants.[454] Fundamentally, Fuller repackaged O'Malley's 750-ft dome for Shoriki. However, Fuller did not cease pursuing an aggrandized dome stadium scheme for O'Malley despite the latter's increasing weariness of the geodesic structure. Fuller lamented that despite possessing experiences which exceeded his competitors, there was little prospects, in big dome business:

> (N)one of the potential owners of the domes get in touch with me or ask my advice ... I know how to build big domes or how otherwise to give desirable and adequate environment controlling for the seven hundred feet to multi-mile diameter areas.[455]

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[451]Ltr. 12/1/55 RBF to W. O'Malley in BFI-CR171. The initial clue to this was O'Malley's objections to the ensuing Princeton University's publicity (press release, 11/23/55) implying Fuller's appointment by O'Malley for the stadium project.

[452]Ibid.

[453]Ltr. 12/9/55 W. O'Malley to RBF in BFI-CR171. Thus said, one newspaper continued to report that O'Malley "directed" Fuller to begin engineering calculations on the dome for "the world champions"(See "Weird Dome of Plastic Might be Dodger's Home," *Newsday*, February 1956).

[454]Ltr. 7/13/60 W. O'Malley to RBF in BFI-EJA Green.

[455]Ltr. 5/11/67 RBF to W. O'Malley in BFI-CR303.

The last-ditch effort in salvaging the geodesic program, if not for its imagined economic viability, then at least for its capacity to awe the public, was through the mega-dome and dome-city project. However, a major interlude cushioned the shock of unfamiliarity in the scale, function and expression of Fuller's grand urban vision in the big domes.

3.5.3. St. Louis Climatron (1958-60)

Fuller postulated that because of the minimal energetic structuring in the geodesic dome, the thermodynamics of the environment contained by the dome would logically conform in some way to its spherical-surface economy [Fig.3.56]. Besides the "optimum omnidirectional wind drag reduction shape" of the sphere, Fuller offered this further advantage of his double-dome:

> As the inner dome is not swept by exterior air and because no metallic heat train interconnects the inner and outer domes, condensations and frosting on interior surface is reduced or eliminated. The interior dome provides favorable internal aeronautical apace shaping, resulting in self-protecting internal flow enclosing the rolling-doughnut shaped circulation of heated air.[456]

Fitzgibbon advanced a similar argument when he responded to an inquiry on the dome to be used as a conservatory:

> It would be simple to arrange a humidity control area in the dome... (and) that this be kept entirely free of the dome itself. Dome ventilation is usually simple to change when the natural ventilation characteristic of the dome shape are respected and taken into consideration...The use of smaller domes internal to the main geodesic domes or external to it in satellite position make pleasant and useful combination of enclosures.[457]

However, the opportunity to test these propositions did not emerge until Dr. Frits Went's arrival in St. Louis, Missouri to assume the directorship of the Missouri Botanical Garden (MBG) in 1958. Went initiated a plan to rebuild all the greenhouses, including the old Palm House, in the garden [Fig.3.59a - b].

Unlike O'Malley, Edwin Locke and other big dome enthusiasts, Went was a man of science. After his studies at the University of Utrecht, he served as a plant physiologist at the Royal Botanical Gardens of Buitenzorg in Java. Upon his arrival at California Institute of Technology in 1933, he established his expertise in climate control, with his interests shifting

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[456]Ltr. 12/20/51 RBF to Commdr. Willems (USN-BuAer, Washington D.C.) in BFI-CR134.

[457]Ltr. 2/26/57 J.W. Fitzgibbon to George W. Parmalee (Curator, Garfield Botanic Garden, Mich.) in BFI-CR183.

from hormonal control in plant growth (auxins) to environmental influences.[458] However, like the O'Malley Dodger Dome, Went's conservatory project was also sited between a pivotal moment in MBG's redefinition of its identity and Went's own ambitions, albeit for scientific prestige rather than for economic or publicity gains. Nevertheless, in different ways, the geodesic dome aptly fitted the respective agenda of both men. While O'Malley was trying to create a new space for public consumption, Went's effort was to extricate the function of botanical garden from the conservative policies of the Board of Trustees of MBG. The vehicle was a new type of greenhouse. Suggesting that the vision of his project for the MBG was similar to that of its founder, Henry Shaw, namely to make the Gardens a center for community, Went subsequently claimed:

> (MBG) started to become an important institution again, and that thing was largely caused by the Climatron.[459]

Went was fully aware that within the year of his arrival at MBG, the Garden would be celebrating the centennial of its founding. Went's own notes in April 1958, spelled out the concerns foremost in his mind:

> (The garden) has deteriorated physically and idealistically. It is not a leader any more. It does not perform the functions it should in the community and in this portion of the Mid-west. It does not provide leadership in Horticulture; it does not provide the necessary information, it does not carry out the developmental work to inform the public as to planting and growing problems in the area, it does not do any introduction of out-of-door plants, it does not have any horticultural research.[460]

Went further identified that the Garden's infrastructure was antiquated and its old type of greenhouses would become "completely obsolete" and that no amount of "patching up" could salvage its past reputation:

> Therefore new houses, new in design, in engineering and in function, are indicated at present. If this can be swung ... A certain amount of air-conditioning repaired ... *with the new green-houses also new types of display* could(sic) have to be considered. It seems that the display greenhouse is well-managed and is beautiful. I would like to see it lighter, and artificially lighted for evening displays, like Longwood ... I thought *all greenhouses should be torn and rebuilt*, and the garden thoroughly renovated because I had been much depressed yesterday with the looks of the whole place.[461](Itl. my emphasis)

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[458]See Emmanuel D. Rudolph, "Transcript of Interview between F.W. Went & E.D. Rudolf," 12/14/88, MBG Oral History Program; E.D. Randolph's "Interview with Dr. Frits W. Went," 12/14/88, Beaverton-Oreg. in MBG-Archives.
[459]E.D. Randolph, "Interview with Dr. Frits W. Went," 12/14/88, Beaverton-Oreg. in MBG-Archives, p.1.
[460]Entry "21 April '58" in Dr. Frits Went's Diary, in MBG: ARC#78-0336(RG3/2/6/1 Series 2 Box 22).
[461]Ibid.

Besides intending the new greenhouses to be air-conditioned "on a large scale," Went's interest exceeded the mere making of greenhouses.[462] At this point, he was interested in creating a "biotron." This was a laboratory model of an environment where "small plants and animals could be considered equivalent in space and condition requirements."[463] A timely visit of a Dutch compatriot from Indonesia refocused his greenhouse as "biotron." Went recorded in his diary on 26 April 1959:

> Dr. Kostermans' (Bogor Arboretum, Buitenzorg) visit just revived in me the desire to recreate the *Tjibodas* jungle in our greenhouse.[464]

Went reiterated this point many years later:

> One of my original ideas, which I had already in Java (in 1930) was to recreate a tropical rainforest in a greenhouse in the temporate(sic) regions, specifically that *Tjibodas*. To that end I had made arrangements with the Botanical Garden in Java to send me seeds and plants from *Tjibodas*.[465]

The "biotron" project, Went proposed, would physically unify the conceptual efforts of the botanist and zoologist, giving rise to overlaps in techniques and problems encountered by both disciplines. Ironically, Went observed that the "biotron" could only emerge from personal initiatives:

> (P)rogress in the controlled environment facility field will obviously not come from cooperative efforts but from individual initiatives ... as previously biologists are not ready to work together in the same way as astronomers and physicists and mathematicians are, but they stress areas of disagreement. This is partly because problems are much more complex, and partly because their experimental procedures are so diverse. *This is what a biotron could remedy*[466] (Itl., my emphasis).

Went also wanted something more than a botanical "demonstration house," the staple of botanical gardens.[467] For the same reason, Went vehemently objected to the plan of the Garden's Centennial celebration fund-raising committee to rebuild "a street of old St. Louis, which he argued would not only be costly, but would probably end up as "a lot of junk."[468]

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[462]Entry "5 May '58" in Dr. Frits Went's Diary, in MBG: ARC#78-0336 (RG3/2/6/1 Series 2 Box 22). See also E.D. Randolph's "Interview with Dr. Frits W. Went," 12/14/88, Beaverton-Oreg., p.2.

[463]Entry "15 May '58" in Dr. Frits Went's Diary, in MBG: ARC#78-0336 (RG3/2/6/1 Series 2 Box 22).

[464]Entry "26 April '59" in Dr. Frits Went's Diary, in MBG: ARC#78-0336 (RG3/2/6/1 Series 2 Box 22).

[465]Addendum to the Interview, Ltr. n.d. F. Went to E.D. Randolph in "Interview with Dr. Frits W. Went," 12/14/88, Beaverton-Oreg. in MBG-Archives p.1.

[466]Entry "15 May '58" in Dr. Frits Went's Diary, in MBG: ARC#78-0336 (RG3/2/6/1 Series 2 Box 22).

[467]Entry "22 May '58" in Dr. Frits Went's Diary, in MBG: ARC#78-0336 (RG3/2/6/1 Series 2 Box 22).

[468]Ibid.

Rather, Went imagined that the greenhouse project should emphasis the "role of the garden in (the) community and should bring (the Garden) a lot of money." Further, he professed:

> We want to be firmly rooted in the present with an eye on the future. I suggested that the celebration be built around plants and flowers.[469]

At this point, as late as December 1958, the first stage of Went's proposed rebuilding focused on the existing palm house [Fig.3.59a]. The earliest site plan sketches show the wider ambitions of Went to renovate the Garden [Fig.3.58a & b]. Within less than three weeks, Eugene Mackey and Joseph Murphy, the architects retained on the Garden's overall design, were able to convince Went that his fast-track plan for the green-houses could only be achieved in a series of dome solutions - a main 175-ft diameter dome supported on five-pylons and three to four other domed "climate control exhibits" alongside it.[470] The completion of the greenhouse in time for the Centennial was probably foremost on both the mind of Went and Mackey. Fitzgibbon highlighted the urgency to commence "design work" in February and for the project to be occupied by October[471] [Fig.3.59b].

In all likelihood, Mackey saw Synergetics Inc.'s trussed geodesic space frame project for the American Society of Metals (ASM) Dome in Metals Park-Ohio, then under construction. Went's own record showed that Mackay recommended, at the Board of Trustees meeting, that North America Aviation (NAA), the fabricator of ASM Dome, be considered for the MBG-job alongside Cupples, a St. Louis based curtain-wall specialist[472] [Fig.3.61 & Fig.3.62]. Because of the tight schedule on the MBG-project, Fitzgibbon recommended to NAA that the design strategy should consist of a:

> modification of the ASM type truss without pylons, and suspended a continuous sprayed on fiberglass surface.[473]

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[469]Ibid. One of Went's ardent supporter, R.B. Smith, believed that the "innovative" project would become "the first in the garden world" (See Eddie Rosenheim, "Transcript of Interview between Robert Brookings Smith and Eddie Rosenheim," 10/20/87 in MBG- Oral History Program, p.7).

[470]Murphy and Mackey (M & M) were employed in September 1957 to do the overall survey of the Gardens; in October, the following year, they were hired to develop the overall survey (See "Notes from Board of Trustees Minutes," MBG ARC). Mackey's son noted that his father had close connections with MBG as "a result of his activity at Washington University." See also Ltr. 6/30/58 K. Wischmeyer to H. Spoehrer among F.W. Went's "Letters 7/9/58" Box1/12 Folder 13 in MBG-Archives, which identified Mackey among several local architects "who would provide the better possibilities for something different in design that Dr. Went (was) seeking."

[471]Ltr. 1/5/59 J.W. Fitzgibbon to J. Lindsay in BFI-CR196.

[472]Entry "19 March'59" in Dr. Frits Went's Diary, in MBG: ARC#78-0336 (RG3/2/6/1 Series 2 Box 22.

[473]Ltr. 1/5/59 J.W. Fitzgibbon to M.A. Haymore in BFI-CR196.

To edge NAA to undertake the work, Fitzgibbon informed NAA that preliminary approval for the dome use had been given, and that final decision was planned in February.[474]

The singular effect of lightness in the filigree of hub-and-strut would have fulfilled Went's conception of a greenhouse with a lighter structure. The ASM Dome (1958-59) was purposefully-designed without a roof to emphasize the precision of high-tech metal works; and its thinness as a structure to carry its own dead-weight, dramatized the elegant strength of aluminum. John Kelly, the ASM Dome's architect called the gossamer net a "realization of Fuller's concept of advancing technology's 'overall trend to invisibility'."[475] His sketches clearly treated the filigree of hub-and-struts and bracings as a progressive sign to dramatize an otherwise mundane assemblage of administrative spaces for the trade organization. However, the initial sketches of the dome, perched on risers over the buildings below, betrayed the architect's general ignorance of the loading behavior of a geodesic structure [Fig.3.63]. Putting aside Fuller's claims of the energetic capacity of the dome environment, the singularity of the ASM geodesic space-frame dome in representing the diverse interests of the metal industry and in crystallizing the industry's technical edge, could not have escaped the attentions of either Went or Mackey.

Went was able to overcome the financial hitches affecting the budgets for the mechanical work of heating, cooling and lighting, as he garnered the resounding support of his plan by the "Civic Progress," an elite and influential group of St. Louis businessmen and members of the "Friends of the Garden."[476]

The functional requirements of Went's proposed greenhouse highlighted a technical problem in geodesic art at this point, namely, how to close a dome of such a size with a transparent skin. The problem was exacerbated by the fact that the adapted ASM structure was developed without any cover. For the MBG Dome, Synergetics Inc. initially proposed a rigid suspended fiberglass cover.[477] Because of its higher cost, the technical difficulties of the added weight of fiberglass and the loss of light transmissivity, Mackey opted for a thin, replaceable

[474]Ltr. 1/19/59 J.W. Fitzgibbon to N.M. Graham (NAA, Ohio) in BFI-CR196.
[475]Quoted in R.W. Marks, *The Dymaxion World*, p.61.
[476]Entry "31 May '59" in Dr. Frits Went's Diary, in MBG: ARC#78-0336 (RG3/2/6/1 Series 2 Box 22). In May, Went had threatened to leave if the project was postponed for a year (See "Notes from Board of Trustee Minutes," undated, in MBG ARC).
[477]Ltr. 1/5/59 J.W. Fitzgibbon to J. Lindsay in BFI-CR196.

Mylar tent instead.[478] However, even as the dome base was completed in August, no solution for the skin design was in sight, though by this time, a decision was taken to use plexiglass panes.[479]

With two months to the projected opening of the project for the Garden's Centennial Flower Festival celebration, Went was anxious for a method of skinning to replace the neoprene gasket, which he deemed expensive, slow and difficult to assemble.[480] In October, the problem appeared resolved; and by December, a test-section of the "extruded aluminum sections and neoprene gaskets to receive plexiglass panels in lieu of a double membrane of laminated nylon" was sent to the building authority of St. Louis for approval.[481]

From his observations of "biotron" construction elsewhere, and probably because of the technical hitches on his own project, Went was increasingly convinced that the design of the "biotron" was a matter for the biologist-zoologist:

> (The) stranglehold by engineers is intolerable ... the performance seems to be excellent, but the engineers are over-designing everything ... The engineers and the architect's plans all have to be subservient to the specific needs of the biologist.[482]

Following a practice in naming his famous experimental biotron in Pasadena a "Phytotron," Went christened the project "Climatron," possibly to avert what otherwise might be subsumed as an engineered novelty. Went began specifically to identify his new laboratory as Climatron.[483] The Climatron eventually opened the following October. It achieved an instant commercial success, produced a heightened, local esteem and received many national

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[478]Entry "18 March '59" in Dr. Frits Went's Diary it was "not strong enough to withstand the building's structural flexibility" while "vinyl was too difficult, in MBG: ARC#78-0336 (RG3/2/6/1 Series 2 Box 22). The initial plan was to have Mylar tent fabricated by the makers of the ECHO-satellites; but, the latter pulled out of the contract, making it necessary to consider plexiglass as an alternative (Notes from Author's Interview with T.C. Howard, Raleigh-N.C., 4/26/95, p.5).

[479]J. Murphy suggested that glass was rejected because to fold" [See "The Climatron: a design that reshaped St. Louis architecture," *Architecture News* (Washington Univ.) Vol.1 #1, Feb.1982, p.5]. J.W. Fitzgibbon explained that Mackey's proposal for a removable Mylar tent was not feasible; even though it was a relatively inexpensive skin to put up, it was technically impossible to replace when all the plants were in place (See "Interview with Harry Richman, Paul Londe, Jim Fitzgibbon & Gene Mackay III" 10/16/80 in MBG Oral History 2-83-0015, p.10).

[480]Entry "2 August '59" in Dr. Frits Went's Diary, in MBG: ARC#78-0336 (RG3/2/6/1 Series 2 Box 22).

[481]Ltr. 12/18/59 M & M in A.H. Baum in MBG ARC 2-83-0021.

[482]Entry "2 August '59" in Dr. Frits Went's Diary, in MBG: ARC#78-0336 (RG3/2/6/1 Series 2 Box 22).

[483]"The Climatron at 25," *MBG Bulletin*, Sept.-Oct. 1985, Vol. LXXIII, No.6, p.4. Murphy recounted that Went coined "Climatron" from "climate controlled" after rejecting suggestions such as "Floradome," "Silverium," and "Plantosphere." H. Richman, another of Makey's partner, offered that Mackey coined the name for Went's "climatological laboratory" (See "Interview with Harry Richman, Paul Londe, Jim Fitzgibbon & Gene Mackay III" in 10/16/80 MBG Oral History 2-83-0015, p.1).

accolades.[484] The Climatron fulfilled what Robert Brookings Smith, President of the Garden Board of Trustees, called a "scientific excellence and pioneering spirit traditionally associated with the Garden."[485] Smith also recounted how the Climatron rejuvenated the Garden, giving it an edge:

> We advertised the Climatron, and of course that brings up the other point of what you do to rejuvenate something. You develop publicity - you've got something to talk about. You've got the Climatron to talk about.[486]

3.5.3.1. The Issue of Credit and the Price of Success -- Specially Designed versus an Anonymous Object

In April 1961, the hefty $25,000 R.S. Reynold Memorial Award was conferred on Murphy & Mackey at the AIA National Convention in Philadelphia.[487] The success of the Climatron developed into a predicament for the architects, as the public immediately viewed that the dome structure was pivotal in the Climatron's success. Among the first national coverage of the Climatron, *LIFE* identified the it as "Fuller's dome."[488] H. McClue, Dean of the School of Architecture, Clemson College in South Carolina, enthusiastically noted:

> I was delighted that the Reynolds Aluminum Award went to Joe Murphy's structure and that you were recognized at least in some manner. After all, we really consider it *your structure*[489] (Id., my emphasis).

Even the architectural profession's bulletin ascribed the dome as giving the dramatic expression to its botanical content; the architects had merely "chosen" the dome.[490] Fuller had "minimal" contact with the project from start to end, and the Climatron project is conspicuously

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[484]Went reported collecting $2,500 in admissions for the Climatron during the first week despite the 50-cents admission fee; and that some "424 thousand visitors (were) counted at the turnstiles." In no small way, this was due to the Climatron (See Entries "8 Oct. '60" & "10 Jan. '61" in Dr. Frits Went's Diary, in MBG: ARC#78-0336(RG3/2/6/1 Series 2 Box 22).

[485]Publicity release, Lemoine, Skinner Jr., PR Inc., 3/27/61, in MBG-Archives.

[486]Eddie Rosenheim, Transcript of Interview between Robert Brookings Smith and Eddie Rosenheim," 10/20/87 [MBG 'Oral History Program], p.8.

[487]The award cited the architectural firm of Murphy & Mackey, Frits Went & the MBG, Synergetics Inc. and Paul Londe, the mechanical engineer (See "The Climatron, the 1961 R.S. Reynolds Memorial Award," *AIA Journal*, May 1961; also "How Building Team Achieved an Award-winning dome," *Building Construction*, December 1961, pp.19-24).

[488]_, "A Garden-filled Dome of Many Climates," *LIFE*, 31 October 1960.

[489]Ltr. 6/8/61 H. McClue to RBF in BFI-CR221.

[490]*AIA Architecture in the News*, 2 April 1961, p.1.

absent in the compendium of his life's work.[491] But in the public eyes, then as now, the professional credits for the Climatron were accorded to Fuller [Fig.3.60].

The mis-identification of the professional credit was a serious enough issue for Mackey's successor-firm to seek public redress. The opportunity arose on the twenty-fifth anniversary celebration of the R.S. Reynolds Memorial Award in 1978.[492] Though admitting that the award had "contributed greatly" to the architectural firm, Joseph Murphy lamented that the "recognition of (their) carefully executed responsibility as the architect of the Climatron (had) been slowly taken from us or obscured...in some other publications and news articles."[493]

Murphy argued that as the architects commissioned for the job, they were responsible in drawing Went closer to his "biotron" idea through "preliminary studies to relate the building form to the plant materials." This process culminated in the dome as "a natural response."[494] Mackey's son, Eugene Mackey (III), separately took up cause in claiming the firm's stake in the design.[495] Mackey argued that his father conceptualized the dome as a design solution not because the geodesic dome was available or that it was a ready-made solution. Rather, Mackey proposed that his father chose the dome in response to Went's requirement of a "column free space."[496] Similarly, Mackey III's partner, Richman, argued that the decision "to go to the

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[491] "Interview with Harry Richman, Paul Londe, Jim Fitzgibbon & Gene Mackay III," 10/16/80 MBG Oral History 2-83-0015, p.6. One possible explanation of this is that MBG was wholly a Synergetics Inc. project, commissioned at a time when Fuller had relinquished his shares in that enterprise to his previous collaborators (T.C. Howard, J.W. Fitzgibbon & P. Barnwell); though they continued to operate as one of his many licensees.

Mackey, M. Fitzgibbon recalled, exhibited no malice towards Fuller. Though he initially omitted Fuller on the list of guests-of-honor at the opening of the Climatron, he quickly "straighten(ed) up" the oversight (Notes from Author's Interview with M. Fitzgibbon, St. Louis-Mo., 9/15/94). Mackey further demonstrated his magnanimity and deep regard for teamwork by sharing the prize with the MBG, Synergetics Inc. and Paul Londe (See Ltr. 4/4/61 E. Mackey to Collaborators of the Climatron in MBG-Archives).

[492] Ltr. 11/27/78 J. Murphy to M. Murray (Administrator for the Reynolds Program, AIA) in MBG-Vertical File. This file also contains a letter which Murphy had written to Fuller, to which Fuller did not reply (See Ltr. 2/18/76 J. Murphy to RBF).

Earlier, in a self-published leaflet, the firm claimed that it "designed the dome" (Murphy, Downey, Wofford & Richman, Architects, Inc., "The Climatron, Missouri Botanical Garden, St Louis, Missouri," 1/9/77, in MBG 770375).

[493] Ltr. 11/27/78 J. Murphy to M. Murray (Administrator for the Reynolds Program, AIA) in MBG-Vertical File. Murphy included a list of publications, from 1965-78, on the Climatron which accredited Fuller and not the architects – including one of the Garden's own publication, a 1977 visitor's guide.

See Murphy's personal accounts in "The Climatron: A Design that Reshaped St. Louis Architecture" in *Architecture News* (Washington Univ.) Vol.1, #1, Feb.1982; "The Climatron at 25" in *MBG Bulletin*, Sept.-Oct. 1985, Vol. LXXIII, No.6, pp.3-5; Joseph Murphy, "Twentieth Anniversary Celebration of the Birth of the Climatron," 2/7/81 in MBG 3/4/1 Box 3 Folder 7 (R.H. Daley Records).

[494] "The Climatron: a Design that Reshaped St. Louis Architecture," *Architecture News* Vol.1, #1, Washington Univ., Feb. 1982, p.5.

[495] See Eddie Rosenheim's "Transcript of Interview between Eugene Mackey (III) and Eddie Rosenheim," 8/11/88 in MBG Archives - Oral History Program.

[496] Ibid., p.7.

hemisphere shape" was made by Mackey after "the explorations of many different systems." Thus:

> (The dome) all fell into place as a kev compatible system where doing it one time, handling all of its climatological requirements, the structural requirements, the shape, the functional needs and so forth, that developed a very attractive & strong & forceful concept.[497]

Whatever Murphy had meant by "great thought before deciding on a final design,"[498] he nevertheless omitted, in his consideration, that the major structural idea and geometry of the Climatron was prefigured in the ASM Dome solution. It only awaited skillful readaptation. As early as 1956, Mackey indicated his eagerness to test the geodesic dome as an architectural feature. A dome for Went's greenhouse seemed opportune.[499]

Finally, to establish the distinctive mark of the architect's work on the Climatron, Mackey (III) proposed that besides correlating the needs of Went's greenhouse, his father creatively resolved the placement of the dome on the sloping site of the old palm house and worked out the skinning solution. Murphy reiterated this facet of the architect's original contribution to the appearance on the final dome:

> The plexiglass enclosure or 'skin', which is suspended by stainless steel rods from the outer structure was a unique solution developed by my partner, Eugene Mackey. This was *the indispensable key* to creating the transparency necessary to let the sunlight in abundance[500](Itl., my emphasis).

497"Interview with Harry Richman, Paul Londe, Jim Fitzgibbon & Gene Mackay III," 10/16/80 in MBG Oral History 2-83-0015, p.3.

498"The Climatron at 25," *MBG Bulletin*, Sept.-Oct. 1985, Vol. LXXIII, No.6. Murphy also suggested that there was a "great deal of similarity" between the plan of the Climatron and the Pantheon. This formal precedent was intended to establish the Climatron as a architectural rather than a technical innovation.

499Mackey then a faculty member at Washington University met Fuller on one of his studio projects. His proposed (geodesic) dome project on Chaminade College Chapel was recently rejected, but he assured Fuller that there were "other opportunities ahead...for collaboration" and when "circumstances permitted" (Ltr. 12/11/56 Eugene Mackey to RBF in BFI-CR190).

500Joseph Murphy, "Twentieth Anniversary Celebration of the Birth of the Climatron," 2/7/81, in MBG 3/4/1 Box 3 Folder 7 (R.H. Daley Records).

This was also Murphy's point to Fuller, as he attempted to establish the architects' original contribution to Fuller's art:

> The use of plexiglas, aluminum frames and neoprene gaskets suspended by stainless steel cables from a structure was a decision we arrived at after thorough study of all alternate enclosure systems available at that time. The transparent enclosure, the first of its kind on this large scale, was a vital element in the successful functioning of the Climatron.[501]

The last claim, that of deriving a skinning solution, is of course contentious given the standing expertise of Synergetics Inc. in developing the geodesic space truss as strut-and-panel system in the UTCC and Kaiser Domes [Fig.3.66; Fig.3.67a & b]. Even as Synergetics Inc. was contemplating on using J. Lindsay's spray-on fiberglass process to produce a monolithic suspended shell, the suspension point reinforcements at the hubs were already imagined to be "spring loaded absorbers." They were, in principle, similar to the final cable assembly solution.[502] Further, neoprene gasketing technology for sealing the plexiglass panels was a curtain-walling standard, previously developed by the automobile industry.[503] In August 1958, Fitzgibbon wrote to Fuller with a full disclosure of the "weather structure" that Synergetics designed:

> (W)e are in the final stage of a rather prolonged long-distance series of conferences and slowly-won decisions regarding the suspended 2/16" plexiglass skin we have designed. It became quite evident when all of the facts were in hand that the suspended clear vinyl covering was a bit inadequate solution for this job. *They accepted our design of a 2 inch wide aluminum triangular network with pan vertexes suspended from the truss with a 4 foot triangular 3/16" plexiglass panels fitted to the aluminum channels with lock strip self-sealing neoprene gaskets.* The system is so good and has such promise for many kinds of geodesic surface solutions that we live in a mild sweat of concern that the architects or owners will find reasons for refusing to use it. The reasons would be primarily cost reasons but even these are actually disappearing as bid prices are improved and alternate systems are turning out to be

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501 Ltr. 2/28/76 J. Murphy to RBF in MBG-Vertical Files. See also Mackey (III)'s version of the same contribution in Eddie Rosenheim's "Transcript of Interview between Eugene Mackey (III) and Eddie Rosenheim," 08/11/88 in MBG Archives -'Oral History Program, p.9.

502 See Ltr. 1/5/59 J.W. Fitzgibbon to J. Lindsay in BFI-CR196.

503 "Interview with Harry Richman, Paul Londe, Jim Fitzgibbon & Gene Mackay III," 10/16/80 MBG Oral History 2-83-0015, p.10.

The skinning system or the "weather structure," curiously, was not included in the original contract with NAA, the dome structure fabricator. The contractual amendment stated that the "geodesic weather surface (would be) designed by the architect & Synergetics" (See Amendments to Agreement (6/12/59) Arch-2-83-0018 with North American Aviation in "MBG- Building Climatron Construction Document 1959-67," 9/22/59 in MBG-Archives).

Through MBG-Archives contained several letters showing Mackey's initiatives in reporting test sections of the weather structure [See 1/14/60 M & M to M.A. Haymore and Ltr. 12/18/59 M & M to Albert H. Baum (Building Commissioner, City of St. Louis)], the prototype unit was tested at Synergetics -- this technical expertise alone affirmed them as the original designer (See Ltr 4/9/60 J.F. Barnwell to M & M and Ltr. 10/14/60 J.F. Barnwell to M & M; also "How Team Building Achieved an Award Winning Dome" in *Building Construction*, December 1961 p.24). Further, the architect's general difficulties in monitoring the work quality of its contracted glazier, Nurre Glass Co., highlighted their general unfamiliarity with the subtleties of the "weather structure" design (See Ltr. 10/3/60 M & M to Nurre Glass Co. and Ltr 9/8/61 M & M to Robert B. Smith, Frits Went, et. al.; all letters cited in this section in MBG ARC 2-83-0021, "Murphy & Mackey Correspondence-Climatron").

poor technically and equally expensive. Cost of this skin installed in place is about $3.25 a surface foot [We tested a full size panel up to 40lbs and a heavy term load up to 30lbs - all ok][504] (Itl., my emphasis).

3.5.3.2. Reluctance rather than Resistance

One could argue that by the late fifties, both in public and professional circles, the geodesic dome was fully lodged as a trade-mark and had assumed an iconic status closely associated with Fuller. None of Fuller's artifacts was ever an anonymous object. Rather, each was carefully cultivated in the public's imagination and intimately related to the inventor's life history. The anxiety of the architects of the Climatron exceeded the issue of mis-directed credit; it pertained directly to the question of what constituted an architect's creative input under the circumstances of using a structural system which had a deep identification with its originator. Indeed, despite voluminous inquiries from architects about geodesic structuring in the records of both Synergetics & Geometrics Inc., the final adoption of the geodesic dome in the architects' buildings was disproportionately scarce. The reluctance stemmed from the figurative dominance of the geodesic structure and its concomitant association with Fuller making it difficult for architects to escape the hold of such a signature object.

Privately, Fuller was irate over the omission of credit due to him for the Climatron, then featured in one of *LIFE*'s Nature Library Book series on plants. As usual, professing his highest mission of "better technical advancement of humanity in the shortest possible order," Fuller nevertheless staked the claim of his original work:

> Dr. Went had the idea of his Climatron, but he had no special building in mind, just a controlled environment. The architects for the Missouri Botanical Gardens, Murphy & Mackey, were given the job for providing the building for Dr. Went. Murphy and Mackey came to me and *I gave them the geodesic dome*. My dome, however, *has been considered a piece of hardware* employed by the architects. It is true that you can't see any other architecture, but the architects did plan the concrete foundation for the dome....
> The fact is that my conception of the geodesic dome and its employment of aluminum was uniquely my own, and *its realization in the Climatron was a consequence of the set of events that I have recounted* ... What we are talking about here is the great complexity brought about by industrialization, as it impinges on the old stone-age world, individual artistry and craftsmanship. Industry is so complex that the General Motors Company does not let anyone know who designs or invents their cars. The public will never know who designed the Boeing 707. They are unquestioningly important leaders and conceivers, but modern mass industry and government *swallow up those individuals*[505] (Itl., my emphasis).

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[504]Ltr. 8/4/59 J.W. Fitzgibbon to RBF in BFI-CR203.

[505]Ltr. 11/11/63 RBF to Ernest G. Friesem (Flushing, N.Y.) in BFI-CR249.

In the same way, Fuller's promotion and the notoriety of the geodesic dome swallowed up the creative aura of the architects. In claiming the Climatron as conceptually his, and charging that the architects treated the dome as a "piece of hardware," Fuller ironically reneged his consistent characterization of his works as tools or artifacts.[506] And though he openly professed the redeeming social values of industrialization, with the Climatron and many other projects, he showed his inability to accept the attributes of team-work in modern production, namely, anonymity and subordination of the originator's identity, as he ironically enumerated in the design of the Boeing plane.

3.5.3.3. The Energetic Valve

When Fuller claimed that the Climatron was preempted in sets of events he had recounted, he was referring to his emblematic Garden of Eden project. In this sense, the Climatron is significant in the historic account of Fuller's geodesic project because the project coalesced Went's scientific novelty of climate-control with the broad claim of the dome as an ideal environmental conditioner.[507] In one account, Fuller called the Climatron the "most complete application of his theory."[508] Privately, Fuller called it "my Missouri Botanical Garden Climatron" and explained how the Climatron proved the efficient radiation heat effect of large domes:

> The Climatron, 175' diameter, contains a tropical forest. *The air-conditioning problem was not excessive as the forest absorbs radiation*. In Montreal, there will just be the exhibits and the people; the air will be 'fractionated' in horizontal layers of varying temperature - allowing the hot air to pool at the top where there will be no people and the cool to settle to the bottom. Local cooling devices are used in all around the exhibits. Our air-conditioning engineer is accomplishing the air-conditioning at half the energy cost of conventional systems[509] (Itl., my emphasis).

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[506]The issue over credit was not confined to the Climatron project. An earlier high-profile geodesic dome project, the U.S. Moscow Pavilion also elicited similar problem of attribution. In this case, J. Dixon complained to *New York Times* that its article, "American Architect Practices His Profession on a Global Scale" (2 February 1959), erroneously credited Welton Beckett with the dome design. Dixon argued that Beckett merely "used" a geodesic dome in their design for the exhibition and that it was Fuller who "invented, prime-designed and patented" the dome (Ltr. 2/22/59 J. Dixon to *New York Times* in BFI-CR198). J. Dixon's account was also inaccurate. The Moscow Dome was developed at Kaiser Aluminum in Chicago. D. Richter recounted that, nevertheless, Fuller took "a lot of bows," in Moscow, for the job (Notes from Author's Interview with Don Richter, Singapore, 11/12/97).

[507]Fuller once proposed to Gerald Piel, editor of *Scientific American*, that the combination of his NSCS Cotton Mill Project (1951) and the Climatron could be used for automated food-growing factories. In a "giant metabolic valve," vegetable growths mounted on open wire meshes, supported by trusses, would be "evenly nurtured by saturated atmospheric circulation" (Ltr. 3/30/63 RBF to G Piel in BFI-CR247).

[508]See remarks of Mackey (III) in "Interview with Harry Richman, Paul Londe, Jim Fitzgibbon & Gene Mackay III," 10/16/80 MBG Oral History 2-83-0015, p.6.

[509]Ltr. 9/21/65 RBF to Prof. Hyman Cumin in BFI-CR271.

This energetic efficiency of the dome was not perpetuated by Fuller alone; architects and critics alike echoed similar claims. Fitzgibbon explained that the Climatron was an "innovative" coordination of mechanics and architecture, with the dome shape proving its efficiency for heat gain, loss and dissipation in laboratory modeling.[510] Paul Londe, the mechanical engineer for the Climatron, professed using it as a laboratory to ascertain the economical thermal performance of large domes, and argued for its use again on another project -- the U.S. Pavilion at Montreal-Expo'67.[511] Richman called the Climatron a "very close symbiotic relation between structure and the plant life within," and perhaps articulated an implicit assumption that edged Went and Mackey into selecting the dome.[512] For Reyner Banham, an ardent enthusiast of Fuller's philosophy of technology, the Climatron represented a masterful blending of "the aesthetic and the functional into an indissoluble artifact," qualifying it as a modern update of the Crystal Palace.[513]

3.5.3.4. The day-to-day Workings of the Climatron

The reality of the day-to-day workings of the Climatron was far from the accolades accorded to it. The Climatron was, ironically, maintained mechanically at tremendous expenses, far from the low-maintenance conservatory which Went had idealized. Three years into the operation of the Climatron, the original plan to use it as a laboratory for scientific investigations of "climate control" was abandoned. The environmental load of the plants, primarily as humidity and the heat gains of the dome, overran the capacity of the air-conditioners and fans. The condition erased some of the micro-climates that were planned. Went's Climatron, described by *LIFE* as a "garden-field dome of many climates," proved to be a liability. Instead of becoming a living laboratory to explore distinct tropical climes, the Climatron, one observer noted, "devolved into a huge, split-level greenhouse."[514] Fitzgibbon, who visited the Climatron in the fall of 1964, similarly reported:

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[510] "Interview with Harry Richman, Paul Londe, Jim Fitzgibbon & Gene Mackay III," 10/16/80 in MBG Oral History 2-83-0015, p.6.

[511] Londe, Parker Michels, "Appendix 3-A: Comments Regarding AIA Questionnaire, Reynolds Memorial Award," 11/20/78, included in Ltr. 11/27/78 J. Murphy to M.F. Murray in MBG-Vertical File.

[512] "Interview with Harry Richman, Paul Londe, Jim Fitzgibbon & Gene Mackay III," 10/16/80 in MBG Oral History 2-83-0015, p.5.

[513] Reyner Banham, *Age of Masters (A Personal View of Modern Architecture)*, New York: Harper & Row, 1975, p.14, 150.

[514] Christine Bertelson, "The Climatron's Secret - How a Landmark Went From a Lab to a Greenhouse," *St. Louis Post Dispatch*, September 1987.

I inspected the Climatron which is in good structural shape although the gardens, the plant trees, etc. are in very poor conditions. The Garden trustees have cut their maintenance budget and lost so many of their staff members since Went left that decay is only too evident.[515]

This setback did not implicate the potentiality of the dome as a micro-climatic regulator; perhaps only more effective mechanical augmentations were needed. Rather, it raised issues over the more bombastic claims of Went and Fuller during the inception of the project.[516] Though planned as a "four climate chamber," the Climatron was finally "used as a tropical chamber with some variations in maximum and minimum temperatures (with) all these plants...from similar type growing areas."[517] In fact, one observer, Dick Daley, came close to asking if Went's "biotron" was a passing novelty:

Where the Climatron was kind of on the cutting edge ... of display houses at the time and did it really lead to anything(?) Where did display houses go as a result of the Climatron, or was it just a side a side branch that was unimportant(?) Did it lead to some important development?[518]

Given Went's illustrious reputation, it is difficult to propose that a scientist of his caliber and experience would have undertaken a project of such a scale if he had anticipated its unsatisfactory outcome. However, nothing in Went's concept of a modern greenhouse stipulated four-climatic zones; in fact, Went's overall greenhouses project consisted of several "climate control exhibits" besides the main conservatory [Fig.3.59c-e]. In February 1959, when the Gardens' landscape planner, E. Clayton, proposed six climate zones, each contained within its own "climate structures" (of diameters ranging from 15 to 110 feet with climates ranging from sub-arctic to desert), under a "cool tropical" 175-ft dome for the purpose of consolidating the mechanical equipment, it was immediately ruled out[519] [Fig.3.67c]. Besides the spatial clutter, Layton's domes within a dome scheme would have created problems in lighting and cooling of the dome as a whole. Though rejecting Layton's proposal over these reasons, much of the evidence pointed to the fact that Went was fully aware of certain inherent flaws in a single, large-space greenhouse. He was quietly skeptical of the broad claim that convention currents could

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[515]Ltr. 9/30/64 J.W. Fitzgibbon to RBF in BFI-CR269.

[516]See Fuller's exposition on "environment controlling structural enclosures" in *Critical Path*, New York: St. Martin's Press, 1981, pp.209-212.

[517]Stevie Frowine's observations in Interview with Harry Richman, Paul Londe, Jim Fitzgibbon & Gene Mackay III,"10/16/80 in MBG Oral History 2-83-0015, p.10.

[518]Dick Daley's questions in Interview with Harry Richman, Paul Londe, Jim Fitzgibbon & Gene Mackay III,"10/16/80 in MBG Oral History 2-83-0015, p.1. Daley was a member of the Missouri Botanical Garden staff; he was the Garden's first director of Ecological Services, then assistant to the Director of the Garden, and finally Director of public programs from 1973-1984 (See *MBG Bulletin*, Vol. 62, No. 4, p.13, June 1984).

[519]Layton, Layton & Rohrbach, "Report Number I, 2/11/59" in MBG 2-83-0083/Climatron.

sustain an even temperature in the dome. Indeed, Went recounted many years later that given the volume contained under the more than a half-acre domed conservatory, his primary worry was to maintain a constant temperature for its size. It was this difficulty that led, he explained, to his four-climatic zones:

> No, at first (I) thought it was impossible. I wanted the whole greenhouses air-conditioned. So to have air conditioning every place. To have everywhere the same temperature for this size. About half the space would be used by dirt....
> So, when one building which would not have all the same conditions. So then the idea came up and *that was quite an idea*, to have variable climates in the same space[520] (Itl., my emphasis).

It was at this point that the original scientific project of a domed environment with even temperature was hurried into a uncertain novelty. While the warm and cool air systems created a diversified plant environment, it did not produce the four climates that Went had planned.[521] All accounts of the Climatron held steadfastly to its characterization as Went's "laboratory." However, there is no evidence that during his tenure, Went or any of the Garden's horticulturists used it substantially to advance any scientific knowledge, validate or uncover what Went imagined as new "operational botanical possibilities."[522] Clearly, Went had not intended his modern greenhouse to be a prototype "biotron." In effect, by Went's own records, he spent time keeping after the insects.[523] His own diary accounts primarily highlighted his concerns with public reception of the Climatron, its eventuality as "an eighth wonder of the world" or its lighted effect as a " breathtaking sight" or public complaints over the admission charges.[524] Otherwise, his focus was on the appearance of the Climatron, from a most curious angle, not available too many:

> On Sunday evening, I had invited the Cultures for a sightseeing flight over St. Louis in the evening. We had lighted the Climatron and this was certainly most spectacular from the air even in the seas of lights of the city. But the blue light did not show at all. *We have to try now some red and orange lamps*[525] (Itl., my emphasis).

520E.D. Randolph, "Interview with Dr. Frits W. Went," 12/14/88, Beaverton-Oreg., p.1.

521See also Edgar Anderson's "The First Five Years of the Climatron," *MBG Bulletin* Vol. III, No.6, June 1965, p.4.

522Entry "31 October '59" in Dr. Frits Went's Diary, in MBG: ARC#78-0336(RG3/2/6/1 Series 2 Box 22). Ken Peck reported that Went had considered directing one of his graduate Ph.D. students to work on a project in the Climatron, as a way "to bridge the chasm between the botanists and the horticulturists" (See "Synopsis with Ken Peck" in MBG: ARC, undated, p.1).

523Entry "21 February '61" in Dr. Frits Went's Diary, in MBG: ARC#78-0336 (RG3/2/6/1 Series 2 Box 22).

524Entry "8 October '60" in Dr. Frits Went's Diary, in MBG: ARC#78-0336 (RG3/2/6/1 Series 2 Box 22).

525Entry "23 October '60" in Dr. Frits Went's Diary, in MBG: ARC#78-0336 (RG3/2/6/1 Series 2 Box 22).

Perhaps the most telling confession of all, suggesting that Went did not mean the Climatron to be his serious "laboratory," came in this note:

> At the (Systematics) Symposium I talked about controlled climate as a tool in taxonomy. This made me think again of a low-maintenance phytotron *which I perhaps should build after all* to study in a systematic fashion the climate requirements of families and genera[526] (Itl., my emphasis).

There are two standing accounts for the dismal performance of the Climatron. The first proposed that, upon Went's resignation as Director of the Garden, his successor, Henry Hitchcock, a retired "conservative" St. Louis banker lacking in scientific mantle, failed to continue the breakthrough that Went had initiated.[527] Instead, Hitchcock redirected priorities in improving other infrastructures of the Garden at the expense of the integrity of the Climatron as a laboratory. In this explanation, the absence of the huge roof-fans which Went had planned to prevent over-heating of the Climatron, supported the theory of neglect.[528] The second account, claimed by those working closely in the Climatron, attributed the paradoxical success of the plants in the early years with destroying the Climatron.[529] In other words, the mechanics under estimated the force of nature. The moisture from the plants and spray machines created high humidity which accelerated fungal diseases, spotted all the flowers and rusted the exhaust fans.[530] Alan Godiewsky, the Garden's Director of Horticulture, even questioned that given the exorbitant resources to run the Climatron, whether it ever could be a laboratory; thereby, proposing instead, that it was "to be something very exciting to visitors."[531]

The first account of ill-fated workings of the Climatron enabled the Garden to redeem Went's pioneering spirit and thus rehabilitated the Garden's own future stakes, by side-stepping the persistent technical problem of the second. Even with subsequent improvements, the promise

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[526] Ibid.

[527] This version was perpetrated in "Chapter X: Building the Climatron" (unattributed author), in MBG ARC- Folder - Buildings, History of Climatron, #2-83-0014; and also Londe's explanation in Christine Bertelson's "The Climatron's Secret - How a Landmark Went from a Lab to a Greenhouse."

[528] Notes from Author's Interview with T.C. Howard, Raleigh-N.C., 4/26/95.

[529] See Stevie Frowine's commentary in "Interview with Harry Richman, Paul Londe, Jim Fitzgibbon & Gene Mackay III," 10/16/80 MBG Oral History 2-83-0015, p.10. Frowine was a public horticulture specialist at the Missouri Botanical Garden from 1980-1984 (See *MBG Bulletin*, Vol. 62, No.7, December 1984, p.13).

[530] Edgar Anderson "The First Five Years of the Climatron," *Missouri Botanical Garden Bulletin*, Vol. LIII, No.6, June 1965, p.11.

[531] Christine Bertelson, "The Climatron's Secret - How a landmark went from a lab to a greenhouse," *St. Louis Post Dispatch*, September 1987.

that the "unusual degree to which climate control is possible" proved fleeting.[532] Thus, on the twentieth anniversary of the Climatron, a more moderate claim was made of its legacy:

> Rather than a laboratory, the Garden had found that it serves best as a display house of tropical plants ... and because of the dome structure, (visitors) can observe (the plants) in a setting that is close to a natural one.[533]

The Climatron, as an object of local and national esteem, at least, from its inception to the late seventies until its renovation, disguised its more debatable performance as a scientific "laboratory" for the investigation of climate-control and its effects on plants.[534] The Climatron was, in the end, a deeply speculative rather than a systematically worked-out proposition. Went's primary concern was about the historical mission of the Garden, the public reading of its scientific edge and the role of the Climatron in jump-starting the Garden as a whole, as a "symbol of the Garden's second Century." In February 1959, in the middle of the Garden's "tremendous financial problem," the Board of Trustees concluded that Went's new greenhouse "would accomplish the most important hurdle in the Garden's rehabilitation."[535] With increased attendance at the Climatron, Went's dedication to transform the Garden into "a social and cultural center" was a logical follow-up[536] [Fig.3.68]. Perhaps one could argue that this redirection of his emphasis was inevitable, since public support was turning in more revenue than at any time in the Garden's history. Under Went's leadership, the Garden appeared to have broken through its persistent financial difficulties.

Went had earlier criticized the much-publicized scientific endeavors like rockets, Antarctic explorations, cyclotrons as "technological achievements, with precisely little basic

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532 Murphy, Downey, Wofford & Richman, Architects, Inc., "The Climatron, Missouri Botanical Garden, St Louis, Missouri," 1/9/77 in MBG 770375.

533 "The Climatron at Twenty," in *Missouri Botanical Garden Bulletin*, Vol. LXIX, No.1, January/February 1981, p.4.

534 See R. Dingwall and B. Lawton "The Climatron - Missouri Garden's Space Age Greenhouse." An estimated six million visited the Climatron between its opening in 1960 and 1981. In the 1976 Bicentennial survey of the AIA, "the Climatron was named as one of the most significant architectural achievements of the first 200 years of American history" ("The Climatron at Twenty," in *Missouri Botanical Garden Bulletin*, Vol. LXIX, No.1, January/February 1981, p.4).

535 -, "Notes from Board of Trustees Minutes," undated, MBG ARC.

536 Sometime in 1961, Went assembled evidence to show that his "new source of income" in the modern greenhouse exceeded the projection he had made to the Board of Trustees. He showed, through statistical analysis, that not only had the Climatron "caused an increase in attendance at the Garden in general, but it (was) producing a steady-much needed income for the operation of the Garden." At a stunning projection of $100,000 per year, the financial woes of the Garden were partly settled. A further $50,000 revenue, Went proposed, would come in a battery of other attractions like improved outdoor gardens, better outside lighting, outside concerts (See Frits Went, "The Climatron as a Source of Revenue" in MBG Box1/12, Folder 5, 3/2/6/1 Went's Collection).

significance."[537] With the public success of the Climatron, he appeared to have gradually revised his earlier harsh readings:

> Just as the cyclotron, beratron(sic), synchrotron belong to the most ambitious research tools, the physicist has created, the Climatron undoubtedly is the most modern and advanced research and demonstration tool for the horticulturist and botanist. It allows for the growing of tropical plants under almost ideal conditions and the trees, shrubs and herbs growing now in it show clearly how well we have succeeded in recreating the best climatic conditions for most of these tropical plants.[538]

Publicly, MBG continues to maintain Went's desire for a leading edge, modern greenhouse. The history and legacy of an entangled object like the Climatron, however, is being unraveled in a different way today. This time, the objective is not about a simulated tropical ecology, but rather, as an avatar of a new conservation spirit, perched ominously at the last frontier, preserving the disappearance of the real thing. So, as the Climatron closed for extensive renovations in the late eighties, the Garden planners proffered upon its opening, "a unique example of a tropical rain forest environment" amidst a global devastation of the tropical forest, a guardian against spoils:

> Fifty years from now, you will only be able to see a tropical rain forest in a greenhouse, they will not exist in nature.[539]

This reinterpretation of the Climatron, as a guard to an imminent ecological apocalypse was offered earlier by another writer:

> The dome already houses plants that are so rare they have all but disappeared from nature. If massive development continues, as in Brazil for example, Fuller's dome may have a larger rain forest than the Amazon.[540]

In these update of its meanings, the cultural significance of the Climatron, as a "garden-field dome of many climates," remains in its physical testament of the creative energy produced when scientific novelty meets dome fantasy.

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[537]Entry "17 May '59" in Dr. Frits Went's Diary, in MBG: ARC#78-0336 (RG3/2/6/1 Series 2 Box 22).

[538]Frits Went, Notes on "The Climatron of St. Louis," in MBG Box1/2 Folder14 Record Group 3/2/G/1.

[539]_, "Synopsis of Conversations with Bill D'Arcy & Bill Wagner,"9/11/85 in MBG ARC.

[540]H. Barnes, "Our Tropical Half Acre," *St. Louis Post Dispatch* Sunday Magazine, February 1981, p.6, 12.

3.6. Conclusion

Fuller's geodesic enterprises were advanced by a retinue of dedicated architects. Through their works, the potentials and the fundamental problems in the implementation of a novel structure were raised. Some of the problems were caused by the openly contradictory objectives of these enterprises, as the mechanics of day-to-day business eventually brought them out. Others emerged from the division of labor in these enterprises, between the concrete prototyping efforts of his franchisees and the abstract-managerial-promotional activities of Fuller. This division had presentational significance -- it enabled Fuller to stand apart from his work, and promote them without indemnity to his pristine interests.

Through Fuller's promotion and hype, and through the reciprocal desires and needs engendered in the process, Fuller and his patrons transformed the dome into a most unlikely candidate for a modern structure for a broad range of new uses. Fuller was also skillful in garnering and managing the media's obsession with novelty; he engaged the professionals' concern about its own practice; he expanded industry's desire for enlarged consumer market; and finally, he crystallized the State's search for a world image of democracy while eschewing state propaganda. Thus, from the late forties to the mid-fifties, his geodesic invention was advanced not merely as a structural innovation, but also as an offensive instrument driven by the increasing demands of fleetness in the new warfare, a survivalist paraphernalia for an ominous nuclear holocaust, and finally as epitomizing the leanness of American technology.

The Marines, in particular, gave the dome enterprise a national urgency which legitimized its use and status. With the assurance of the Marine domes, Fuller was able to garner industry support while drawing upon an increasing retinue of free college student labor and design skills. As the project advanced and unfolded, Fuller sought various ways to ensure his control of the direction, desires and demands of the project. The success of the Marine domes, however, raised Fuller's liberal anxieties about war in general. In reforging the credits from the military demonstration to create another identity for the geodesic dome, Fuller ironically redirected it to another "front," namely for Cold War propaganda. Beginning with the Milan Dome and the Kabul Dome, Fuller's geodesic structures fulfilled what he personally termed the "second" and "cool barrel" of a "double-barreled weapon."

The success of the geodesic dome was propped up primarily by patronage of the State --through the military contracts and requirements, and the trade fair circuits. The success was short-lived but the patronage shielded the geodesic enterprises from the harsh tests of the market place. For American industries and businesses, the geodesic dome was the stuff of dreams which lay between technological optimism and hype. However, as they were drawn into their respective ventures, the broad problems of manufacturing and mass-production for a building market quickly dampened their initial ambitions. The industrial enterprises ranged from the specialized domes of Kaiser and UTCC on one hand, to the plydomes which were intended to be low-cost shelters, on the other hand. The dismal performance of both these categories of domes led Fuller to explore high-profile clients with big dome dreams. Here, Fuller revisited the principle myth of the geodesic dome as an "environmental valve" of great efficacy. The commission of the Climatron in St. Louis, Missouri, one of the most exquisite of the geodesic structures ever built, was underpinned by these considerations. It also highlighted the scope of problems created by Fuller's promotional activities, which led to the increasing identification of the geodesic dome with him, thus preventing its broad reception as a utilitarian and anonymous structure, like he intended.

Ch.4 The Visionary and Symbolic Agenda of the Geodesic Artifacts 1958-67

By the late fifties, Fuller was emboldened by the technical success of his geodesic structures at all fronts. The graduation of the geodesic dome to a higher function, in scale and transcendence, seemed natural. To understand the Fuller's mega-dome projects such as his visionary cities, one needs to recognize Fuller's confidence in the universality of his artifact. As a science-object, supposedly distilled from scientific principles, Fuller saw the geodesic artifacts as a panacea for a wide range of problems. With respect to urban problems, his approach to enclose cities with domes was environmentally deterministic; with respect to the broad disenchantment of youth and other marginal cultures in America, the discipline of his geodesic structure became an avatar of a new consciousness and a quest for personal control.

4.1. Visionary Cities. Frobisher Bay (1958) and New York City (1959)

The first opportunity to test the geodesic structure as a city-enclosure and environmental conditioner was Fitzgibbon's "temperate oasis" in 1958. In the Frobisher Bay Project, Fitzgibbon proposed for the consideration of the Governor of Canada, a 2,300-ft diameter "town-enclosure" in the eastern Canadian Arctic[1] [Fig.3.53].

Frobisher was a thriving frontier town that served as a strategic center for the DEW-line project, equipping many of the radar installations for the United States Air Force. Paid employment on the DEW-line projects and the mines had led many Eskimos away from their nomadic lifestyle, and created a housing situation which the Ottawa authorities concluded, require an "economic" solution. This was an impetus for the Frobisher Bay Project.[2]

The city fathers had observed, first-hand, the engineering marvel of geodesic structuring. Even the Canadian team, comprising of G.B. Pritchard (Canadian Public Works Department) and D.A. Davidson (Northern Affairs Department), assigned the task to conceptualize the scope of the project, openly suggested its preferred solution was a dome. It was to be made of "honeycomb structure of steel rods from which plastic sheets would be hung to form a solid globe."[3] The description quaintly resembled a hybridized radome of Geodesic Inc.-Cambridge and the Union Tank trussed structure, then being developed at Baton Rouge. Indeed, along with Synergetics

[1] "James Walter Fitzgibbon, Architect (Resume)," in M. Fitzgibbon's Collection (St. Louis-Mo.).
[2] Tania Long, "Town of Future Sought in Arctic," *The New York Times*, 14 Jan. 1959.
[3] "Canadians May Build Domed City in Arctic," *New York Herald Tribune* (Section 3), 9 Dec. 1958, p.11.

Inc., Union Tank was simultaneously developing a 700-foot dome project for a shopping mall in Frobisher Bay, perhaps a demonstration for the "town enclosure" project.[4] A budget of $10 million for a dome-enclosure to accommodate up to a projected population of 5,000 was proposed. In the end, however, the project was quietly abandoned for a low-profile proposal of interconnected housing.

The futuristic impressions created by the projects of Fuller and his associates, like Frobisher Bay, did not escape the eyes of Arthur Drexler, Director of the Department of Architecture and Design at MoMA, then curating Fuller's *Three Structures Exhibition* in the museum's garden (May -Nov. 1959) [Fig.4.01]. Drexler reflected on the significance of Fuller's artifacts:

> Building might no longer be a series of separate boxes with people moving from one to another ... In effect the city would be one building, with its necessary functions accommodated quite differently than they are today. We could climate control and reclaim whole areas of the Sahara, or of the Arctic. We would have to rethink architecture as we know it now.[5]

The enormous time lag between vision and implementation became the subject matter of the next MoMA Exhibition in September 1960, *Visionary Architecture*. Drexler explained that in the "visionary present" as opposed to "visionary past," neither social usage nor practicality determined what was visionary and what was not.[6] Thus Fuller's structures previously characterized as "revolutionary" became visionary.[7] Naturally, this transformation qualified two fantastic projects by Fuller's enterprises. A project submitted by David Sides and Fitzgibbon of Synergetics Inc., titled "Bridge City" featured prominently on the cover of the exhibition's pamphlet [Fig.4.28]. Its design premise was to find use for inaccessible sites in order to leave the last vestiges small towns and villages entirely undisturbed. In this proposal, apartments for a hundred thousand people were organized around a 6000-foot diameter ring, spanning Hudson river from 110th Street in Manhattan, New York to Fairview, New Jersey. The structural system was made of three concentric rings of octahedral trusses held together by cable, within which were vertical cylinder and diamond-shaped decks which served as gardens and recreation areas[8] [Fig.4.29].

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[4] Ltr.7/7/58 W.M. Parkhurst to RBF in BFI-CR195.
[5] "Geodesic," *New York Times*, 27 Sept. 1959. The MoMA Exhibition opened on 22 Sept. 1959. See also A. L. Huxtable's less optimistic review of the same exhibition, "Future Previewed? Innovations of Buckminster Fuller Could Transform Architecture," *New York Times*, 27 Sept. 1959. Huxtable questioned the unresolved and new construction problems associated with the geodesic domes.
[6] A. Drexler, "Visionary Architecture," MoMA 1960.
[7] See "Revolutionary Architecture at Museum of Modern Art," *New York Herald Tribune*, 22 Sept. 1959.
[8] A. Drexler, "Visionary Architecture."

The second entry submitted by Fuller was a partial enclosure of Manhattan Island. It was a project based on a postcard-collage made by Fuller and Fitzgibbon, in mid-1959, presumably during the preparations for *Three Structures Exhibition*[9] [Fig.3.39a]. The initial collage comprised of two domes in Lower and Midtown Manhattan. A smaller 3/4-mile diameter one-third sphere covered the Wall Street area; while a larger, 1 1/4-mile diameter one-quarter sphere covered mid-town. Fuller subsequently developed the latter, enlarging it to a two-mile diameter and one-mile high dome. This scheme was published in *Newsweek* in July 1959[10] [Fig.4.27; see also Fig.3.39a-c]. Fuller projected that a fleet of sixteen Sikorsky helicopters could cover an area from East River to the Hudson at 42nd Street, and north to south from 62nd to 22nd Street in three months.[11]

Fuller's broad confidence for a dome project of this scale was based on two inter-related considerations. In term of techniques, he had successfully created larger models of tensegrity spheres with greater surface flexibility, lightness and strength. Their almost magical structural qualities were continually rehearsed, though not proven:

> Unlike other structures, tensegrity domes increase in strength by a factor greater than that governing their growth in dimensions; the larger they are, the stronger they become.[12]

The aircraft industry, Fuller argued, possessed the capacity to manufacture such a sphere in large sections. Nevertheless, he omitted any discussions of how structural resonance in all tensegrity spheres could be resolved. Second, he was still persuaded by the prospects of creating a controlled climate which would negate the need for self-contained units. Instead, there would be landscaped gardens and expandable shelters, an urban Eden [Fig.3.39b]. Fuller proposed that the New York City dome would produce positive environmental qualities by reducing energy consumption, pollution and the snow loads.[13] Though the general misgivings of the Climatron would have created broad skepticism over the efficacy of the dome-city as an energy project, its image as a magnified "energy valve," in Fullerian parlance, was seductive and elegant. Unwittingly, Drexler paraphrased this intention when he described Fuller's structures in this manner:

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[9] Author's Notes from Interview with M. Fitzgibbon, St. Louis-Mo., 9/15/94. This collage technique was previously used by James Fitzgibbon to convince the Marines that fully-assembled geodesic domes could be lifted and flown.
[10] _, "Architecture: Umbrella Man," *Newsweek* (Art Section), pp.21-23.
[11] R.W. Marks, *The Dymaxion World*, p.163.
[12] Ibid., p.57.
[13] R. Buckminster Fuller, "The Case for a Domed City," *St. Louis Post Dispatch*, 26 Sept. 1965.

> The 'building' has disappeared. In its place Fuller makes very large models of the lines of force by which atomic particles - matter itself - seems to adhere.[14]

The choice of New York City as a site for his dome-city demonstration was symbolically charged. For Fuller, its characteristic concentration of skyscrapers was blatant affirmation of physical mass and real estate. Besides the pervasive orthogonality of the city blocks, Fuller previously described New York City as "eloquently articulate of an old materialistic civilization."[15] In 1932, along with Simon Breines, one of his *SSA* cadres, Fuller created a media stir of a proportion similar to his dome-city project. Together, they proposed the occupation of forty percent of one hundred skyscrapers on Manhattan. They claimed that not only would their plan transform half-occupied skyscrapers into huge lodging houses for the unemployed, it would also engage, simultaneously, some four-thousand unemployed architects registered at the Architectural League.[16] For Fuller, the real intention, he explained several years later, was to devalue the skyscrapers by making them "makeshift for slum exiles" before their final evacuation beyond the suburbs.[17]

The more fantastic deployment of the tensegrity sphere, however, was not as a dome over New York City. Rather, Fuller envisioned a "skin sieve mesh" with an almost biological-mechanical valve-like function. Through the adjustment of the pores on the surface, a mega-sphere could literally ascend, descend and be propelled along by rockets.[18] This notion of a floating and moving city, "sky islands" or floatable cloud structures, fitted hand-in-glove the broad public excitement over space exploration and high-altitude flights[19][Fig.3.47a & b]. Finally, even the city moves.

While Fuller's "sky islands" was remotely distant, the earthly Eden as a domed-over city, by contrast, seemed ostensible. Also, in the mid-sixties, these projects provided a reprieve to the dire financial problems faced by Fuller and his associates. The projects provided national publicity without cost and with almost total impunity.

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[14] Arthur Drexler, "Three Structures By Buckminster Fuller," MoMA Exhibition brochure, 22 Sept. 1959.
[15] R.B. Fuller, *Nine Chains*, p.162. Fuller also continuously drew upon New York's buildings for comparison. For example: New York Hotel Belmont versus the Mauretania, a passenger ship. (See "Designing a New Industry," p.14)
[16] "Asks Skyscraper Use to House Idle (Structural Studies Associates proposes Architects transform half-occupied towers)," *N.Y. Evening Post*, 1 June 1932.
[17] R.B. Fuller, *Nine Chains*, p.324.
[18] D. Robertson, *The Mind's Eye of Buckminster Fuller*, p.108.
[19] "Fuller F re," *Time*, 20 Oct. 1958.

As early as 1965, Fuller professed that his royalties on the domes had approximately ceased rather abruptly, affecting his financial capacity to sustain his patent applications.[20] Increasingly, his lecture, writing engagements, and consulting activities acted as financial cushion to support his patents and other prototyping activities. Similarly, Fitzgibbon reported on the dire condition of the dome business. He lamented that despite "prospects all around," none were fruitful, and as a result, Synergetics Inc. was "pretty close to the rocks."[21] Nevertheless, in his own efforts to extricate Synergetics Inc. from a "depressingly slow work period," he reported that his visionary projects or "the tomorrow's projects" were encouraging; and he identified among them "relocatable school, mobile temporary supermarket."[22]

4.2. Instant Cures for Ailing Cities

> The established cities will probably not adopt the doming (of the city) until environmental and other emergencies make it imperative.[23]
>
> Having undertaken the solution by artifacts of the world's great housing crisis, I came to regard the history of cities.[24]

In the nineties, the Biosphere II project represented and was impelled by a hysteria of ecological Armageddon. Fuller's urban vision was spurred by an Armageddon of a different sort, namely the plight of American cities. With radomes dotting the Dew-line acting as sentry to external threats, the mechanical *Garden of Eden* of the Climatron St. Louis promised deliverance from the internal threats of the cities faced by architects, planners, and policy-makers alike. This machine in the city with a garden within, appeared as an elegant solution to the woes of the inner cities, ranging from physical decay, economic stagnation and racial segregation.

Perhaps it was because of the prospect of a working reprieve in the mechanical *Garden of Eden* of the Climatron St. Louis that persuaded the Model City Agency of East St. Louis to approach Fuller in 1967. Initially it enlisted Fuller to assist its design of a neighborhood service center under a pilot social program initiated by President Johnson. The proposed $1.2 million center, the city's project planner explained, was to be used "to coordinate and augment the whole range of social services in urban slum neighborhoods." And Fuller, he continued, could provide a right kind of design to "capture the hearts and imagination of neighborhood residents."[25]

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[20]Ltr.2/24/65 RBF to D. Robertson in BFI-CR267.
[21]Ltr.3/10/65 J.W. Fitzgibbon to RBF in BFI-CR268. See also Ltr.2/24/65 J.W. Fitzgibbon to RBF in BFI-CR280.
[22]Ltr.8/26/66 J.W. Fitzgibbon to RBF in BFI-CR289.
[23]R. Buckminster Fuller, "The Case for a Domed City," *St. Louis Post Dispatch*, 26 Sept. 1965.
[24]R. Buckminster Fuller, *Critical Path*, New York: St. Martin's Press, 1981, p.315.
[25]Ltr.5/24/67 S.I. Darlick (Chief Planner, Model City Agency) to RBF in BFI-CR303.

Declining the commission, Fuller nevertheless sketched his vision of Model City's "neighborhood service center":

> I feel confident that it would work and should be under a very large geodesic dome, thus supplying an enormous amount of protective covering as against a plurality of buildings. I am confident that under the comprehensive umbrella, which will conserve energy in an important degree, there could be a complex of activities arranged with the greatest triangular grid of economy of intercourse yet effectively providing privacy where privacy should occur with liberal use of not only screens but natural planting. Under the great umbrella open terraces may be tiered one above the other to great heights.[26]

The scope and ambition of Fuller's proposed design clearly exceeded the pettiness of the planner's original bureaucratic brief. Since the proposal exceeded the modest ear-marked budget, nothing immediate emerged from the brief exchange. However, the formal image of a large dome city as a social vision was not to remain fallow for long. In between that time, Fuller was trying to find a patron for his other visionary city projects.

The foremost of these projects was an experimental "tetrahedronal city," presumably based on his fantastic tetrahedronal floating organic city [Fig.4.02a-b]. This project hastily proposed to Shoriki in December 1966, after the equally fantastic 4000 meter high super-vertical city, the World Peace Prayer Tower (also known as 'The Tower of World Man' and Yomiuri Tower) was abandoned[27][Fig.3.52]. Both phantasmagoric objects, to immortalize Shoriki within the rubric of Fuller's structural invention, are vividly objects of intemperance. Practically, they were probably intended as publicity exercises to outpace a Japanese government initiative to create the Tama New-town project, a satellite city of 300,000 inhabitants, adjacent to Shoriki's benevolent company retreat, the Yomiuri-land.[28]

In the Fuller-Shoriki relationship, there was a continuous jostling of egos and general suspicion between both men. Up until the end, however, their quiet conflicts remained as undercurrents, as both men had disguised their respective self-interests in increasingly megalomaniacal schemes. As a benevolent patriarch, Shiroki's building ambitions had started from a plan for an indoor baseball stadium to a golf club house, called the Yomiuri Golf Club Star Dome (1964)[29] [Fig.4.02c-f]. But probably because of a final falling out with Shoriki rather than the latter's untimely death which Fuller claimed, the tetrahedronal city was suspended.[30]

[26]Ltr.6/20/67 RBF to S.J. Dardick in BFI-CR303.
[27]Ltr.3/4/67 S. Sadao to H. Shibata in BFI-G91.
[28]Ltr.8/19/66 H. Shibata to RBF in BFI-G91. See also Ltr.1/26/67 RBF to H. Shibata in BFI-CR296.
[29]O'Malley's contact led to the 1963 Yomiuri Clubhouse dome, a project essentially designed by Geometrics-Cambridge. The project highlighted Fuller's effort to convince Shoriki to adopt a variety of essentially still untried structural systems, which Shoriki's own consultants prudently resisted till the last - from aspension dome (Ltr.1/17/62

Shoriki's tetrahedronal city was a start in a line of Fuller's speculative machine-cities. It was conceptually re-presented and re-packaged along by Fuller as "Experimental City" (X-MC), for which he sought U.S. governmental findings at the University of Minnesota.[31] Fuller's speculative and hyped theory of the "northwest spiraling" of human population dramatized Minnesota as an "unsettled frontier," thus legitimizing his X-MC project as a new opportunity for an environmentally tempered experimental city.

Fuller worked out his environmentally deterministic theory in "northwest spiraling" from his speculative world history. Man, Fuller claimed, developed the capacity of "contemplative or abstract concepts" above the isotherm of 32 degree. In geographical terms, these capabilities moved westward in a pattern of sporadically northward spiraling. Twentieth century American civilization, Fuller claimed, was the culmination of this spiraling effect. From here, the American-grown capabilities would "jump the Pacific," and in this home-coming, will return "to the vast body of world population" the American fruits of "advanced mechanized industry and end-products."[32] American and traditional cultures conjoin in this new commonwealth:

> With the closure of the great circle, and with many world-wide catch-up adjustments germane to this concept, long lasting world prosperity may well ensue.[33]

Perhaps more appropriate to American ears was the capacity of a mechanized macro-climate regulator like X-MC to affect human behavior, and eliminate urban pathologies. Fuller proposed that in America, the 32-degree isotherm had differentiated the historical destiny of the industrial Yankee-North from the slave-owning South.[34] However, air-conditioning technologically moved the 32-degree isotherm further south, altering this division and diffusing fascism in the process:

> This is the probable antidote to fascism arising amongst the warm lethargic and surface glamour loving people. Louisiana, the center of the area of the U.S. below the 32 degree isotherm was naturally productive of a Huey Long. It is no reform urge that persuades industrialist to open new air-conditioned plants in the South. It is the scientific evolution.[35]

RBF to H. Shibata in BFI-CR227), the dog-boned pre-stressed concrete dome (Ltr.8/10/62 RBF to H. Shibata in BFI-CR240), to final "star-dome" version of triple-bonded octahedron truss system.

[30]R.B. Fuller, *Critical Path*, p.333.

[31]Ltr.6/14/68 O.A Silha to RBF in BFI-CR328.

[32]R. B. Fuller, "Ballistics of Civilization," BFI MSS 40.01.01, p.161.

[33]Ibid., p.161.

[34]R. B. Fuller, *Nine Chains*, p.157.

[35]R. B. Fuller, "Ballistics of Civilization," BFI MSS 40.01.01, p.19.

Nothing substantial emerged from the X-MC project despite securing close to a quarter million dollars in federal funds, and numerous pilot studies.[36] Nevertheless, in mid-1967, Fuller separately created a new corporate-research instrument, the Triton Foundation Inc., and successfully secured further funding from the Department of Housing and Urban Development(HUD) to develop a floating community [Fig.4.03a-b]. The megastructure was called the Triton after its namesake, a U.S. nuclear submarine which had circumnavigated Earth submerged the whole way in eighty-four days. Despite its radical and technological appearance, Fuller explained that his Triton project fulfilled low-income housing requirements. But literally, as a solution, it was socially detached, and perpetuated a modern myth of housing as problem merely requiring only formal and technical solutions.

Fuller's grand urban vision was not limited to new projects in the uncharted frontiers. In 1965, he had proposed for Harlem-New York, a massive urban intervention which one writer variously described as a "total solution" and an "exorcism" for an "American (urban and social) dilemma."[37] Fuller's solution to Harlem's "problems," touted as "Skyrise for Harlem" consisted of a network of fifteen conical cooling-tower like residential high-rises to accommodate over a hundred thousand displaced families. In claiming that the project would take thirty-six months of "tooling-up" in organizing the parts, it was evident that Fuller imagined his solution as a mechanical prosthetic insertion rather than a spatial framework for an organic community. Its effect, even on cursory inspection, would displace and fracture the vibrant urban enclave rather than cure its perceived ills. The dominance of the ramp, given its position and scale, attested to this fundamental unstated assumption. The formal precedent of the individual tower was one Fuller recycled, with minor modifications, from his foiled 4D arage-factory of the thirties which were variously offered to Gillette Company in Boston and the Chicago World's Fair[38] [Fig.4.03c-e].

Despite the limitations of his previous city-machines, Fuller's large scale revitalization proposals and new urban vision were effortlessly imageable. Their potentials in projecting social-political and personal ambitions, albeit megalomaniac, were neither lost to Fuller nor his supporters for urban reforms. The encapsulation of hope in distinctive form promised to deliver a cathartic effect on its distressed population, as Fuller returned to the City of East St. Louis in

[36]See Leslie Rich, "What Marvels of Housing Lie Ahead?" *The Washington Daily News*, May 26, 1967.
[37]June Meyer, "Instant Slum Clearance," *Esquire*, April 1965, p.35.
[38]See Ltr.6/15/29 RBF to Frederick C. Church in BFI-CR36. See also two drawings on the 4D garage tower are presented on pp.41-42 in *The Artifacts of R. Buckminster Fuller Volume One: The Dymaxion Experiment 1926-43.* The drawing on page 42 is an earlier version, and was probably the one circulated in the original *4D Timelock*

1970. The community, as one of its representatives expressed, was dismayed and tired of small scale rescue efforts in city repairs:

> The city has been studied enough, dissected enough, drawn enough, cut up enough (through gerrymandering and highway building. It is time ACTION is taken to arrest the downslide of the community. And such ACTION will not be prompted by continued study and analysis. This community (East Louis) may well be the most studied in the country. Was Watts studied? Was Harlem? Was Filmore District? Was Southside Chicago? No, but most of these communities have aid that is allowing them to move along self-help lines. Why cannot East St. Louis get similar help (not hand-outs) instead of remaining a guinea-pig for rich white school boys and the professorate?[39]

4.2.1. The Old Man River Project (1970-77)

According to Fuller, after a hiatus of two years, the effort to revivify East St. Louis City was initiated by Katherine Dunham, a retired Afro-American dancer at Southern Illinois University (SIU).[40] This time the initiative took on a poetic name of the Old Man River City Project (OMR).

In late 1970, the City Council of the City of East St. Louis resolved to establish an OMR-Design and Development Team. Fuller was appointed as a consultant for the "redevelopment and renewal of East St. Louis area" through an "optimum design" and "economic feasibility of East St. Louis riverfront."[41] This time, the East St. Louis initiative was spurred by a National Park plan to develop the site, across the Missouri River directly opposite Saarinen's Gateway Arch, in a rather nebulous project billed as a "demonstrative urban conservation park."[42] The site was called Jefferson Archway Park to differentiate it from the Jefferson National Expansion Memorial Park on which Saarinen's St. Louis Gateway Arch stood.

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[39]Editorial, *East St. Louis Monitor*, 6 Feb. 1969 quoted in R. Mendelson, et.al., "East St. Louis - Studied and Re-studied." (unpubl. Regional and Urban Development Report, SIU-Edwardsville, March 1969)
[40]*Critical Path*, pp.315-323. This initiative was also recounted by Robert Arhart, Chairman of the Steering committee of the East St. Louis project in "Geodesic Dome Inventor to Offer E. St. Louis Plan," *St. Louis Post Dispatch*, 18 Nov. 1970.
[41]For details of the resolution (dated 11/18/70) and the formation of the East St. Louis Riverfront Development Commission, see James Fitzgibbon's "The Notebooks, Old Man River Project," (self-published) September 1972, pp.1-2.

Though only licensed professionally to practice as an architect in New York and Ohio in 1974 and 1979 respectively; Fuller began to identify himself openly as an architect from the start of his commission for the Montreal-Expo'67 U.S. Pavilion project in 1965. Thus he claimed the role of "Chief architect" for the Old Man River Project, even though James Fitzgibbon handled the project almost single-handedly (See "Chronology of Past and Present Prime Functions" in *Fuller's Biography*, BFI-Philadelphia, ca. 1983, p.11).
[42]"East St. Louis Riverfront Suitability, Feasibility and Alternatives," U.S. Department of Interior, National Park Service-Western Service Center, October 1970.

Given the formal and symbolic relation of this East St. Louis development to the Arch, the tourist-potential of the project was recognized from the start. Thus, Fuller's early sketch executed in late November courageously lined up his proposed new city on axis with the Gateway Arch [Fig.4.04a(1 - 4)]. The "demonstrative urban conservation park" proposal was, for all intentions and purposes, a dressed-up project for enhancing the St. Louis Gateway, with envisaged trickled-down benefits for the City of East St. Louis. This premise was implicit in Wyvetter Younge's, the Chairman, East St. Louis Planning Commission, reminder to Fuller of the design specifications of the National Park Service:

> The specifications were that the structure *be essentially complementary* to the Arch and symbolic for an Urban Park designed as a cultural center for performing and creative arts.[43] (Itl., my emphasis)

Probably, also recognizing how the Climatron had enlivened the Missouri Botanical Gardens, Younge saw greater possibilities beyond the objectives stipulated by the National Park Services. Hence she requested for an extensive study of the Climatron's relationship to and impact on the entire Metro East Area.

A key unstated factor of the project was its priority to give development opportunities to industrialists and private capital. Robert Arhart, the Chairman of the project's steering committee, was taking advantage of the signing in of Title VII Housing Act by President Richard Nixon in December 1969 which permitted developers to apply for federal loan guarantees for developing new towns.[44] How such a project could be developed otherwise without massive private investments remains a standing question. Fuller nevertheless denied the need for such funding to launch the project, as he privately recorded his continual suspicion of any form of support from "large business and large government support and (their) concomitant exploitation prerogatives."[45] Instead, the project would be, for him, a demonstration of self-help and affirmation of personal initiatives. The City of East St. Louis, on the other hand, quietly recognized the need for some kind of outside assistance beyond the federal and state grants.[46] For this reason, Rep. Wyvetter Younge proposed that Design and Development teams of OMR City

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[43]Ltr.11/4/70 Wyvetter Younge to RBF in BFI-CR396.

[44]Statement of Robert Arhart, Chairman of the Steering committee for the East St. Louis project quoted in "Geodesic Dome Inventor to Offer E. St. Louis Plan," *St. Louis Post Dispatch*, 18 Nov. 1970.

[45]R. Buckminster Fuller, "Old Man River" (draft), 2/23/74 in BFI-OMR Folder (Active Files). Also, Interview with M. Fitzgibbon, St. Louis, 15 Sept. 1994.

[46]See the conclusion of "East St. Louis (Illinois) Industrial development Survey & Implementation Program," (Final Report, TA1 Project No.06-6-09195, Office of Technical Assistance, Economic Development Association, U.S. Department of Commerce, May 7, 1968-March 1, 1970) p.45.

directly solicit direct early assistance from industries like Monsanto, Alcoa and MacDonnell Aircraft - potential beneficiaries of the project.[47]

For Fitzgibbon who was tasked to oversee the design of OMR, the project was not a new genre of urban design. Besides the Frobisher Bay project, and before his arrival in St. Louis to join the School of Architecture at Washington University, he had executed one of his most fantastic projects -- a prospective "full city cover" for Kuwait City.[48]

In 1966, on a short week's trip to Kuwait, and working from a hotel room, Fitzgibbon imagined a project with the largest deployment of a geodesic-type structure.[49] The "Kuwait umbrella idea" consisted of an elliptical structure 13,500 by 7,100-feet, rising 2,000-feet from ground to zenith and covering a ground area of 60 million sq. ft. [Fig.3.54]. For comparison, he proposed that UTCC would be "the size of a cough drop" next to a "watermelon sliced lengthwise." Its significance was, he described, one that Fuller who had partly bankrolled the expenses of the trip, fully emphasized:

> We have been thinking about this study and the formidable scale of the structure itself and the scope of work and thought that will be required to produce the engineering feasibility study appropriate for this world event. The study, perfect in all its content should certainly be put together in a beautiful book. Indeed the structure we will be considering and the scale of all the tasks that surround it are each so gigantic that we will in all cases have to resort to mapping techniques - *the exploration of a microcosm.*[50](Id., my emphasis)

For reasons unknown but readily fathomable, the Kuwaiti Planning Agency did not undertake the proposal, even though Fitzgibbon argued that with the project, Kuwait City would be transformed into, what Fuller termed, "the great prototype bridge for eventual urbanization of the great world deserts."[51] The project nevertheless articulated what the designer imagined as befitting of a state welfare program namely, that rational planning sensibility was needed to accomplish a project of such a scale over a period of ten years, and with a positive projection of a transformed lifestyle. This second objective, Fitzgibbon argued, would be achieved through the transformation of a "microcosm," via sun and rain control such that the "roof gardens (would)

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[47]Ltr.11/4/70 Wyvetter Younge to RBF in BFI-CR396 (Enclosure: "Proposal for E. St. Louis Riverfront Development").
[48]Ltr.8/23/68 J.W. Fitzgibbon to RBF in BFI-G-91 #5 (JWF Dossier Kuwait project).
For a coverage of the spate of infrastructural development in Kuwait, see "Riches in the Sand: Kuwait Builds Urban Welfare State in the Desert," *Wall Street Journal*, 18 Sept. 1967.
[49]Ltr.7/27/68 J.W. Fitzgibbon to RBF in BFI-CR330. Fitzgibbon turned out six drawings of the Kuwaiti umbrella idea in Kuwait-Sheraton Hotel, in the hope to gauge his client's intentions. The "umbrella" turned out larger than previously imagined -- 3.2 miles by 1.7 miles.
[50]Ltr.8/23/68 J.W. Fitzgibbon to RBF in BFI-G-91 #5 (JWF Dossier Kuwait project).
[51]Ibid.

become an important part of the new city life" and where, with a new "indoor-outdoor" life, people would be able to "enjoy themselves and conduct life in increased comfort and dignity."[52]

Fitzgibbon was primarily responsible for evaluating the entire Metro East site for the viability of Fuller's initial sketch. He concluded that the site along the Arch-axis which Fuller proposed, besides being too narrow, was also inaccessible from existing highways and interchanges. Instead, he moved the project to the north of the Arch axis and the Veterans Bridge to facilitate the connection of the project to existing transportation network as well as to avoid "invidious comparisons with the Arch"[53][Fig.4.04b(1-2)]. Fitzgibbon's proposal was not only pragmatic; it was also politically prudent, since Metropolitan St. Louis probably harbored tacit fears of the Fuller's 800' high dome dwarfing the 634-ft Arch.

Fitzgibbon's first sketches consisted of groupings of stepped-up apartments of twenty-four to fifty stories high for a population of forty-thousand [Fig.4.04c & Fig.4.05g]. The groupings of these towers, their density and physical features drew upon, he related, the urban-neighborhood sensibilities of Kevin Lynch and Jane Jacobs while fulfilling Fuller's intentions:

> My earnest effort is to keep the spirit of your original idea- terraced density-open easy living, and to induce an arrangement that has identifiable 'neighborhoods' so that people live here live in the Town and also in a specific Town neighborhood area.[54]

Fitzgibbon's cautious references to these two seminal American urbanists were vital, given St. Louis's disastrous experience with Pruitt Igoe, the infamous large-scale urban housing project. Further, he was trying to moderate Fuller's public presentation of the project as a purely ecological one. Fuller had openly professed:

> My work (on OMR) deals with how to find the ecological problems involved and how to solve them, hoping thereby to bring about the occupants' satisfaction at the earliest possible moment.[55]

In February 1971, Fuller gave a charismatic presentation of Fitzgibbon's revised site plan and model to a closed forum at Mary E. Brown Community Center in the City of East St. Louis. He publicly announced the "high technology town-in-town" of the City of East St. Louis as the Old Man River City (OMR) [Fig.4.05a-f]. The forum, Fuller subsequently explained in a press

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[52]Ibid.
[53]Ltr.12/23/70 J.W. Fitzgibbon to RBF in BFI-OMR Folder (Active Files).
[54]Ltr.12/23/70 J.W. Fitzgibbon to RBF in BFI-OMR Folder (Active Files).
[55]Fuller's quote in "Fuller' s Vision: City under dome" in *Metro-East Journal*, 26 Feb. 1971.

conference, was a people's referendum.[56] In other words, the fate of the project rested on its approval or disapproval. Amidst the "stunned fascination," "cautious questioning" and "tentative approval" of the audience, Fuller tried to allay local fears that the project might turn into a draconian device for social control or that it would disenfranchise the Afro-American population by pricing it out in the market place.[57] In reaction to the latter, Fuller qualified that OMR City was not an "all black" town; rather, it was for a "raceless and classless" society, a "Garden of Eden community."[58] While such maverick remarks befitted Fuller's long-standing theory of race in America and his ideological position on race; it cruelly glazed over the insidious race-poverty nexus so evident in East St. Louis. All these anxieties were lost in the mesmerizing moments.

To capture the full force of the "momentum and support" after the East St. Louis forum, Fitzgibbon and his team at Washington University designed a walk-in model which consisted of a one to twenty-five scale model of the city and several full-sized terraced apartments under a 120-foot diameter dome [Fig.4.06a-b]. The idea of "prototyping a 'city'" to be realized from private and corporate gifts and subscriptions, Fitzgibbon explained, would be valuable in "maintaining a citizens' dialogue."[59] The final project, if it was eventually realized, promised to be a windfall for all concerned.

Besides creating jobs, OMR City was an exemplary consumptive machine. In the projected construction of OMR City over twenty years under a budget of a half to one billion dollars, an estimated 200-acres of glass or plexiglass, 2000-miles of framing steel beams and numerous other infrastructures would be expended.[60] Functionally, in the concentration of commercial and recreation enterprises in the "crater" of the scheme, the zoning rationalized a one-stop "town-in-town" consumption. However, downplayed in Fuller's initial plan was a symbolically unpalatable proposition that a primary economic life-line for the dome-city dwellers was in servicing and managing the waste production of metropolitan St. Louis.[61]

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[56] John Shaffer, "Fuller Vision under the Dome," *Metro East Journal*, 26 Feb. 1971.
[57] Rube Yelvington, "Fuller's Dream for East St. Louis: Everyone has Place Under the Sun," *Metro East Journal*, 26 Feb. 1971.
[58] R. Buckminster Fuller, "Old Man River," (a poem), 3/11/71 in BFI-OMR Folder (Active Files).
[59] Ltr. 12/30/71 J.W. Fitzgibbon to RBF in BFI-OMR Folder (Active Files).
[60] Donald E. Franklin, "Building a Small City," *Sunday Post-Dispatch*, 9 Jan. 1972.
[61] In "Fuller's Vision Under the Dome" *Metro East Journal*, 26 Feb. 1971, Fuller was quoted as saying "yesterday's pollution (is) tomorrow's prime resources." Fuller was privately taking cues from one of his assistants' suggestion that OMR be considered as an "industrial park" for recycling "waste materials, sewerage, trash, and what-have-you for the entire metropolitan St. Louis area" (See Ltr. 12/15/70 D. Klaus to RBF in BFI-OMR Folder (Active Files)).

Over the next six years, the project stagnated in its planning stages, though ideas for financing the project were not lacking[62] [Fig.4.07]. The Old Man River Community Economic Corporation was established in 1971 for the purpose of soliciting support from private developers and limited partnership investors. The projected support from business and industries did not materialize, even though it drew national attention to the city's plight. As a last ditch effort, in the late seventies, Fitzgibbon heightened the original ecological angle of OMR City as American cities reeled under the thick of the energy crisis. He proposed that OMR City be used to harness the potentials of alternative wind and moving energy sources[63][Fig.4.08].

The padded hopes of the OMR City dramatized Fuller-Fitzgibbon's idealism in the capacity of an artifactual invention to catalyze social changes. Tragically, as an exemplar of Fuller's design science approach, it was reductionist and environmentally deterministic. It under-rated the social-political dimension and the insidious nature of poverty in the City of East St. Louis. Fuller's convoluted anthropological construction of the OMR City as a return of the Afro-American to his "island in the sun," though romantic and poetic, remained impotent to the palpable distress that the community faced. Even conceptually, while his theory of the human race alluded to the uniqueness of the human body, vis-à-vis the evolutionary adaptation of "dark-skinned being" to his locale, OMR City is finally about a desire to mechanize not only the human body but the communal body-image. Its heroic stance, also became fodder for the media, hungry for public spectacles and social-fixes. A local public television station, KETC was quick to note the media value of OMR City as a public spectacle:

> Your unique, architectural concept of this troubled city is unusually central to the planning for this telecast. The philosophical dimensions of an idea such as yours are almost limitless - and *certainly public television at its finest*[64](Itl., my emphasis).

OMR City tragically chalked up further criticisms alongside all earlier reforms experienced by the city – yet another project of "rich white school boys and the professorate."

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[62] Individually, Fitzgibbon sourced governmental fundings with no success (See Ltr.11/5/71 *NSF* to J.W. Fitzgibbon on the proposal to advance "the design of an umbrellaed(sic) high technology town-in-town"). See also "Research Proposal submitted to the Department of Transportation," Wash. D.C. 1976 by URDC-School of Architecture, Washington University & East St. Louis Community Economic Development Corp.. In 1994, Illinois City State Representative Wyvetter H. Young once again tried to revive OMR under "Project Genesis," billed as an "environmentally sound city in the form of a terraced moon crater under an umbrella dome a mile in diameter, able to house up to 250,000 people" (See William Perk, "Project Genesis: Old Man River City Revisted," *BFI Trimtab Bulletin*, Autumn/Winter 1994, p.12).
[63]Ltr.3/10/77 J.W. Fitzgibbon to Rep. W. Younge in BFI-OMR Folder (Active Files). See also John Michael Palmer's "The Energy Implications of Old Man River City" A Conjectural Investigation," M.Arch Special Project 1977, School of Architecture-Washington University.
[64]Ltr.7/20/76 KETC-St. Louis to RBF in BFI-CR619.

Unlike Fuller's visionary floating cities, OMR City was sited in the thick of a real city of abject poverty, rendering it curiously modest. Its fate, even as a lovely dream of a utopia of consumption, naturally raises a fundamental ethical and political question -- whether it had merely engendered insatiable desires at the expense of more radical social solutions. John Kwait of *The Masses* had broached this issue in the thirties when he criticized Fuller's repro-shelter project. In the nineties, Max Dublin, a harsh critic of futurism updated a similar criticism but along a theological and moralistic line. Dublin proffered that the ethical problem of such future visions was socially disarming. He argued that these "futurological boosterism" and fixation on "inevitability," which Fuller's projects entailed, tend to inspire and put one into false positions, causing one to "act irresponsibly to the present" or abandon the viable.[65] Clearly, Fuller's sundering of class and race in OMR City made a virtue of his scientistic trend-forecasting. It narrowed the horizon of solutions, and forced choices along a purely technologistic line, namely along efficiency.

As Fuller's ideas expanded, his environmental vision eased seamlessly into an urban vision. It was a process assisted and exaggerated by media and gallery culture. For example, in Thomas Garver's curatorial effort, "Two Urbanists. The Engineering-Architecture of R. Buckminster Fuller and Paolo Soleri" broadly accepted Fuller's construction of the urban environment as a natural one, reducible to population and resources. Thus, he offered this assessment:

> By stressing the vast sameness of problems, not the seeming differences, Fuller's theories have broad social as well as technical implications for architecture.[66]

The context of OMR City and its ensuing rhetoric were, however, furthest away from the narrow "energy valving" concerns of Fuller's earthly Eden dome-city. At the time of the project, the City of East St. Louis comprised of approximately 70,000 inhabitants, of whom 70% were non-white. Since the close of WW II, both the depression of railroad business and loss of industries for unskilled labor added to the city's economic doldrums.[67] If the East St. Louis project emerged by emergency, it was not from the environmental imperatives that Fuller had predicated. Rather, its problems had roots in decades of national neglect, exacerbated by the loss

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[65]Max Dublin, *Futurehype. The Tyranny of Prophecy*, New York: Plume Book, 1992, p.5.
[66] "Two Urbanists. The Engineering-Architecture of R. Buckminster Fuller and Paolo Soleri," Rose Art Museum, Brandeis University, Waltham, Mass., December 21 1964 - January 17, 1965. See also John McHale's *The Future of Future* (New York, G. Braziller, 1969) and Thomas Creighton "Architects with Feel for Future needed," *Honolulu Advertiser*, November 16, 1970.
[67]See "East St. Louis Riverfront Suitability, Feasibility and Alternatives," U.S. Department of Interior, National Park Service-Western Service Center, October 1970, pp.38ff.

of jobs and decades of abject poverty from which the city's inhabitants had not been able to extricate. Even as a misguided hope, it is arguable if any large-scale projects of the sort in Fuller-Fitzgibbon's stable would be beneficial. In the end, if OMR City was a misguided political project, it was so because it rode tragically on the seemingly sensible and serious enterprise of Fuller's projected future.

4.2.2. The Charas Project (1970-73)

OMR City represented one end of a spectrum of urban self-help under the auspices of middle-class Afro-Americans. The Charas Project to create urban dome shelter represented the other end of this spectrum of ad-hoc self-help. This time it was undertaken by ex-gang leaders and delinquents in the Lower East Side of Manhattan. Under Mike and Fred Good, and with Dr. Charles Slack (a gang-psychologist at Harvard University) as patron, the precursor of Charas was The Real Great Society Inc. (1967). It was intended to showcase a "new life-force " amidst the "underprivileged and disillusioned youths of city center areas."[68]

Fuller's interest in Charas, besides its apparent populist angle, was also instilled by his belief that such initiatives by the dispossessed urban population, epitomized action over revolution. They would quieten past summers of rage and riot in Harlem (1964) or similar ghetto uprisings in Watts (1965). In this context, Fuller commended Charas members:

> There is nothing more exciting to me now than the fact within the community on these streets I find leaders emerging who just don't *want to take the law into their own hands*, who don't just want to protest, but who, with a deep and intuitive earnestness and dawning awareness, *want to make things work*....
> They are able suddenly to *master environmental controlling* and to realize that they are going to make the breakthroughs ... The *movement is in the streets*, and it is wonderful news for humanity[69] (Id., my emphasis).

Charas, on the other hand, was captivated by Fuller's vision of a real great society, his "world community" would somehow include them directly. Thus commented the chronicler of the Charas experiment:

> (Charas) had realized it was, somehow necessary to begin with the microcosm of their own neighborhoods before approaching the macrocosm of the whole system. Bucky's words and images touched their aspirations for a world based on true equality and plenty....

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[68]For a valorized account of Charas, see Syeus Mottel's *Charas - the Improbable Dome Builders*, New York: Drake Publisher, 1973.
[69]Syeus Mottel, *Charas - the Improbable Dome Builders*, p.20.

> The dome, more importantly, is an introduction to the whole system of thought. Bucky had developed for man's survival and utopian technological growth that can set man free from needless drudgery.[70]

If fighting the negativism from abject poverty and against the "local apathy and the lethargy of governmental bureaucracy" were primary objectives, the Charas dome project succeeded momentarily and to a certain degree. It galvanized the weary spirit of the "street people" and enlivened them over a period of five months. The testimonies of some participants highlighted the therapeutic qualities of the dome. One participant proposed that the urban dome enterprise was "more of a life style"; another claimed that the tactile and palpable quality of the geodesic dome would "shake some of the apathy from the community."[71]

Michael Ben-Eli, who was charged with directing the whole project, kept the participants in the project under a routine of Victorian-like self-discipline, and diffused potential-personal episodes of violence and antagonism.[72] He offered the process almost like a conversion in this patronizing tone:

> They turned from things like mugging and other negative episodes to activities of great positive worth. But they had absolutely no ideas, no previous training, no tradition, nothing of knowing how to really change a concept into a reality. And they had a tendency, I think to shy away from problems. In that case they were a little bit like children in their enthusiasms.[73]

Charas had contacted Fuller in January 1970, with the plan to develop their dome-making skills into a commercial activity in order to capitalize on the low-income housing opportunity opening up in East Harlem.[74] However, what Charas chose to make work as an alternative urban housing was deeply problematic, if not technically flawed. The Charas dome used a paperboard structure as a mold for its ferro-cement finish. However, even under the best possible technical and industrial conditions, variations on the project of this sort previously attempted were either aborted or their results, dismal.

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[70]Ibid., pp.20-22.
[71]Ibid., p.72 & 83.
[72]Michael Ben-Eli, one of Fuller's ardent student supporter from the UIA-days, worked on the WDSD project with Keith Critchlow and John Lloyd at Architectural Association. Ben-Eli's own dome experimentations were conducted with John Lloyd at Kumasi-Ghana (ca. 1965); and in the summer of 1967, as part of Phase II-WDSD project, he had designed a paper cardboard shelter for disaster shelter (Notes from Author's Telephone Interview with Michael Ben-Eli, 6/30/95).
[73]S. Mottel, *Charas - the Improbable Dome Builders*, p.110.
[74]Ibid., p.108.

In the early sixties, after abandoning the Paperboard dome, Fuller prospected on several low-profile, low-cost domes with several franchisees. These included the fiber-glass reinforced plastic Geospace domes by Monsanto Chemical Company, which he thought was so low cost that even the Marsh Dwellers of Iraq, who lived in traditional thatched reed huts, would probably find the domes acceptable.[75] Monsanto also quietly eyed the Indian shelter market and considered collaboration with the influential mill-owning family in Ahmedabad, the Sarabhais, to produce geodesic domes. It subsequently experimented on a "foam-core" dome of 1/2" polystyrene, sandwiched between cord jute and aluminum foil reinforced Kraft paper, dipped in alkyd resin.[76] There was also a series of domes of indigenous low-cost materials - the Indlu Domes (1958), and the Bamboo Domes (1960-62) [Fig.4.26]. The former, named after the Zulu dome-shaped grass habitation was prototyped in corrugated metal sheets at the School of Architecture, University of Natal; the latter, developed by Fuller at Long Beach State College, was redeployed for Calcutta when Fuller was appointed as a consultant to the Ford Foundation's Calcutta India Planning Organization.[77] However, nothing practical or substantive came out of these projects.

The singular dome was also a gravely naive housing form, especially for the urban ghetto. Thus, while OMR City was misguided by media-hype and the unreality of its magnitude, Charas was trapped in the narrowness of its tactics and definition of what housing as a social phenomenon entailed. The dome component in both OMR City and the Charas Project signified very ideologically-different agenda and levels of self-sufficiency. OMR City capitalized on the positive ecological-productive image of the dome; while Charas used the geodesic dome more as a pedagogic and instructive device for self-dependency. Charas, however, was not an aestheticized object of poverty, but rather, one that emerged out of abject urban poverty and a context of constraints[Fig.4.09a-c].

In the early nineties, Fuller's geodesic domes revisited a new homesteading site -- this time as "Genesis 1" in downtown Los Angeles. Under the aegis of Justiceville /Homeless U.S.A. and Future Group Inc., the founder and president, Ted Hayes, previously a homeless man, proposed a series of twenty dome homes as transitional community for the homeless. Funded by ARCO, a prototype 20-foot diameter dome that could house up to 24-25 homeless people was erected by homeless workers and the American Temporary Housing Corporation.

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[75]Ltr.10/31/61 RBF to J. Lovari in BFI-CR224.
[76]Ltr.6/23/62 RBF to John V. Moore in BFI-CR233. See also D. Robertson, *The Mind's Eye of Buckminster Fuller*, p.65.
[77]Ltr.7/28/62RBF to J.K. Delson in BFI-CR234. For the Indlu dome see School of Architecture University of Natal, INDLU Geodesic Dome Project, May 1958, in BFI-CR194; for the Long Beach State College (LBSC) Bamboo dome see LBSC's News Release by Schaaf Miv, "Fuller Tackles Shelter Problem in Asia, 12/15/60. Copy in BFI-CR216.

Besides the speed of erection, enabling the whole community to participate in "quickly getting people off of the streets and into a very safe, clean and productive environment," there were also other advantages. Hayes explained that the mobility of the dome enabled the transitional community to be moved to a new location after a year to ward off local residents' opposition, "so that surrounding residents are not so opposed to the idea of a transitional homeless community in their neighborhood." Further the project promised to bring back the "social skills" gradually while providing a degree of permanence.[78]

As before, a larger enterprise looms beyond the initial issue of self-sufficiency in the pilot structure. One dome-manufacturer enthusiastically advocated:

> Hayes intends the domes, whose occupants he describes as 'Earthonauts' - inhabiting space-age technology, on Earth - to provide Justiceville/Homeless USA not only with shelter, but also the opportunity to eventually own, manufacture and market Omnispheres worldwide; the aim to contribute to the alleviation of hopelessness and to a more environmentally responsible form of habitation. Perhaps Buckminster Fuller's dream for mass housing in lightweight domes is finally to be realized by the very people for whom his ideas were intended.[79]

These representations of the geodesic project differed substantially from the earlier portrayal of the geodesic structure as a purely functional implement [Fig.4.10]. In the sixties, the transformation paralleled a fundamental shift in Fuller's public presentation of his work. As he graduated to a public philosopher, his geodesic artifacts were received not only as functional-aesthetic instruments, but were also viewed as objects imbued with a social and personal therapeutic edge [Fig.5.10a]. In each case, Fuller's geodesic dome became emblematic of personal control and self renewal. Even today, dome-raising acts are symbolic at a personal and collective level. They re-enact creation and integrate individual acts into a communal body-image.

4.3. Emblematic Domes in the Margin (1961-67)

In another quarter of America, particularly among recent white middle-class college graduates, Fuller's geodesic artifacts and ideas entered a new orbit which is seemingly different from the earlier futurological fantasy. Fuller's long-standing presentation of his anti-

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[78]Melinda McDonald, "Dome Village for the Homeless Opens in L.A.," *BFI TRIM-TAB Bulletin*, Fall/Winter 1993, p.7.
[79]"Homeless USA Try High-tech Domes," *DOME*, Winter 1993-94, p.26.

establishment past endeared him to the "flower-power" era, prompting one social pundit to call Fuller "an ageless oracle tuned to all frequencies."[80]

Peter Drucker, who was acquainted with Fuller when he first worked at *Fortune* magazine and later at Bennington College, characterized him as the most unlikely hero of the counter-culture movement. Nonetheless, the attractions operated along a similar ideological line that Fuller had nurtured throughout his life; one, Drucker explained, that was assisted by the growing quest for a technology which would allow an immediacy of personal control:

> Suddenly, in the 1960s, technology was seen as a human activity; formerly it was a 'technical' activity ... Technology moved from the wings of the stage of history to which 'humanists' had always consigned it, and began to mingle freely with the actors and even at times, to steal the spotlight.
> To a generation which realized that technology had to be integrated with metaphysics and culture, aesthetic and human anthropology and of the self-knowledge of man – these two prophets offered a glimpse of a new reality. That their landscape was fog-shrouded and their utterances oracular only added to their appeal.[81]

Indeed, how Fuller's corporate-slanted technologism and arch-technological positions from the fifties were transformed into an advocacy of personal technology, and subsequently presented as "appropriate" technology, is historically remarkable. One could identify two primary factors which assisted his ascendance into this new custodianship. Firstly, his long-standing rendition of energy as a determinant of industrial civilization finally received poignant recognition at a time of Arab embargo on oil exports to the United States. His proto-ecologism was rediscovered, and its technologistic and technocratic strains, purged. Secondly, there was the associated social-symbolic revivification of his Garden of Eden project, augmented by the proliferation of consumer technologies. Thus, in Fuller's retooling of his public identity, his demonstration of a life of using energy rationally and efficiently is now unwittingly remapped as a sensibility to consuming less energy. Fuller's artifacts, as exemplars, immediately found eager reception in new identities.

4.3.1. The Student Fronts (1961-67). Domes as Emblematic of the Design Science Revolution

Fuller's position within American counter-culture did not emerge overnight. Rather, it was a fork along a route built on increasing student reception and support of his world-around

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[80] Peter Brown, "SIU's Famed Designer," *St. Louis Post-Dispatch*, 5 Nov. 1969.
[81] Peter Drucker, *Adventures of a Bystander*, New York: Harper & Row Publisher, 1979, pp.245-426.

vision for design, which he touted as "design revolution." Its activity, formed around a morally-principled technology, was a redeemed technology which required no social transformation.

The project, initiated through the auspices of UIA (Union Internationale des Architectes) for a period of six years, began in 1961. Fuller was initially invited to UIA as an independent member to the RIBA-hosted VIth Congress (July '61) in London to lead one of its plenary sessions, "The impingement of Technology upon Architecture."[82] It was at this session that he spelt out his idea for the World Design Science Decade (WDSD). This was projected as a "10-year 'world retooling design program' to be adopted by architecture schools worldwide on 'how to redesign the worlds' prime tool networks and environment facilities so as to make the world's total resources ... serves 100 percent (of humanity) through competent scientific and anticipatory design.'"[83]

The primary agents of the WDSD-project were design students; and it broadly showed how Fuller recognized long before H. Marcuse or T. Roszak, two of the counter-culture gurus of the sixties, the instrumental role of students as quintessential outsiders in advancing changes. While they were harbingers of change, Fuller, in opposition to Marcuse and Roszak, portrayed the students as apolitical and disinterested. Thus, they were like his former SSA-cadres awaiting persuasion by a transcendental, transnational ideology akin to his:

> The students have no political motives. They are not supported by any political organization. As amateur design scientists, the students deal only in resource statistics, computation, inventions, schematics, drawings and models which dealt with the world's industrial network growth. They deal thoroughly and experimentally with man's external inanimate, industrial network organism in the same way that medical science deals with mankind's internal organism. Their design science findings may be employed alike by all political states, whenever, in emergencies, the students' inventions and network integration become as logically employable as are medical science's research 'breakthroughs'. Anticipating a broad spectrum of critical needs, the students' design science breakthroughs' are placed upon the, world news published, standby awareness 'shelves' in the same way that medical breakthrough techniques and antibiotics become standby.[84]

Over a period of six years, Fuller executed what could rightly be characterized as a minor coup on the internationalist agenda for UIA. As a confederation of architects from around the world desperately seeking, since the post-war years, ways to forge its identity amidst respective

[82]Ltr.11/30/62 RBF to McGeorge Bundy in BFI-CR236.
[83]Monica Pidgeon, "Taking London by Storm," *The Architect's Journal*, 14 Dec. 1995, p.23.
[84]Extracts of Fuller's speech to The American Institute of Planners, Annual Congress, St. Louis-Mo., 18 Oct. 1965, quoted in J. Dieges & E. Schlossberg's "*Prologue to Design 100,*" (ca. November 1967) in BFI-CR312. Compare this characterization of students as agent of change with an earlier tract by Fuller, "The Architect as World Planner," *AD (Architectural Design)*, August 1961.

mounting local pressures and interests. The UIA, founded in Lausanne in 1948, drew members from national architectural associations. Its professed mission is to "unite architects from all nations throughout the world, regardless of nationality, race, religion or architectural school of thought." A primary activity of UIA is the world congress organized every three years on thematic concerns, beginning with the first, "Architecture Faced with its New Tasks," at Lausanne in 1948. Out of prudence rather than by choice, the UIA Congress since 1958 had carefully steered away from bi-partisan politics by alternating the venues of its Congress between the Communist and non-Communist countries.

For Fuller, UIA offered the ideal platform to forge the new agent of change. Its identity was to be forged through influencing architectural education directly at the various university architectural schools. Fuller proposed that his ten-year biennial program would transform architecture from an "over-specialized slave profession" to a "comprehensive anticipatory design science."[85] The program entailed a re-designed use of the total world resources, based on an ideological premise that the world was not constituted by national boundaries, but rather, by resources and climates.

Perhaps out of ideological identity with Fuller's project, a segment of the British architectural fraternity and *Architectural Design* played active roles in spearheading Fuller's "world program" to make the "total world's resources serve 100 per cent of humanity through competent design." RIBA installed him legitimately in a forum of professional architects.[86] Monica Pidgeon of *Architectural Design* played a proactive role in advancing Fuller's agenda, and strategized afterwards "to stuff the results down (the) throats" of UIA and Sir Robert Matthew, Chairman of RIBA.[87] The journal did this by circulating Fuller's statements on education to architecture schools and student organizations of every member country of the UIA.

The British architects, joining Fuller's bandwagon against the "too-local horizon of town planning," probably saw that by championing Fuller's "total world planning," they would revive a grand world past, dulled by the state of their post-war welfare state activities. Rawstone, for example cited as "signs of the rejuvenation" of the architectural profession in Britain when Sir Robert Matthew made "unprecendented plans for world-wide collaboration on housing needs and patterns."[88] Reyner Banham, Peter Cook and Cedric Price were primary arbitrators of the English

[85]Ltr.9/26/63 RBF to G. Piel in BFI-CR247.
[86]"The Architect as World Planner. R. Buckminster Fuller addresses the UIA Congress," *AD*, August 1961.
[87]Ltr.12/17/62 M. Pidgeon to RBF in BFI-CR238.
[88]Peter Rawstone, "Building For One World," *The Observer* (London), 12 Aug. 1962.

interests in Fuller. To them, Fuller was attractive philosophically "as a father of futurism" rather than as an architect; and through Fuller, Banham "reinforced the movement of technology in architecture."[89] John McHale, a British futurist sociologist, who was active in promoting Fuller's ideas and works in the British circles in the fifties, was directly instrumental in laying out its research program at SIU-Carbondale.[90]

The Cuban missile crisis of October 1962 dashed Fuller's initial hope to implement his plan at the VII[th] UIA Congress in Havana-Cuba the following year.[91] The State Department severed diplomatic ties with Cuba and forbade Americans from traveling to Cuba. Nevertheless, viewing the urgency of his project, Fuller embarked on alternatives to circumvent the ban. How Fuller argued for the exceptional merit of his project highlighted his idealistic, albeit misplaced belief in the efficacy of his project.

Though publicly eschewing politics, Fuller was nevertheless worried that under the politically-charged climate, the media would taint the meaning of his initiatives by improperly misinforming the public regarding the intent of his work. Hence, Fuller tried to rally the support of his wide network of liberal Americans. Towards McGeorge Bundy, the President's assistant for National Security, Fuller asserted that his "private U.S.A. individual initiative" was a primordial form of American free enterprise, now corrupted by government bureaucracy and corporations.[92] He further proposed that his popular reception in Cuba and the international goodwill his project had engendered might even diffuse the existing political tension.[93] But rather than resorting to personal boycott of the U.S. travel embargo which would have eminently symbolized the transnationalist cause of his project, Fuller resigned to McGeorge Bundy's decision. While acceding to the international goodwill of Fuller's project, Bundy nevertheless maintained the political necessity of the embargo on travel and advised that he presented his program in a carry-over session on neutral grounds in Mexico City.[94]

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[89]Notes from Author's Telephone Interview with Michael Ben-Eli, 6/30/95.

[90]Monica Pidgeon, Ibid., p.23. J. McHale's contribution included the following key documents of WDSD-project:

- PHASE I (1963): Document I, Inventory of World Resources, Human Trends and Need
- PHASE I (1964): Document II, The Design Initiative
- PHASE I (1965): Document III, Comprehensive Thinking
- PHASE I (1965): Document IV, The Ten-year Program. Documents prepared in time for the 7th UIA Congress in Paris
- PHASE II (1967): Document V, Comprehensive Strategy
- PHASE II (1967): Document VI, The Ecological Context: Energy and Materials

[91]For an enthusiastic reception by the organizers of the VII[th] UIA World Congress, see Ltr.10/29/62 R.M. Franco to RBF in BFI-CR236.

[92]Ltr.11/30/62 RBF to McGeorge Bundy in BFI-CR236.

[93]Ltr.11/27/62 RBF to Delyte W. Morris (President, SIU) in BFI-CR236. See also Ltr.3/30/63 RBF to G. Piel in BFI-CR247.

[94]See Ltr.12/20/62 McGeorge Bundy to RBF in BFI-CR226 & Ltr.1/4/63 RBF to McGeorge Bundy in BFI-CR243. For Fuller's apology for being able to go to Havana, see Ltr.4/2/63 RBF to R. M. Franco (Dir., Organizing Committee of the VII[th] UIA-Congress, La Habana, Cuba) in BFI-CR237.

The move to a neutral ground was prudent, Piedgon similarly advised, since a large contingent of UIA delegates from South and North America would not have been represented at Havana.[95] Perhaps anxious of potential public mis-reading of his steadfast position as tyranny, Fuller explained to one of President Kennedy's insiders, the condition of his trip:

> I will only go to Cuba under the condition of enthusiastic good-will, not only of our Government Officials but of our President and the segment of our U.S.A. National Press typified by the New York Times.[96]

Fuller continued to maintain that it was the behind-the-scene bi-partisan American politics which really prevented him from traveling to Cuba.[97] However, his own behind-the-scene lobbying demonstrated how Fuller, despite publicly eschewing politics, saw no contradiction in actively crafting political influences to advance his cause.[98]

One of the most significant claims Fuller advanced to argue for an exception to be made towards his agenda was its transcendental intent - standing above national and international politics. He boasted to August Heckscher, an old friend and a White House adviser, of the capacity of his "design science" to tame the student's turmoil:

> It must be remembered that it is the students around the world who represent the physically active passion of political turmoil. In this connection, I have been much more of a factor than the Administration can realize in *bringing world students into powerfully expectant attitude in respect to the positive potentials of United States moral and industrial leadership*. For instance, there were approximately 30 days of maximum negative agitation in Tokyo by the Japanese students regarding the proposed visit of President Eisenhower in 1961. On every one of those 30 days I was being featured prominently in Japanese newspapers and on their television as a popularly welcomed protagonist of the swift realization of the new era capabilities of man, to be realized only through design science initiative and competence; as being a vastly superior popular democratic stratagem than that of asking our politicians to get us out of troubles by political reforms such as socialism, which is useless when the resources as designedly(sic) employed can only take care of 44% of humanity. My thoughts were popularly received. On one occasion, I had 20,000,000 Japanese listening to me on a 3-hour national television hook-up[99] (Itl., my emphasis).

Besides describing how his "very sensitive, single handed, yet powerfully positive potential" as a metaphorical lightning rod had grounded student-led social agitations, Fuller also

[95]Ltr.1/7/63 M. Pidgeon to RBF in BFI-CR237.
[96]Ltr.5/20/63 RBF to A. Heckscher in BFI-CR242.
[97]Ltr.5/20/63 RBF to A. Heckscher (Special Consultant on Arts-White House) in BFI-CR242.
[98]See also Ltr.5/29/63 RBF to G. Piel in BFI-CR239.
[99]Ltr.5/20/63 RBF to August Heckscher in BFI-CR242. Fuller subsequently reported of spontaneous student's "political outburst" and "resentment" because of his absence in Havana (See Ltr.11/6/63 RBF to W.R. Ewald Jr. in BFI-CR249).

implied that his agenda signified the end of ideology. Fuller confidently claimed that had he been allowed to present his design science in Cuba, his "non-politically angled world plan for solving techno-economic problems might possibly have become adopted by Cuba in lieu of communist ideology."[100] In this context, the "active passion" of the students could be rallied into a rear-guard apolitical agenda.

The students' separately launched Fuller's Design Decade initiatives in UIA (under his partial funding and Southern Illinois University) at the Tuilleries Garden, Paris received more press coverage than the Congress proper [Fig.4.11a-c]. Except for several English schools and isolated few in the Commonwealth (Australia, New Zealand and Ghana), the enthusiasm for the program dwindled quickly. Even among these English schools, Fuller's program was only partially successful at the Architectural Association (AA). This was primarily because that institution's own ethos as an alternative to the professionally-dominated schools; and it had served as a forum to undermine professional practice. Still, among the English schools, Fuller nevertheless effectively portrayed WDSD as a "real on-going robust program."[101]

Fuller did not view his project as propagandistic or political even though the innuendoes of his descriptions, privately and publicly, suggested both. Ideologically, Fuller's design science is a home-brewed futurology. Though unlike the doomsday model of Meddows and Forrester at MIT, his project was nonetheless offered as an alternative to the Marxist monopoly on scientific prophecy.[102] Despite his transnational rhetoric, Fuller believed that through design science, the "free" world, led by America, would maintain the moral leadership and thwart potential succession by either the Communists or the developing nations:

> Recourse only to yesterday's non-priority, low order of energy efficiency, craft techniques in the attempted solution of the underprivileged and heretofore non-industrialized countries' living problems will be not only abysmally ignorant but will bring about *the swift economic suicide of the world's free enterprise countries.*
>
> I am convinced by ... my private intelligence that the Russians are secretly preparing to use the highest industrial technology in the solution of their own, then the Chinese, then the Indians, Africans, and finally the rest of the world's livingry (sic) system solutions. *We must wake up to this fact or else fall behind in world initiative*[103] (Id., my emphasis).

[100]Ltr.11/6/63 RBF to W.R. Ewald Jr. in BFI-CR249.
[101]Notes from Author's Telephone Interview with Michael Ben-Eli, 6/30/95.
[102]See criticism of futurology by Georgi Shakhnazarov, "Futurology Fiasco: A Critical Study of Non-Marxist Concepts of How Society Develops," cited in M. Dublin's *Futurehype*, p.84.
[103]Ltr.7/28/62 RBF to J.K. Delson (Energy Resources Panel, National Academy of Science, Washington-D.C.) in BFI-CR234.

While UIA was initially enthusiastic about Fuller's agenda for an internationalist architectural education, it was generally unable to support fully, on a continual basis, Fuller's student-driven "design science" initiatives. Technically, its Congress was reconstituted every three years. Perhaps UIA also came around, after the VIIIth Congress in Paris, to the realization that Fuller's project was overtly subversive to their liking. If successful, it would undo the profession along what he claimed would be an emancipation of world society with "world architects, led by the world architectural students."[104] J. Lloyd, the Principal of AA characterized Fuller's WDSD as "anti-establishment and almost of an under-cover nature." He further noted that any "officially organized and establishment patronized" effort would not comprise this radical edge.[105]

Finally with the IXth UIA Congress at Prague (1967), Fuller's "theme" and the demand of his students' program, then singularly advanced by John McHale, veritably acting as Fuller's Executive Director of the World Students' and World Resources Inventory programs, were seen not only as increasingly out of line with the Congress' own mission but also violated its statutes. Perceiving a loss of control, Jiri Gocar, President of the IXth World Congress of UIA, Prague, commented:

> I was told by lots of interveners more or less authorized a parallel manifestation of private character is being prepared. It looks like as (sic) this whole activity goes on purposely without any proper knowledge of the Congress organizers; that surely may lead to an extremely difficult situation and put the Congress organizers in serious troubles, without any possibility for remedy.[106]

Partly because of the inhospitable climate at UIA-Prague and possibly to upstage its students' event, Fuller separately convened a World Architectural Students' Day for "Design Science Decade" students at the site of his magnum opus, the American Pavilion in the Montreal-Expo'67 Fair.[107] Speaking of the English students' Design Decade activities, Fuller felt impelled to report on *modus operandi* after the UIA-Prague incident:

> (I) always undertake to come in the front door and not through the attic or cellar windows. It is no use getting into the attic and hiding there only to be thrown out by the scared occupants of the Status Quo Family and thus to land on one's own 'neck' and have broken it.[108]

[104]Ltr.3/29/66 RBF to The Participants in the Hotel Palais Gare d' Orsay correspondence in BFI-CR270.
[105]Ltr.3/22/67 J. Lloyd to J. McHale in BFI-CR301.
[106]Ltr.1/24/67 J. Gocar to RBF in BFI-CR279.
[107]See Ltr.4/4/67 RBF to L.J. Fricker in BFI-CR300; also itinerary for the "World Design Science Day/Expo'67," 28 Aug. 1967 in BFI-CR307.
[108]Ltr.4/4/67 RBF to L.J. Fricker in BFI-CR300.

By then, however, even this explanation seemed gratuitous and unnecessary. His ideas for student-led initiatives, whether demonstrated as the informal Edenic garden dome projects or the formal World Games, had been effectively lodged in the American home ground.

4.3.2. Domes as Technology of Personal Control.

> You technocrat! You technofascist![109]

> Fuller's relation to nature is profoundly felt and intimate – in an almost San Franciscan sense. To hear him speak of a bird – its form, its pattern of behavior – 'process bird' as he calls it; or of a tree, the principles of construction that combine to form this marvelous phenomenon, a tree - (he becomes a tree in describing) – is to see him relate to the bird or the tree with an empathy, an identification such as an artist feels for the object of his attention and inspiration. Each focus of his wondering observance illuminates an abstract principle that finds its place in the vast order of inter-relationships forming his inner world.[110]

The ambivalence of Fuller's public reception has been debated as the difference between the "read Fuller and the performed Fuller."[111] Yet, Fuller's cultivation of his life as a perpetual outsider shared certain common attributes with American youth culture of the sixties. This youth culture is formed by, as Keniston described, "an ambivalent tension over the relationship between self and society."[112] To explicate Fuller's apparently anachronistic position among the insurgent youth culture of the sixties, one needs to recognize that this media-hyped youth phenomenon, collectively billed the "counter-culture," was neither monolithic nor anti-technology as it was often portrayed.

Counter-culture was a spectrum of diverse and sometimes divergent cultural practices which accounted equally for the acceptance and rejection of Fuller. For instance, Jay Baldwin, a frequent contributor to *The Whole Earth Catalog*, parenthetically differentiated the sensibilities Fuller represented from the ignorance and escapism of the "hippies" [Fig.4.12a]. In the same vein, Fuller's retainers under the rubric of *The Whole Earth Catalog* movement were also anti-political purists, intolerant of the activism of the New Left. Thus, in contrast, Baldwin proposed that Fuller's technological project as ideologically "counter-counter culture." In the parlance of the sixties, *The Whole Earth Catalog* was "tuning in," rather than "turning out" or "dropping out." *The Whole Earth Catalog* was, Baldwin proposed, Fuller's world and words embodied in

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[109]Outburst by E. Floyd during Fuller's talk at Coffman Memorial Union, Univ. of Minnesota, Minneapolis, Oct. 1973 quoted in Jon M. Shafer's unpubl. MS., "Innocence and Knowledge: Early Influences and Events in the Life of R. Buckminster Fuller, Jr.," 9 Apr. 1976, p.7.
[110]Mercedes Matter, "His Life as a Work of Art," *The Architectural Forum*, January/February 1972, p.52.
[111]See debate between Kirby Urner and Alex Soojung-Kim Pang (Christopher J. Fearnley, cjf@netaxs.com, "The R. Buckminster Fuller FAQ," v.1.0, 12 July 1994).
[112]Kenneth Keniston, *Youth and Dissent; the Rise of a New Opposition.*, New York, Harcourt Brace Jovanovich, 1971.

tools. With "good complete information" and "good tools as extension of the mind," Baldwin suggested that living was no longer a "simulation," rather one was "living (one's) own living."[113] Recalling Stewart Brand's (founder of *The Whole Earth Catalog*) disgust with the "geodesia" in the Southwestern communes, W. Rybczynski advanced a similar assessment of the pedagogic intention of *The Whole Earth Catalog* :

> The youth culture until then had been long on youth but rather short on culture; in many ways Brand's (*Whole Earth Catalog*) supplied the latter.[114]

4.3.2.1. Drop City (ca.'67-71)

Regardless of the ideological distinctions, Fuller's "oracle" appealed to both. In the late sixties, Fuller straddled a middle-road position in an effort to reconcile an unfolding pitched battle between the technologically-savvy faction and its opponents. In 1967, at a three-day *Newsweek-Washington Post* sponsored "Conference of Agents of Change" ar Park Sheraton Hotel, Washington D.C., P. Rabbit (pseudonyın for P. Douthit) reported on the exchange between two popular futurists, Alvin Toffler and John McHale, over the professed anarchism of Drop City, an emblematic commune of dome-dwellers in Trinidad-Colorado. Against the backdrop of his increasingly politicized Spaceship Earth, Fuller interceded in a two-hour closing speech, its survivalist imperative:

> It just doesn't make sense for the kitchen to fight with the engine room; it makes even less sense for the whole crew to do their damnest to wreck the ship.[115]

The counter culture initiates and psychedelic radicals, exemplified in T. Roszaks' and C. Reich's camps were enthralled by Fuller's recently re-formed rhetoric of wholeness and hope.[116] However, they were generally uncritical of the technological ramifications of Fuller's one-city world which had oscillated between domination by transnational corporations and the survivalist agenda of Space-ship Earth. Rather, their own malevolence towards technology and industry fed on Fuller's anti-establishment rhetoric, thus quietly overshadowing what many would have otherwise nominally viewed to be an uncomfortable past of successes based on establishment patronage, both corporate and militaristic. Nonetheless, under the psychological circumstances of their respective disenchantments, Fuller's Baconian-inspired "technological valving of the

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[113]Notes from Author's Interview with J. Baldwin, Santa Barbara-Calif., 8/31/94.
[114]W. Rybczynski, *Paper Heroes. A Review of Appropriate Technology*, Garden City, N.Y.: Anchor Press, 1980, pp.93-94. Henceforth as *Paper Heroes*.
[115]Peter Rabbit, *Drop City*, New York: The Olympic Press Inc., 1971, p.144. Henceforth as *Drop City*.
[116]See Theodore Roszak, *The Making of a Counter Culture ; Reflections on the Technocratic Society and its Youthful Opposition*, Garden City, N.Y.: Doubleday, 1969 and Charles Reich, *The Greening of America ; How the Youth Revolution is trying to make America Livable*, New York: Random House, 1970.

universe" was rendered in a mixture of cosmic, spiritual and sexual terms. An experimenter of the "hippie-domes" of the notorious Drop City evoked a similar ecstasy, as he recounted that the making of the domes -- this "crystal molecular good sense of a dome going up," and which he likened to "the grunting goodness of eating and sex."[117]

Rather than a coincidental entanglement, it could be argued that the ascetic features of Fuller's geodesic artifacts fitted hand-in-glove with the alternative low consumption lifestyle of counter-culture practices. For the "new people" the geodesic artifacts were matters of choice rather than necessity.[118] W. Rybczynski explained that under Ken Keasy, the beat author, the fantasy of geodesic dome, like that of a bus as a nomadic shelter, "percolated into the psyche of the youth culture."[119] Fuller's artifacts augmented a pervasive image of an appropriate technology that could, on the one hand, empower individuals, and on the other hand, remain non-competitive. In this regard, the historian Bruno Zevi romantically termed Drop City as "zero degree of architectural culture"[120] [Fig.4.13a].

The Droppers of Drop City, self-styled dwellers of the six-acres of abandoned goat pastures, had attended one of Fuller's lecture in Boulder (possibly the World Affairs Conference, Boulder-Colorado in April 1965), and was encouraged by Fuller to make Drop City, a city of geodesic domes.[121] Despite its short existence, ca. 1966-71, its significance and meaning was hyped by media and the Droppers' own self-history. These accounts gave a heroic dimension to their creative destruction. Likening their work on the edge of a new frontier, the Dropper explained that they were "mak(ing) the land free, and start(ing) rebuilding the economic and spiritual structures of man from the bottom up."[122]

In Zevi's construction of the Dropper's anti-technological stance, their retreat to margins to live under a context of austerity and make-do were enabled by the implicit ascetic-survivalist nexus of Fuller's geodesic project. Nevertheless, in anointing the expressive make-do environments of the Droppers' camp-out alongside the Las Vegas strip as a new "vernacular," Zevi erased their hidden relationship to the main-stream society which they abhorred. Their ascetic formalism depended on the symbolic and literal wasteland of consumption of the other. More than merely surviving on the garbage dumps, the Droppers claimed that Drop City

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[117] *Drop City*, p.29.
[118] For a period-argument of the dome preference see Jim Donally's "Geodesic Domes & Dome Plans," (Corrallis: Experimental College, Oregon State University), 1974.
[119] W. Rybczynski, *Paper Heroes*, p.92.
[120] Bruno Zevi, *The Modern Language of Architecture*, Seattle: Washington Press, 1978, p.222.
[121] *Drop City*, p.20; also Ltr.10/28/66 P. L. Douthit to RBF in BFI-CR285, provides a progress report on Drop City.
[122] *Drop City*, p.151; See also P. Rabbit's later account in "Drop City Revisited," *Shelter*, p.118.

demonstrated the creative potential of scrounging out of choice. As an artifact it prefigured a new type of urban frontier built on the wastes of troubled larger American cities. Privately, the Dropper informed Fuller that their project was a "recipe for survival" in the "war against poverty."[123]

In an ironical twist of destiny, Fuller's geodesic project that he had nurtured under the aura of precision to be produced under the technology of abundance, now devolved into an ad-hoc object under a circumstance of symbolic scarcity of a cottage industry. The hand-made geodesic domes of apparent harmony with natural settings, expounded by the back-to-land woodsmen and counter-culture hippies were accomplished in opposition to the industrial-capitalist production system. As a "synergetic" rather than a "psychedelic" community,[124] Drop City was meant to represent an experiment in quiet creative living in "the center of nowhere." Yet, it is ironically tuned to the "obsolete structure" of the world it had spurned through the emblematic television antenna [Fig.4.13b & c].

4.3.2.2. Self-help Domebooks. *The Whole Earth Catalog* (1968-71)

Beginning in the early seventies, publications like *The Whole Earth Catalog*(1968-71), Lloyd Kahn's *Domebook I* (1970) & *Domebook II* (1971) and Steve Baers' *Dome Cookbook* (1968), more than any other publication perpetuated the gentle philosophy of Fuller under the rubric of appropriate technology [Fig.4.12b]. Collectively, they ploughed a wake along a trail set by the nationally-publicized Drop City and other back-to-land experimentations. Stewart Brand, for example, introduced his new project "the Whole Earth Truck Store" as a service to "new close-to-the-land intentional communities," by facilitating their "access to products, services, and techniques they need." With the success of the truck-store project, he offered to expand the service to a "Whole Earth Catalog" to "put buyers in closest, lowest-cost communication with manufacturers, suppliers, authors, inventors."[125]

This phase of hand-made, self-help domes mythified by claims of ease in assemblage even by the unskilled, rather than augmenting the geodesic arts was by all accounts disastrous for its hard-fought reputation. The popularization of the dome in this quarter was, as argued by Fuller's collaborators, a death-knell for future serious undertaking of geodesic structuring in the

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[123]Ltr.10/28/66 P. L. Douthit to RBF in BFI-CR285.
[124]Ishamel, "Drop City," *Innerspace* , New York, ca. 1967.
[125]Ltr.4/10/68 S. Brand to RBF in BFI-CR325.

architectural circles, a route riddled with continuous skepticism from the start.[126] In terms of techniques, L. Kahn's[127] "refried" domes or S. Baers' "cook-book" models were generally regressive technically; and despite the pervasive use of the geodesic domes, the overall sloppy constructions added adverse publicity to the accumulated art. The precision of measurements and discipline of the industrial methods associated with geodesic artifacts that Fuller had advocated was abandoned for immediacy of radical appearance.

Fuller, on the other hand, was not perturbed by these developments. Rather, he openly basked in the energy of the new-found popularity and openly endorsed his new-found converts. He valued his new advocacy role [Fig.4.14a]. Lynn Sherr, a syndicated writer for Associated Press, describing the pulse of the youth culture, commented that Fuller openly accepted his role as a "universal guru" and "whole earth man." She recounted Fuller's rejoinder to a role he had long nurtured, as a world-saver:

> The kids are looking for what it's all about and I know what it's all about.[128]

Drop City received his Dymaxion Award for their initiative, spirit and poetically economic structural accomplishments" in 1966.[129] In public presentation, Fuller's carefully-honed attributes and personal history variously described as apolitical, anti-establishment, selfless, holistic, etc. - were, in a nutshell, a testimony to a life of humanizing technology, and a demonstration of resilience of human nature in an open universe. From this enigmatic position, Fuller was just at home in the Gaia-driven Aquarian age of the seventies as he was in the world of liberal corporate board-rooms.

His rhetoric of ultra-free trade struck a chord with the expansionist agenda of American multi- and transnational corporations, then trying to unravel the obstacles of nationalism, and one of the few effective political tools of resistance used by emerging countries against transnational

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[126]Notes from Author's Interview with T.C. Howard, Raleigh-N.C., 4/26/95; Notes from Author's Interview with B. Kirshenbaum, New York City-N.Y., 10/5/94; Notes from Author's Interview with Don Richter, Singapore, 11/12/97.
[127]Based on his personal experimentations on dome-making, L. Kahn eventually became openly venomous towards the dome-form and its technology. In two subsequent publications ("Smart but Not Wise," *Shelter*, Bolinas-Calif., 1973, pp.112-114; and "Industrialized Housing" *Shelter II*, Bolinas-Calif., 1978, pp.200-208) he repudiated many of the ideas he had earlier proselytized and enthusiastically embraced. Fundamentally, he became convinced of the inherent flaws of Fuller's geodesic domes-their machine-bias and dependence on patronage involving corporate-technology (See L. Kahn "Further Thoughts on Domebook 2. Plastics and Whiteman Technology," an account & reflection of the MIT sponsored Conference, "Responsive Housebuilding Technology," May 1972). As Kahn drew gradually towards Roszak's anti-technological sensibility, he proposed that there is:

> far more to learn from wisdom of past: from structures shaped by imagination, not mathematics, and built of materials appearing naturally on the earth, than from *any further extension of whiteman technoplastic prowess* ("Smart but Not Wise," p.112, Itl., my emphasis).

[128]Lynn Sherr, "Buckminster Fuller becomes Youth Hero," ca. May 1972.
[129]Ltr.12/29/66 RBF to J. Fudge, J. Clower & B. Wadman (Drop City) in BFI-CR293 (See also *Drop City*, p.28).

capitalism. Paradoxically for a similar reason, Fuller was appointed by Indra Gandhi, the Indian Prime Minister, as a keynote speaker for the 1969 Jawaharlal Nehru Memorial Lecture. The subject matter of his discourse, "Planetary Planning," supported Indian ruling party's Congress-I's own technocratic agenda to transform sectarianism of India at a critical moment in its political history. Fuller advised in his speech:

> (T)o do the job man must have absolutely free intercourse and access to the distribution of resources around the world. We have to deal with our spaceship, Earth, as a machine, which is what it is.[130]

Yet, many of the ideological underpinnings of counter-culture are diametrically-opposite to the values circumscribed by Fuller's technological project. While counter-culture subscribed to the doomsday theory of the limits to growth, Fuller viewed abundance as an end and growth presented no structural limitation. His *World Resource Inventory* and *World Game* (1969) pivoted upon on a critique of the arbitrariness of nations and the infinite possibility to recycle resources. These views stood glaringly opposed to the zero-sum gain model advanced by the neo-Malthusian Club of Rome, which implicitly underpinned the counter-culture movement.[131]

Second, counter-culture had a predisposition for subjectivity over objectivity. Fuller's apologists however tried to diffuse and distance technocratic implications of Fuller's ideas and projects, particularly the World Game project. Reporting on Fuller's lectures delivered on "Earth Day," at the School of Architecture, University of Southern California (22 April 1970) for the *Los Angeles Free Press*, Gene Youngblood prefaced his commentary that all "crisis of planetary planning for the future" are "global crisis of consciousness." Thus, he argued, Fuller's World Game and comprehensive anticipatory design science was "really dealing with individual human psychic freedom" and "not about technocratic dehumanization."[132] Elsewhere, Youngblood called two of Fuller's retainers in the World Game projects, "Paleocybernetic men." They were, he proposed, real revolutionaries, unlike the "misguided souls like the Chicago Seven" who resorted to incendiary political tactics[133]

Third, the implicit model of reference for counter-culture was biological-organic as opposed to Fuller's energetic-mechanistic view of the world. Increasingly, through the late

[130]R. Buckminster Fuller, "Education for Comprehensivity," 1968 Franklin Lectures in Science and Humanities (Auburn University), p.73.
[131]See Donella H. Meadows, et. al., *The Limits to Growth; a Report for the Club of Rome's Project on the Predicament of Mankind*, New York: Universe Books, 1972.
[132]Gene Youngblood, "World Game – Scenario for World Revolution," *Los Angeles Free Press*, 29 May 1970, p.2.
[133]G. Youngblood, "Earth Nova," *Los Angeles Free Press*, 3 Apr., 1970.

fifties, Fuller professed affiliations with system theorists, particularly Ludwig von Bertanfly, Norbert Weiner and the later-day general semanticists. In the analysis of Fuller's ideas and his artifactual production, A. Gerber noted the overtly reductionist aspect of the latter in relation to the expansiveness of the former. Gerber nevertheless tried to reconcile this disparity by rendering all prosaic and academic aspects of Fuller's self-professed "total unified philosophy" into a holistic mold, just as he collapsed a wide variety of late-sixties paradigms, for example, "systems view," "organic view," "non-linear," under the rubric of holism.[134]

Just as Dublin criticized the fetish of Fuller's technical approach, he also questioned Brand's "techno-romantic" form of empowerment built upon Fuller's ideology. Dublin's most incisive criticism centered on what he perceived as the political quietism over the issue of ownership of technology or the means of production. Thus, as with access to knowledge, Brand's purported common sharing of tools is, Dublin argued, a form of "pseudo-egalitarianism" because it "avoid(s) the real issue of how fundamentally different is the relationship of different classes of users to technology, present, past and future."[135] Besides this inequality, the political implication in the glorification of individual empowerment lies in a new type of politically, reactionary alienation; namely, in nourishing the banal and turning one's back on the social inequities. It perpetuates a behavior "more narcissistic, self-flattering (and) close-minded."[136]

4.3.3. Geodesic Artifacts in Popular Imagination

The ideological line separating the ecological rendition of OMR City and the cultural-political dimension of counter-culture domes is a thin one. One could relegate the diverse, pervasive and popular receptions to a general lack of self-criticism and intellectual rigor of their respective exponents. But, it would be more accurate to explain them as evidence of confidence in tools as a means to bypass social and institutional reforms. These receptions were accentuated by the constitution of the respective participants. They were either, drawn primarily from a middle-class which had no cultural heritage to hold them together, except an alternative "new anarchy" shaped by the romance of technology, or from a marginal population who saw a narrowing horizon of solutions available to them. In both, they mythicized the moments of autonomy. Gardner for example observed that *The Whole Earth Catalog* as a tool for "cutting dependence on the economic system" fulfilled the similar ends as hallucinogenic drugs in

[134]Alex Gerber Jr., "The Educational Philosophy of R. Buckminster Fuller," Ph.D. Thesis, University of Southern California, Dec. 1985.
[135]M. Dublin, *Futurehype*, p.78.
[136]Ibid., p.65.

"cutting dependence on others for the social support of one's ego."[137] However, rather than an unremitted confidence, Kuhn, a keen reader of Fuller's ideas, betrayed an ominous sense amidst the new:

> A clear geodesic dome reflects the onlooker and his vantage point. From wherever a person approaches a geodesic dome, he glimpses himself, distorted by the curved surface, but mirrored plainly against his background.
> The difference is significant. In an organizational age, the towering flat-surfaced skyscrapers reflect what is most important in the culture: themselves. In another post-organizational age, the reflection may once again become man and the whole landscape of earth - technological and natural.
> The profound question raised by Fuller's theories, and possibly the ultimate criticism of them, is whether he promises a valid society for man or a *crystalline technological dream - a geodesic shell containing a dead embryo*[138] (Id., my emphasis).

This "crystalline technological dream" continued to ascend in popular imagination. In urban America, the geodesic dome, among other nomadic structures like the yurt and teepee, became a didactic device for rethinking the problems of American urban conditions and environment in general [Fig.4.14b]. In one event, touted as a "design-in," Fuller's dome (a 50-foot diameter, 4 -frequency 5/8 sphere) represented one among many artifacts illustrating "man's capability for dealing effectively with environmental problems when politico-economic forces provide the motivation."[139] It was this potential of Fuller's domes and ideas acting as ideological "alternative wholes" rather than an "assemblage of alternative components" which drove Stewart Brand to enlist Fuller's participation in an Education Fair of the Portola Institute, to be held in the San Francisco Bay Area in October 1968.

Offering the Fair as a creative alternative to "Human Be-In" psychedelic happening in San Francisco of January 1967, Brand professed that the Fair would, among other reasons, proactively affirm the positive role of "powerful tools technology."[140] After a follow-up meeting with Fuller at Big Sur, Brand drew increasingly closer to Fuller's ideas. On the eve of his conceptualization of *The Whole Earth Catalogue*, Brand's prelude to a preamble for the Fair unmistakably echoed a Fullerian sensibility:

> (W)e share the view that humanity's task in universe is anti-entropic: the achievement of ever higher ordered regenerative behavior, the performance of increasingly elegant figure of understanding and action on the increasingly expanding ground of universe. The role of

[137]H. Gardner "Our Global Alternative: Communes" in *Esquire*, September 1970.
[138]William Kuhns, *The Post-Industrial Prophets Interpretation of Technology*, New York: Harper Colophon, 1973, p.242.
[139]The Institute for Ecological Studies, Press release "Design-In -- A First Step Conference on Environmental Problems of Our Time," Central Park, New York City, N.Y., May 11-13, 1967 (Copy in BFI- CR300).
[140]Ltr.11/21/67 S. Brand to RBF in BFI-CR312. For the significance of the January 1967 "Human Be-In" in San Francisco, see Todd Gitlin's *The Sixties, Years of Hope, Days of Rage*, pp.208ff.

education in this process seems central. One metaphor for it is the operation of the conscious on the unconscious, the discovery and conduct of immanent order. As evolution is the process of the species, education is the process of the individual (adaptation is the biological term in this formulation) Education – individual growth – is self-initiated, self-evaluated, self-controlled. In this process education discovers and incorporates the grander scheme of evolution. As in most matters of health, there are today industrial tools and techniques of great sophistication to serve education. *Our perception of this more-with less technology in education is that it serves to accelerate access. 'Further' equals 'closer'*[141] (Id., my emphasis).

Brand's pedagogic agenda, epitomized by *The Whole Earth Catalog,* built upon Fuller's philosophy and the counter-culture practices. It was a new Puritanism in a most general sense. While seeking a redeeming technology, the discipline that the movement demanded distanced its adherents from the distractions of bourgeois self-indulgences that had plagued the psychedelic hippies. As anti-political purists, their technological route was a constructive quietism against the increasing militancy of the New Left activists. In place of the hippies' hallucinogenic "Yellow Submarine" and the activists' broad but chaotic political resistance, Fuller's Spaceship Earth provided *The Whole Earth Catalog* with a primary motif of finitude and order. It was a reassuring closure to a new Millenarian hope based on actions of man rather than God; and making the American dream of plenitude and personal agency, believable.[142] Hence the difference between Roszak's "intimate, personal power"[143] and Fuller's or Brand's, pertained directly to the means. The former saw individual expansiveness manifested through the human mind and connectedness to the "world's majesty," while the latter, through his tools in ordering the abundance of world.

When E. Schlossberg, one of Fuller's retainers, claimed that the "universe that starts and ends at the edge of (one's) skin" he was paraphrasing Fuller's confidence in the prospects of human knowledge.[144] This psychological assurance was augmented by unproblematic access to tools for self-dependence and self-education. Thus Fuller's ideological position underpinned and sustained a variety of marginal practices from alternative education, legitimate self-help groups to urban gangs. While geodesic play-structures populated playgrounds of schools, in countless classrooms across America, geodesic dome models began to assume a symbolic identity with varied and rich educational experiences [Fig.4.15aFig.4.15b & Fig.4.15c]. One teacher professed

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[141]Ltr.1/3/68 S. Brand to RBF in BFI-CR296.
[142]For a discussion of millenarian movements and millenarianism as "preindustrial form of social revolutions," see Carolyn Merchant's *The Death of Nature*, San Francisco: Harper & Row Publishers, 1980, (especially Ch.3, "Organic Society and Utopia", pp69-98); also Howard P. Segal's *Technological Utopianism in American Culture*, Chicago: The University of Chicago Press, 1985.
[143]T. Roszak, *The making of Counter-culture*, p.234.
[144]E. Schlossberg, "Dedicated to Alternative Futures," Project at UC-Berkeley, ca. August 1968 in BFI-CR331. See the works of Edwin Schlossberg and John Dieges with the Berkeley Unified School District (Summer 1968).

its pe gogical value "involving advanced mathematical principles, aesthetic and philosophical considerations, and perhaps most important, human relationships and politics."[145] Ideologically, she continued, the dome was an exemplary artifact of the "prophet of a new age" who had "reconcil(ed) the evolution of man and the evolution of technology":

> (M)ore importantly (the geodesic dome) is symbolic. By definition, one can never ensure the full meaning of a symbol. But for us it represents change, vitality, a reordering and reaffirmation of genuine educational processes. We believe it cannot fail to enable the physical and spiritual environment for all of us here. We think of it as a kind of modern cathedral to be built at the school we serve and love.[146]

Among the students, dome-making became a popular element in the youth's rite of passage. Like Fuller, one of the young dome-builders echoed the institutional resistance that he encountered in his dome project:

> Large scale student projects are not yet accepted by traditionalists. The banker-contractor-architect system is a very large obstacle.[147]

4.3.3.1. The Cult Value of the Fuller's Geodesic Artifacts. Synanon and *est*

Against the radical social-political initiatives of the New Left, the New Age advocates discovered a spokesman in Fuller - his structures giving palpable forms to their rhetoric. The variegated meanings of Fuller's geodesic dome and the Energetic Geometry on which it was based, opened them to unscrupulous religio-cultish and scientistic appropriations. In the sixties, cults' and individual eccentric's attractions to Fuller's project abound under the rubric of names such as pyscho-social geometries; but it was hardly a recent development. For example, as early as 1951, Bradford Shank, a member of Ron Hubbard's *Scientology* movement tried to convince Fuller to participate in his Dianetics project. At that time, he claimed that Fuller's Energetic Geometry would bring "modern trends in thought & technic, an absolute minimum of distortion."[148]

Although Fuller did not directly encourage the cultish appropriations, it is not apparent that he vehemently disavowed their activities. Of the myriad groups seeking a legitimate framework and a publicity edge to advance their respective causes, Charles Dederich's Synanon and Werner Erhard's *est* were the more prominent.

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[145]Unpubl. Report, "Gardena Dome 72/73" (Gardena High School, Los Angeles), ca. May 8'73. Copy in BFI-CR76.
[146]Virginia Buchanan, "Gardena Dome 72/73" (Gardena High School, Los Angeles), Unpubl. report, 8 May 1973 (Copy in BFI-CR76).
[147]Ibid.
[148]Ltr.5/27/51 B. Shank to RBF in BFI-CR137.

Dederich, a recovered alcoholic, founded Synanon Foundation Inc. in 1958, based on his reputation in curing drug addicts successfully. In the late sixties, Synanon developed into a full-fledged non-profit self-help drug-rehabilitation group based in Tomales Bay, California. Dederich began incorporating Fuller's geometric pedagogy into its rehabilitation rituals particularly using tensegrity domes in his self-help sessions.[149] Synanon also abandoned its initial mission formally, namely; that of assimilating its cured addicts into society.[150]

The addition of Fuller's geometric pedagogy into Synanon rituals provided what one of the chroniclers of the Foundation called "the most accurate analogue for (Synanon) community"; giving Synanon "a wholeness, a ballast it had lacked" [Fig.4.16]. Thus, the chronicler continued, the geodesic-synergetic artifacts of Fuller visualized and formalized Dederich's own rendition of community as made of "vector and valences."[151] In the same way as that geodesic artifacts fulfilled the desires for a holistic education, they were now used to simulate, in Synanon rituals for motivational therapy, the purported complex real-life problem-solving experiences. It is not possible to assess for how long or to evaluate how effective Fuller's social-geometric ideas were deployed to advance or front Synanon's deception. Eventually, however, the misdeeds of Synanon in tax-evasion were uncovered in an exposé, as Dederich resorted to violence to silence his critics.[152]

Fuller's participation in *est* (acronym for Erhard Seminars Training)[153] is harder to extricate, since he is publicly linked with its founder, Werner Erhard[154] [Fig.5.09d(1)]. Unlike Synanon, *est* was not a therapy community drawn from socially-disturbed marginals. Nevertheless, it was just the same, albeit a sleekly-marketed therapy which aggressively drew upon segments of the psychologically-unsatisfied and significantly-distressed white middle-class

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[149]Ltr.9/18/68 D. Gordon to RBF in BFI-CR332.
[150]Dave Mitchell, "Former president of Synanon dies" at *Point Reyes Light* web-site (http://www.nbn.com/home/prl/columns/sparsely/sparsely59.html).
[151]T. Patton, "Synanon Philosophy" in BFI-MSS by Others, p.20, 28.
[152]For this expose, a weekly newspaper, *The Point Reyes Light* (Marin County Coast of California) won the 1978 Pulitzer Prize.
[153]*Est* was founded in Oct. 1971 in San Francisco by Werner Erhard (charismatic motivator, former used car salesman, aka John Paul Rosenberg) with 92,000 graduates; at its height in 1976 had 13 training centers. It was a self-help training, billed to move beyond "needs" to "something else" It grew to a multimillion dollar enterprise within four years. For *est*'s aggrandized self-history, see S. Pressman *Outrageous Betrayal: The Dark Journey of Werner Erhard From est to Exile*, 1993. For a critical-skeptical account of *est* and Werner Erhard, see R.T. Carroll's "Werner Erhard, est and the Landmark Forum" in The Skeptic's Dictionary; also F.W. Hofmann & W.G. Bailey, *Mind & Society Fads*, p.119.
[154]Megan Rosenfeld, "Encountering Werner Erhard. Getting His Bearings by Moving West and Heading est," *The Washington Post*, 14 Apr. 1979. Rosenfeld skeptically noted that Erhard six-hour audio-visual event at the Sheraton Park-New York was Erhard's fund-raising benefit for Fuller's project. Fuller's grandson, Jaime Snyder was instrumental in facilitating the Fuller-Erhard connection.

Americans bent on the security of accomplishments. *Est* was one of the many manifestations in the Human Potential Movement which inundated America popular culture landscape in the seventies. Its particular marketing angle was in transforming a person's life by changing the way they looked at things.[155] Through its pseudo-scientific self-improvement programs, it promised its "graduates" that they would feel better, though in reality many did not really have better lives subsequently.

Fuller's purposeful life, presented as an exemplar of an average man who reorganized his life and thinking against all institutional and self-created odds, directly lend itself to Erhard's question, "Can an ordinary individual make (a) difference in the world?" The singer John Denver, an *est* enthusiast and supporter of Erhard, added to the color of pop-psychology movement with his song-dedication, "What One Man Can Do," to Fuller on his 85th birthday celebration at Windstar Foundation, Aspen Colorado.[156] Openly, Fuller acknowledged that his identity was shaped largely by self-help:

> Werner (Erhard) said I probably went through my own sort of *est* 52 years ago. In 1927 I reorganized my life when I was 32 years of age, the year [my daughter] Allegra was born.[157]

Fuller's public presentation of his life-history unabatedly heightened his own self-help efforts. He eschewed bad habits by reprogramming and replacing them with positive, life-enhancing attributes. In this transformation towards a reformed self-image, the ritualistic demonstration of geodesic structuring, its rigor, rationale and "synergistic" offered a potent metaphor. Like a psychological complement, it was instructive of the geometrical dimension of human behavior. The "scientific mysticism" in *EG* was recognized, very early on, by A. Korzysbki's General Semantics movement. In 1957, Talbot, a student of the movement offered this comparison of Fuller's ideas and Korzysbki's :

> (F)or students of Korzysbki's work, even more important than the geodesic dome are the insights offered by Fuller into our epistemology (evaluating processes). Any unfamiliarity that Fuller's outlook and formulations may present should not deter us from acquiring it; both time-binding and psycho-logical therapy proceed by treating the familiar as unfamiliar, and this is a scientific method of realizing human potentialities.[158]

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155 Werner Erhard, "The Transformation of est," *The Graduate Review, est* November 1976, p.15.
156 See *People Weekly*, 21July 1980.
157 Megan Rosenfeld, "Encountering Werner Erhard. Getting His Bearings by Moving West and Heading est," *The Washington Post*, 14 April 1979.
158 Ltr.1/15/57 W. Talbot to RBF in BFI-CR184.

In the sixties, Fuller's geometrical proposition of a universe, from macro-to micro, that was structured along lines of energy with the geodesic structure as a prime motif, was emboldened by findings in the biological and physical sciences. In both areas, the ubiquitous presence of geodesic structuring at the macro-level of cells and molecules were affirmed [Fig.5.11a-b]. He thus reported with vindictive satisfaction the identity in strength of his domes with the resilience of virus:

> I am not displeased by the fact that my domes are isomorphous, with noxious gas. Simply because the noxiousness is apparently due to the fact that they are impossible to destroy and because the geodesic dome structure is employed in the protein shell of the viruses.
> I assume that their lethal characteristics are caused by the fact that they contribute the most indestructible system to be found in nature. This would then seem to validate my geodesic structure. It also tends to illuminate the fact that the strength of my structures has never been explained by conventional engineers' analysis.[159]

On this basis, he began to offer his geometrical work as the "inadvertently integrating science." It could, he continued, explain "the total orderliness discovered throughout the universe."[160] This expansive and ambitious science would even capture the structure of human thoughts under the rubric of "psycho-social geometries." Here, Fuller claimed that his geometrical ideas not only bore a kinship to the holistic, organismic view of psychology, but it was also a more precise social-psychological model:

> I have discovered and disclosed my mathematical reasoning as implicit in nature's a priori formulations. Mathematics is different from philosophy and psychology. Both deals from time to time in the same concepts but the mathematical rigor is not required in psychology or philosophy. Psychology or philosophy based on mathematical rigor is more powerful than amorphous pattern speculation.[161]

While it was impossible for Fuller to control the appropriation and exploitation of his ideas and works, he was not entirely innocent in encouraging such activities. His complicity in the *est* connection was in lending legitimacy and credibility to a questionable, expensive, mind-programming project and financial fraud.[162] To understand why his life and works assisted and

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[159]Ltr. 7/25/69 RBF to A. Loeb in A Loeb's Collection. See also Fuller's inaugural address to the First International Congress for Stereology, Vienna, Austria, April 18 - 20, 1963.
[160]Ltr. 12/11/61 RBF to Mrs. Peter Brattinga (New York-N.Y.) in BFI-CR225.
[161]Ltr. 10/1/63 RBF to S. Z. Bardinin BFI-CR247.
[162]Besides his tainted personal life of wife and child abuses, Erhard's *World Hunger Project*, was also a subject of damaging journalistic exposés. The project collected monies through volunteers merely "to raise awareness of the plight of the hunger" without a cent going to alleviating actual hunger problem (See "The Power Of Positive Eyewash" *Forbes*, 1 Dec. 1975, p.22; William Sypher "New Age Workshops: Superlearning or Psychobabble?" *Vermont Business Magazine*, May 1987, p.37; and David Gelman, "The Sorrows of Werner: For the founder of est, a fresh round of charges," *Newsweek*, 18 Feb. 1991, p.72).

Fuller's apologists are generally reticent of the Fuller-Erhard episode. Arthur Loeb suggested that there was nothing intrinsic in Fuller's work that was cultish, rather there was an unfortunate Fuller following in *est* (Notes from Author's Interview with A. Loeb, Cambridge-Mass., 4/21/95). Umer explained Fuller's complacency on this issue by lent themselves to the cultist appropriations, one must examine his ambivalent, "scientific mysticism."

The magnified role of *EG* as *Synergetics* is pivotal for understanding the attraction of Fuller to cultish appropriation. What started as an ambitious effort, in *EG*, to forge a continuous and unified connection between different scientific explication of physical reality, gradually became, in *Synergetics*, a monumental, expansive accounting of the phenomena and processes of the human mind. In the broadest sense, Fuller's *Synergetics* was offered as recuperation from the "estrangement" of nature. This objective shared some common ground with the tradition of *Naturphilosophie,* exemplified in theosophy. However, unlike the theosophical tradition which attempted to provide a spiritual basis for reality, Fuller substituted a structural one for it. As the physical world entwined with thoughts in what Fuller considered a consistent patterning, the definition of what the spiritual constituted fell on the wayside. So convinced was Fuller of the patterned unity he had discovered that his structural demonstrations and exercises eventually came to be viewed and highly publicized as initiatory rituals to expand consciousness into all realms. Yet, Fuller curiously offered these demonstrations in *Synergetics* as modern-day analogs of the classic *Bowditch Navigational Guide.*[163] Literally as a personal and social pilot through treacherous waters, *Synergetics* was intended eventually to displace politics. Marks suggested that the charting in *EG* was free of cultural, social and political parameters, and that it would provide:

> adequate observation of nature, without recourse to any particular modular frames, and without any elementary theory, nature's whole complexes could be charted and appraised, and that such charting, or orderly inventorying, might yield generalized behavior patterns governing all nature's transformation and accommodations.[164]

Fuller's confidence in the chart emerged from his work at Phelps-Dodge and *Fortune.* Kenner suggested that at *Fortune*, Fuller gained access to the resources of a first rate research staff with "nuggets of hard information." He also honed his skills in a graphic-analytical working method in translating "hard, small, definable units of information" into digestible diagrams.[165] Peter Drucker called Fuller's "graph" and lexicons as "half-lyrical near poetry, half-science fiction terms." Besides using energy as the only factor in projecting the postwar economy of the

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alluding to his first principle of "do your own thinking"; and saw no fundamental contradictions in Erhard's promotion of Fuller at Madison Square Gardens (See Christopher J. Fearnley, cjf@netaxs.com, "The R. Buckminster Fuller FAQ," v.1.0, 12 July 1994: K. Urner's reply to L. Fletcher's "What was the nature of Fuller's involvement with Werner Erhardt, EST and the World Hunger Project?").

[163] Fuller first used the comparison of his works with *Bowditch Navigational Guide* in Ltr.9/6/32 RBF to George Howe in BFI-CR41

[164] R.W. Marks, *The Dymaxion World,* p.39.

[165] K. & K Simon, Transcript of Interview with Hugh Kenner for a PBS documentary "Thinking Out loud," p.26.

world, Drucker further noted that Fuller's approach was "entirely based on geometric vision, devoid of analysis or 'facts'."[166]

In the sixties, Fuller's treatise, unlike, say, Gurdjieff's "Scared Gymnastics" or the hierarchical step processes of Hubbard's Dianetics, became a practical navigator for "spiritual" self-help with no hidden masters and occult communications.[167]

4.3.3.2. A Problematic Mysticism - An Unlikely Mystic

Questions like whether Fuller is a mystic or whether his ideas, particularly in *Synergetics*, constitute mysticism are similar to the ones that plagued Fuller's other activities -- namely, whether his artifactual production constitutes an architectural investigation, or whether his public activities characterize those of an architect. Much of the ambivalence and enigma in personality and life-work, described by many, really grew out of his self-appointed position as a marginal and as a polymath.

Fuller openly eschewed mysticism, but public renditions of him as a mystic, and his congenial relationship with alternative religious and mystic groups created an unsettling reading of his religious propensities. Partly out of opportunism of publicity, and partly out of recognition of kinship, Fuller identified with a range of emerging spiritual self-help practices. In the thirties, he was connected to Gurdjieff. His pulsating "omni-directional halo" contained metaphorical resounding of the Gurdjieffean belief that the universe is made of vibrations, where consciousness could jump from one level to another. In the fifties, his *EG* was compared to Ron Hubbard's Scientology. Fuller's scientific idealism, regimented disciplines, neologisms, and penchants for precision and charts brought him closer to Hubbard's methods. In the seventies, his *Synergetics*, which he explained as the "inside into the mechanics of creation," was received as a tangible amplification of the Creative Intelligence of Maharishi Mahesh Yogi.[168] In the eighties, Fuller's dictum, "making the world work for everyone," redeemed the self-centeredness of *est*. Finally, on numerous other occasions, his panpsychist rendition of the universe as the Greater Intellect paralleled Pierre Tielhard de Chardin's "noosphere," wherein the cosmos exists in a single living organism and consciousness.[169] Philosophically, Fuller's "syntropy" like Sir Julian Huxley's

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[166]P. Drucker, "Adventures of a Bystander", p.246.
[167]For some uncanny similarities between Fuller's *EG* and Ron Hubbard's Scientology, see Robert S. Ellwood's, *Religious and Spiritual groups in Modern America*, Englewood Cliffs, N.J.: Prentice-Hall, 1973, p.172.
[168]See Fuller's lecture on "Structure of the Universe" and participation at Maharishi Mahesh Yogi's sponsored The First International Symposium of the Science of Creative Intelligence (U. Mass-Amherst 21 Jul. 1971).
[169]Pierre Teilhard de Chardin (1881-1955) was a paleontologist and Catholic mystic who coined the term "noogenesis" to illustrate his theistic theory of integrated and evolutionary view of reality. The product of de Chardin's theistic

"social evolution" or de Chardin's "noosphere" were variously held out as foils against entropy of the second law of thermodynamics.[170] Collectively, all these practices offered ways to settle perceived and real individual alienation in the industrial society.

While his public discourses were leavened with these mystical ethos, his personality was the furthest away from the archetypal magus. Even his public name, "Bucky," was one of homely endearment rather than veneration. Further, to offer himself as a "guinea-pig," a label that bespeaks of uncertainty and open-endedness, alone, was antithetical to the constitution of a magus.[171] Fuller's self-presentation of his averageness, if it had initially been used as a guise of humility to garner popular sentiments, nevertheless, worked against the typical magus' profile of remarkable birth and childhood, wide travels, esoteric initiation, enigmatic personality, supernormal powers. Whether explained as a primordial cognition or as an awakening from slumber, both Fuller's childhood and adult traumas were temporal circumstances, rather than pre-ordained events. Though spiritualized, these were not in any way spiritual events or were offered as such. Finally, Fuller's "spiritual" initiation was accomplished in industrial-corporate-bureaucratic apprenticeships, through hours of tinkering with machine-tools and sitting on board-meetings. These experiences were alien to the dogged journeys to seek spiritual masters in the exotic East. His message of hope as success was quaintly materialist, in the American sense, rather than transcendental.

Fuller's public discourses entwined broad facets of reality, but they were rarely efforts to disorient his audiences by allusion to eternal secrets. His message transmission was not through the "ear-whispered" words, but rather in open discourses, laboriously laden with mix-and-match sciences and scientistic observations. He demanded that self-experiences and experiments be taken as the continuous premise for validation of reality. It was a prescription which, at times, verged on the obsessive. Thus, although Fuller's epiphany profiled a yogic process of unclouding senses and memory through the intellect, this was not the initiatory demand he placed on others. There was no demand, as a basis of liberating oneself, to subdue memory or to see self-experience as a delusion. Only automatic and customary habits needed to be unclouded. Even then, the basic premise for undertaking this self-realization was grounded in his popular rendition

evolution was the "noosphere," a realm created by man's thought and culture along the paths of radial, spiritual or psychic energy. New Age believers and progressive Catholics valued his writings as rare vision; in scientific circles, however, his aphoristic writings, or "philosophy-fiction," have been considered to be metaphysical conceits (See *The phenomenon of man*, 1959 and *L'activation de l'energie*, 1963).

[170]See W. Kuhns, *The Post-Industrial Prophets*, p.233; William Marlin, "The Non-Dymaxion World of Buckminster Fuller," *AIA Journal*, June 1970, pp.67-70.

[171]Fuller first called himself a "guinea pig in a lifelong research project" in a letter dated 6/10/63 to Cranston Jones (Editor, Time Magazine) in BFI-CR286.

of Einsteinian relativity and thermodynamics. Despite his use of metaphors of science, he did not offer a scientific method of therapy. Even his preference for cosmography and cosmogony over cosmology to describe his investigations, for example, belabored mysticism.

Nevertheless, Fuller's allegorical use of God as Consciousness, eventually secularized as the Greater Intellect, brought his transformation closer to the theosophical tradition. While theosophy proposed that the human capacity emanated from and could be experienced from the perspective of One Mind, Fuller provided details of its effective presence and working. However, he gave no detail as to what that One mind entailed. Mysticism was neither inherent in the proposition that human habits are automatically and customarily acquired nor in his reactions against orthodoxy. However, it was in characterizing man's existing knowledge as a vestige of primordial cognition, and claiming that man had the latent capacity for horizon-less vision, that Fuller shared a basic theosophical belief. His structural expositions formed a portion of a larger disciplinary prescription of theosophy to recover these human potentials. If *EG* and Fuller's geodesic paraphernalia were meant to be ritualistic initiations, they were vague and dissipated, despite the profuse evidence that these disciplines claimed. In the end, perhaps they should be more appropriately viewed as "demythologized theosophy," emptied of elements that would otherwise have personified cosmic mystery.

The marginal appropriations of Fuller's ideas, consisting of a mixture of scientism and metaphysics were commercially attractive to image and book vendors alike. Many of Fuller's purist retainers, on the other hand, held the development with disdain. For example, Arthur Loeb who valued his collaboration in *Synergetics* as "providing a bridge between Fuller and the scientific world," lamented that the detrimental effect of pandering to the new cultural and media demands. The "excessive excursions into metaphysics," he explained might "expose Fuller more than ever to charges of charlatanism from the scientific world." Further, proposed that the publisher of *Synergetics* was "exploiting" the intellectual climate and "encouraging" the excursions.[172] However, the trend, rather than receding became more pervasive and subsumed under a broad, spontaneous emergence of alternative cultures, which Marilyn Ferguson characterized as the "Aquarian conspiracy."[173] It was only momentarily muted by an odd and surprising resurgence of the geodesic structure -- this time to act as a polemic statement of the destiny and culture of American technology.

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[172]Ltr. 9/3/71 A. Loeb to J. Pack in A. Loeb's Private Collection of Letters.
[173]See M. Ferguson's *The Aquarian Conspiracy* (Personal and Social Transformation in the 1980s), LA: J.P. Tarcher, Inc., 1980.

4.4. American Pavilion at the Montreal Expo'67 World Fair (April 1967)

In 1964, D. M. Wilson, the Deputy Director, USIA approached Fuller with a problem: how should United States present itself at the fair?[174] This was the first official pitch to enlist the use of one of Fuller's structures again at a major world's fair. In the ensuing months, Fuller's design for The American Pavilion became the swan-song of his geodesic project, Here his personal vision of American technology exceeded the national vision, and conceptually, was even at odds with it.

In Fuller's original intention, the pavilion design was an opportunity to test the deployment of the geodesic dome to another end -- as a "geoscope." The geoscope, a word and an object coined by Fuller, could be cursorily described as a dynamic representation of the world. "World patterns" are related to geography.[175] It was, in a nutshell, a modern planetarium. Its pertinence as a vehicle to articulate the vision of American culture and civilization, should thus be seen initially from this imagined objective.

The term "geoscope" was first used in early 1960 when Don Moore, one of Fuller's collaborator, prepared the document, "R. B Fuller Conning Tower Program" as part of his larger Generalized Design Science Exploration project. The thrust of the project was the "reutilization of resources from weaponry to 'livingry'."[176] However, the conceptual underpinning of the geoscope as a means for accessing information to navigate through the changing world was already evident in the visual and model oriented contents of the "Go-Ahead-with-Life room" in Fuller's 4D-Dymaxion House. This technological amenity in the house paralleled the transformation at the workplace. At the workplace, Fuller imagined that the captain of industries would reenact similar controls, albeit in managing resources, by operating in the industrial "conning room."

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[174]Ltr.8/14/64 D.M. Wilson (Deputy Director, USIA) to RBF in BFI-CR265.

The official letter of commission, "to design the structure to cover the US site at the Montreal World's Fair" arrived three months later. (Ltr.11/19/64 D.M. Wilson (Deputy Director, USIA) to RBF in BFI-CR265) Before this august appointment, Fuller's "agents" in Canada were busily attempting to carve out a niche for geodesic projects at the planned fair. It is clear that from the solicitations that both Fuller and his associates had not anticipated the eventual major commission for the U.S. Pavilion. (See Ltr.1/28/64 J. Parkin to RBF in BFI-CR252; Ltr.11/16/64 H.E. Strub to RBF in BFI-CR264; Ltr.11/23/64 S. Sadao to D.A. de Belle in BFI-CR264)

[175]J. Dieges, Design of Alternative Futures (Course Outline for Environmental Design 100Ax-Bx-Cx), Department of Architecture, College of Environmental Design, Berkeley, California. ca. 1968 (Copy in BFI-Archive, G-84, Archive Box#7-Sec.10).

[176]See also Fuller's reply I. Russell's request (Ltr.11/12/60 I. Russell to RBF in BFI-CR215) request to include "Geoscope" in the 1961 *Britannica Book of the Year*.

This industrial control and command room was derived from the naval equivalent of the conning tower, the nerve center on a ship for collecting, channeling, interpreting and coordinating information that might affect its strategic field operations.[177] The "hoop-skirt room" contained tiered seating where conferees were organized around a three-sided projection device for television display and record. For Fuller, the conning tower was more than a metaphorical extension of the eye. Through it, the deck officer as steward, could maintain controls over large mechanisms of the ship, as delicately as over a human body [Fig.4.24].

4.4.1. Prelude – Minni-Earth (1952)

The idea of the "conning room" evolved into Miniature Earth (Minni-Earth) with Fuller's Dymaxion map invention and the development of the geodesic structure. As early as 1949, he had intended the geodesic dome to be used as such.[178] The earliest conjoining of these two idea was in the Cornell Dome (May 1952), then described as an "an inside-out planetarium"[179] [Fig.4.21a]. From the center of the 20-foot diameter world globe assembled from planar members, the observer gains an uninterrupted view of the stars at night and thus experience an immediate and comprehensive physical relationship of the earth and its land masses to the universe. Further, with its North-South pole axis aligned parallel to the axis of the earth, the geoscope acts directly as an analog for earth.

For Fuller, sight assumed among the five senses a privileged connection between the human mind and the external stimulus. In practice, he concluded, even sight has blind spots, thus necessitating the Minni-Earth as compensation, in the form of a spatial-visual framework [Fig.4.21b]. The human body is centered, as if it was a gigantic eye, and towards which celestial information converges. In Fuller's panpsychic moment he even entertained the possibility of human eye as beaming information. Fuller explained this to A.C. Clarke, the futurist writer:

> When human eye gaze at distant stars in the night blue-black sky avoiding the local environmental obstacles their thoughts may quite possibly be beamed into universe without interference. These conceptually scanned and serially formulated signals may sometimes - years or millennia later - bounce off a planet of a distant star to be received on some planet and may even by almost impossible chance bounce back into the eyes of a human passenger abroad 'Spaceship Earth' or the eyes of a human abroad another planet of some star such an

[177] R. Buckminster Fuller, "Conning Tower," *Shelter*, November 1932, pp.64-65.
[178] See Fuller's early lectures at ID-Chicago (1949 Oct 24 -30) titled, "A Conning Room for Home."
[179] "The Sphere Destroyed," *Cornell Daily Sun*, 10 N[illegible] 1952 (Copy in BFI-CR148). Shoji Sadao, then a student at Cornell and subsequently Fuller's partner in the sixties, was the primary person on the project. Sadao subsequently developed icosahedral version of Fuller's Dymaxion map projections.

inadvertent recipient might logically assume that he is spontaneously thinking an original thought rather than receiving a message.[180]

Minni-Earth thus represented a symbolic all-knowing collective eye, surveying the skies beyond its own imaginary body but literally from within, as if through the 'skin' of the earth. The conceptual specifications for building a proto-geoscope in the form of a "great glass globe of the earth" were first outlined by Fuller in 1928. Fuller explained its cosmic significance in this way:

> Through (the center of a great glass globe of the earth) may be viewed the progression of relative positions to the starry universe along the time lines in all directions... (C)ommon truths ... are the material crystalline spheres of sensible and reasonable fact, through which the radial lines of individualism must inevitably pass in their outward progression towards the temporal infinity.[181]

The uncanny resemblance of this personal and multi-symmetrical space to the "sparkling bubble of light" that Fuller recounted in his epiphany, underpinned the intention of the temporal, secular space as an analog for the theological version.[182] However, as Fuller's ideas became secularized, his ambition for the planetarium also expanded. He imagined that its "information" would arise from a coupling of the natural planetary orbits, earth and human geography. Particularly in the last two items, the human-activated and natural patterns would form a consummate "theater of local Universe events."[183] As the Minni-Earth transformed into a geoscope, it would exceed its primary didactic purpose as "a psychologically effective planetarium," beyond debunking the nominal sensations of the sun "setting" or "rising." Thus, while Marks proposed that Minni-Earth would dislodge "the everyday mis-sensing of (the earth's) environment,"[184] Gerber, going further, interpreted optimistically the significance of the high visual augmentation and fidelity of the geoscope:

> (The geoscope) enables one to grasp visually the validity of holistic impulses and integrations *without the need for interpretations*[185] (Id., my emphasis).

4.4.1.1. Ideological Intent as 'Spaceship Earth'

The obviousness and transparency of the geoscope are ideologically significant. These qualities momentarily coincided with the general ethos of the American Pavilion project -- the

[180]Ltr.6/20/68 RBF to A.C. Clarke in BFI-CR327.
[181]R. Buckminster Fuller, "Land to Sky. The Outward Progression," *4D Timelock*, p.31.
[182]See L. Seiden, *Buckminster Fuller's Universe*, p.88. Seiden recounted Fuller's dramatic description of his epiphany, from a public lecture (Univ. Calif.-Santa Barbara, Dec. 1967).
[183]R. Buckminster Fuller, *Critical Path*, p.172.
[184]R.W. Marks, *The Dymaxion World* p.153.
[185]A. Gerber Jr., "The Educational Philosophy of R. Buckminster Fuller," p.14.

supposedly transparency of its intended purpose in representing America. For Fuller, the geoscope was more than a value-added Minni-Earth. It was ideologically charged since it tacitly visualized for all the absurdity of national boundaries in the face of greater forces, whether these were the sublime Universe or the invisible movements of humans, his energies and his enterprises. For this reason, Fuller proposed the Minni-Earth as a contestation of the moral authority of the United Nations in 1956.

Then, he proposed a polemic project in the form of a 200-foot diameter Miniature earth, executed at University of Minnesota, to be sited on Blakewell Ledges in the New York City East River [Fig.4.21c]. Fuller had intended for a rotate-able Minni-Earth, held by suspension from masts at the same level as the United Nations' Secretariat. Passengers would be ferried from the United Nations dock to a slip under the base of the sphere where an elevator would transport them to its center, "from whence a mobile arm could carry them to any part of the surface to check on the accuracy of the data or introduce new devices or information." For this reason, Fuller explained, he rated the Minni-Earth" as possibly the most powerful tool for integrating world mans' diverse interests."[186] Writing in later years, he explained further:

> Geoscope will spontaneously induce total Earth, total-humanity viewing significance in regard to all our individual daily experiences. It will spontaneously eliminate nationalistic celebrating.[187]

The change-over from Minni-Earth to geoscope followed in the wake of Fuller's modeling of earth as a "spaceship" hurtling through space. The description "Spaceship Earth" has been generally credited to Barbara Ward for her 1966 book by the same name which preceded Fuller's own *Operating Manual for Spaceship Earth* (1968). However privately, Ward acknowledged Fuller as the originator of the emblematic term. If the impetus for evoking the image of Spaceship Earth is about human control, the preamble for the idea was first offered in his 1940 essay "Ballistics of Civilization":

> (A)ll mankind is ... ballistic.... 'Ballistics of Civilization' is the art /science of controlling man's otherwise involuntary hurtling through the ages of space.[188]

In 1955, Fuller reformed ballistics into a spaceship:

> Many a youngster says today: 'I wonder what it would feel like to be rocketing through Universe in a Space Ship?' The answer is: What does it feel like? That's what you are doing

[186]Ltr.1/2/60 RBF to H.E. Strub in BFI-CR206.
[187]R. Buckminster Fuller, *Critical Path*, p.174. See also *I Seem to be a Verb*, p.172.
[188]R. Buckminster Fuller, "Ballistics of Civilization (An Explanation of the Dymaxion Charts for Economic Progress)," BFI-MSS 40.01.01, 3/14/39, pp.1-2.

now and have always been doing, but of course like a flea, deep in the carpet of an enormous outside 'decking' of your Space Ship and therefore with a very limited 'flea-eyed' view. Minni-Earth can, if experienced and studied, give you 'feel' - as well as 'know' - of your passaging (sic) through Universe just as you would see and know from your windowed Space Ship.[189]

In the larger context of the American cultural experience, its survivalist-utopic motif is comparable to the metaphorical stage-coach of Bellamy's *Looking Backwards* (1887) and William Ghent's raft in *Masses and Classes* (1904).[190] In the seventies, Gerber proposed that Spaceship Earth was a metaphorical rendition of an ecologically-closed system or a social system of mutual interdependence.[191] Pedagogically, Fuller's original Spaceship Earth was a heuristic device for imagining an analog of the conning room on a planetary scale.

4.4.1.2. Precedent Objects of Herbert Bayer and Patrick Geddes

The idea of presenting earth geography on a large globe to be viewed from within was first attempted by Herbert Bayer. In all likelihood, as Fuller mounted the first exhibition of his Dymaxion map on the walls of the Children's Reading Room of the New York Public Library, MoMA and the Newark Museum (March-April 1943),[192] he was probably aware of the planning of Bayer's 15-foot diameter free-standing demountable globe, suspended from the ceiling for the "Airways to Peace (An Exhibition of Geography of the Future)" Exhibition at MoMa in August [Fig.4.23a-b].

Bayer's project was possibly the first to integrate examples of emerging data of the world in a "visual unity."[193] Because Bayer lacked technical finesse in his cartographic method and was limited by his preferred techniques of representation, his globe presentation remained primarily graphic. He also had to ameliorate the gross inaccuracies of his spherical projections with supplementary smaller hemispheres. Despite its inaccuracies, Bayer's consolidated globe-chart-data project like Fuller's geoscope were conceptually linked by a common interest in graphic readability as a representation of reality. All "world data" was dynamically viewable and pictureable and relayable -- thus making reality "modelable ." However, Bayer would eventually

[189]Ltr.4/19/55 RBF to BG Harold E. Watson in BFI-HEv1, p.6.
[190]See James Gilbert's *Designing the Industrial State, The Intellectual Pursuit of Collectivism in America*, Chicago: Quadrangle Books, 1972, p.56 for the treatment of these two vehicles as class interpretation of American society.
[191]A. Gerber Jr., "The Educational Philosophy of R. Buckminster Fuller," p.2.
[192]Fuller subsequently filed his claims in February 1944, and received the patent (U.S. Patent 2,393,676) for the map invention in January 1946. D. Cort (in *The Sin of Henry R. Luce*, p.350) and W. Paxton, two of Fuller's cohorts of an incognito OSS-team, persuaded J. Shaw Billings (Managing editor for *LIFE*) to publish the Dymaxion map. In the March 22 1943 issue, *LIFE* created a publishing sensation by circulating several million copies of a four-color edition of Fuller's map in an eighteen-page portfolio.
[193]Arthur A. Cohen, *Herbert Bayer: the Complete Work*, Cambridge Mass.: MIT Press, 1984, p.302.

employ his visual-graphic acuity to explore a standardized visual language for corporate use. Particularly, as design consultant to Walter Paepcke's CCA spanning two decades(1946-1966), Bayer employed this visual language in industrial design to homogenize many cultures encountered in multi-national corporate expansion.

As singular representations, the works of both men were extensions in the spirit of Ogden-Richards' *Basic English* of the thirties and the unified visual language project of the Viennese circle philosopher, Otto Neurath. The latter, as a director of a museum in Vienna founded on Visual Education, had in the late thirties developed a consistent method of visual education exemplified in "International Visual Language with Visual Dictionary and a Visual Grammar." This work paralleled Neurath's project for the unity of science.[194] In the respective searches for unity in the works of these men, the physical and the phenomenal collapsed into one entity.

In 1963, Fuller acknowledged an ideological kinship of his geoscope to Patrick Geddes' Outlook Tower (c.1892) in Castlehill-Edinburgh which he chanced to visit the previous year.[195] The "Outlook Tower" was a pedagogical tool for instructing its audience of Edinburgh's historic past. In the camera *obscura* contained within the dome at the top of the tower, revolving lenses and mirrors were aligned to create an image of the surrounding city in real-time. The underlying idealism in this cosmorama was that the "incipient civic observatory and laboratory" would provide visual surveys and data for diagnosis which would eventually lead to treatment of the urban problems.

The Outlook Tower, in other words, was a correlating medium for thought and action, or as Stalley succinctly described, "a clearing house of social science with social action of vital interaction of thought and deed."[196] Though the larger ambitions of the Geddes project was a holistic interpretation of city, region, continent and the world, the "Outlook Tower" was limited by its techniques. It functioned more effectively as an enlightened modern frame to envision the meaning of planning for civic service in terms of local neighborhood and community. It is this focus on civic service which differentiates Geddes' Outlook Tower from Fuller's geoscope. While the former recoiled under what it had perceived as threats of industrialization and urbanization, the latter was an optimistic affirmation of the emergent world community shaped

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[194] I am indebted to Dr. Joachim Krausse for highlighting these connections. See Otto Neurath, *Philosophical Papers, 1913-1946*, Dordrecht, Holland: D. Reidel Publishing Company, 1983.
[195] Ltr.9/30/63 RBF to Prof. F.R. Stern (Dept. of Geography, Rhode Island College) in BFI-CR247.
[196] Marshall Stalley, ed., *Patrick Geddes: Spokesman for Man & the Environment*, SUNY: Rutgers University, 1972, p.239.

increasingly by what Fuller himself had termed "full world industrialization."[197] Nevertheless, the ideological kinship of both men's project lies in an enlightened view of the recuperative image to stand in for reality. Boardman summarized Geddes' work, which could as well apply to Fuller's, in this rhetorical question:

> How can anyone understand this world, not to mention improve it, if he cannot even see it accurately to start with?[198]

Fuller's enlightened optimism was more prescriptive:

> No tool is of real use until it is put into operation. Just thinking about a hammer or even having one idle in the tool box is incomplete. We consider the Miniature earth ... or 'Geoscope' (as) a tool which mankind could use to good advantage in understanding himself, his world, his universe, and his relationships between them. Possessing this advantage and using it properly, he could do a better job, we feel, of planning a successful existence.[199]

4.4.1.3. Geopolitical and Military Tool

The geoscope brought together in a three-dimensional spatial framework the global data gathering and charting skills which he had developed at *Fortune* and Phelps Dodge[200] [Fig.4.25]. This was facilitated by improved high-altitude photographic technology, high-resolution films and new data banks which could be summarily collapsed into trends and patterns. With this information-skin, Fuller imagined that the geoscope would be the ultimate "anticipatory apparatus" of survival for humanity, just as life-rafts, life-belts and life-boats did for passengers on ships.[201] However, more than merely reassuring the "passengers" of Space Ship Earth, the geoscope would "move about within the depths of the celestial ocean theater precisely in every respect as does Parent Earth move within the very same cosmic ocean, or star theater."[202] The penultimate planetary conning function of the geoscope, thus, is to navigate Spaceship Earth.[203]

Through the geoscope, Fuller's ambition, since the forties, to replace the "dead reckoning" course of "short-run data" used by the economist with the "long range great circle

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[197]This was a subtitle to his lecture, "The Next 2 Billion Customers," which Fuller presented to the luncheon meeting of the Export Advertising Association in February 1952 (See Ltr.3/21/52 S. O. Alexander to RBF in BFI-CR138).
[198]Philip Boardman, *Patrick Geddes: Maker of the Future*, Chapel Hill: Univ. N. Carolina Press, 1944, p.18.
[199]Ltr.9/20/60 RBF to F. Upchurch in BFI-CR213.
[200]See Fuller's "Energy slaves" map (subsequently, "World Energy Map") and Dymaxion *Chart* in "U.S.A.," the Tenth Anniversary issue of *FORTUNE* (February 1940); with the key piece, "U.S. Industrialization" where Fuller replaced charting of human progress in terms of tonnage and man-hours by energy.
[201]R. Buckminster Fuller, "Ltr. of transmittal"[Departmental], 1/10/44, in BFI-HEv4.
[202]Ltr.4/19/55 RBF to BG Harold E. Watson in BFI-HEv1.
[203]M. Wigley had proposed that the geoscope was an image of earth: "To construct the Geoscope is to transform the planet into a 'windowed space ship'" (See "Planetary Homeboy,"*ANY17* Architecture-New York, p.17.21).

navigation" charts was conceptually fulfilled.[204] Just as his *Dymaxion Chart* and map were offered to pilot "corporation officers" on "the course of society," his geoscope was offered to organizations with world-around ambitions.[205] Thus, the initial impetus of the geoscope, like his *Dymaxion* map, was neither for differentiating America from the Old Worlds nor of the "potential unity" of world people as Marks and Gerber claimed respectively.[206] Rather, its quintessential purpose was that of geopolitical survey, control and domination.

In the mid-fifties, Fuller sought, as he did with the other geodesic military ordnance projects, Brig-Gen. Watson's (then recently promoted Commander of the Air Technical Intelligence Center, Wright-Patterson Air Force Base, Ohio) support in channeling his Minni-Earth to the "direct interest" of the Air Force and Departments of Defense. At this point, the supposedly innocuous didactic Minni-Earth revealed its original intention for surveillance and control. It was the global sensing which "integrated deposit of fundamental information from the whole gamut of original world resource reporting" and "visibly answer(ing)" questions pertaining to air and sea navigation logistics, Fuller argued, that would give America the edge in world leadership:

> (Minni-Earth) is being developed with the vigorous hope that it also may prove of tactical - if not strategic - value in our maintenance of an earned - and therefore true -world leadership as the most reliable and swift translator of scientific advances into every-day commonwealth advantages through means of our mastery of the principles of industrialization. . . (The project) could greatly augment the development by the United States of a foreign policy so wise and so effective that none on Earth could doubt either our integrity nor our ability to blaze the shortest trail to the most world satisfaction in the shortest time, while ever commanding in all ways the degree of respect essential to our accomplishment of that trail blazing under peaceful world conditions.[207]

Fuller came to recognize the strategic and operational significance of such a map/globe project during WW II. He disclosed this observation to Lewontin, one of his geodesic mathematics consultant at Raleigh:

> I recall the enormous world assembly of the regular 'sectional' aeronautical polyconic charts at the Joint Chiefs of Staffs headquarters in Washington D.C. during World War II.... This major world assembly is, however, extraordinarily desirable so that a Joint Chiefs of Staff

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[204]R. Buckminster Fuller, "Ballistics of Civilization" (An Explanation of the Dymaxion Charts for Economic Progress), BFI-MSS 40.01.01 p.6

[205]Ibid., p.9.

[206]R.W. Marks, *The Dymaxion World*, p.150; See also A. Gerber's "The Educational Philosophy of R. Buckminster Fuller," p.255, in which he claimed the objectiveness of both artifacts to ward off authoritarianism: "No subjective text is required ... we indeed live on the same island."

[207]Ltr.4/19/55 RBF to BG Harold E. Watson (Commander, Technical Intelligence Center, Wright-Patterson Air Force Base-OH) in BFI-HEv1, p.9. Fuller's offer to the Air Force/Department of Defense was instigated by a report on *Hiran* (High-precision, short-range navigation), a new precision system for mapping the world for future guided-missiles of bombing operations, developed by the Air Force (See *NEWSWEEK*, 11Apr. 1955).

may discover that the individual local units which they employ may also be assembled in any preferred flat layout edge to edge sequence.[208]

Fuller also knew that during WW II, triangulation provided an accurate method for radio control for the U.S. bombing missions on Italy and the Nazi countries.[209] Thus, any speedy and accurate cartographic process was a strategic asset. In this case the Dymaxion Mapping process, with minimized cartographic distortions in the constitutional flat equilateral triangle and square components promised to capitalize on aerial mapping and speed up a "world surface unified triangulation." Fuller's awareness of and participation in the military mapping projects were also proposed by Mark Wigley. Drawing from Barry Katz's study of Visual Presentation Branch-OSS (1940-42), Wigley suggested Fuller's possible role in the design of "an immense illuminated globe" with strategic information destined for the Presidential Situation Room.[210] The globe, according to *New York Times*, was "an easy statement for the eye of the war's status quo."[211] Further, Wigley argued that the juxtaposition of Fuller's Dymaxion Map at MoMA Exhibition, "Airways to Peace (An Exhibition of Geography of the Future)," August 1943, alongside one of the President's "Big Globe" was evidence of its military significance.

4.4.1.4. Failed Attempts to Advance the Minni-Earth/ Geoscope

In all likelihood, Fuller's Minni-Earth was already too publicized to be of any strategic value to the Department of Defense. Unless he was merely testing all avenues to advance the application of his geoscope, it is difficult to reason why Fuller solicited military support in the first place. He fully well knew that U.S. Air Force guarded with "enormous secrecy" the exquisite details of its world aeronautical planning charts.[212] His own efforts to advance the project by forming Minni Earth Inc. to enfranchise students at the University of Minnesota participating in his three-year project and other eventual solicitation efforts produced equally dismal results.[213] The University of Minnesota eight-foot pilot dome remains the only Minni-Earth prototype. After the rejection of Minni-Earth by the military, Fuller latched on the opportunities for world-around publicity afforded by the 1956 International Geophysical Year

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[208] Ltr.10/17/57 RBF to R. Lewontin in BFI-CR189.
[209] Ltr.2/23/66 RBF to Dr. J.G. Campbell in BFI-CR280.
[210] M. Wigley, Ibid., p.17.20.
[211] "The War in Pictures," *The New York Times*, October 1941.
[212] Ltr.12/28/59 RBF to J.W. Fitzgibbon in BFI-CR206. For the Cornell 20-foot dome, Fuller had tried to secure the V-30 series aeronautical charts from the Navy (See Ltr.4/23/52 RBF to Dir. of Hydrographic Office, U.S. Navy in BFI-CR138).
[213] See Draft declaration of the intention to form *Minni Earth Inc.*, 11/14/56 in BFI-E Series. In his personal records, Fuller backdated his Minni-Earth activities at University of Minnesota to October 1954 even though the ambitions emerged in 1955 (Ltr.4/19/55 RBF to BG Harold E. Watson in BFI-HEv1) and the first concerted effort at University of Minnesota began the following year under George L. Ah Tou.

(IGY). He offered geodesic services for IGY-South Pole expeditions and the Minni-Earth for "possible kinescoping" of the organization's event.[214]

Separately, Fuller-Geometrics tried unsuccessfully to get a rudimentary 80-foot diameter globe Minni-Earth exhibit built at Brussels World Fair(1958)[215] [Fig.4.21f]. Peter Floyd's Brussels globe was meant to be a "Nuclear Energy Global Display." The project was intended to vividly sideline the petty ideological confrontation between the tractors of the Soviet Union and the washing machines of the United States shown in the respective pavilions at the Fair. In the early sixties, Don Moore tried to resuscitate Fuller's Minni-Earth as "Conning Tower" by forging it as a corporate analytical-tactical tool for sustaining American economic leadership. His prognostication was that America would "find itself in a much lower relative position in the world community of socio-economic states."[216] Through the "science of comprehensive anticipatory design," the primary activities of Dymaxion Institute (later Buckminster Fuller Institute), Moore proposed, the economic dangers would minimized and the opportunities maximized.[217]

The most ambitious pre-Expo'67 geoscope imagined from all these early efforts, however, was Fitzgibbon's 200 and 600-foot diameter geoscope designs destined for the 1964 New York World Fair[218] [Fig.4.22a-b]. The sketches were probably spin-offs of an earlier Fuller-Fitzgibbon initiative to convince the Aluminum Secretariat, a holding company of aluminum companies of Canada and ALCOA, to build a 200-foot diameter world-globe dome for its headquarters, which they claimed, would become a "world pilgrimage" point.[219] The Secretariat building would act as a pedestal containing a core platform, elevator facilities and an array of telescopes. Instead, Fuller's primary promoter at Aluminum Secretariat, H.E. Strub, Director of Public Relations, saw its greater publicity value at the 1964 New York Fair.[220] In October 1960, Strub lined up its potential deployment and presented the geoscope to the Fair planners Robert Mosses and Wallace Harrison. Rather than the technical problems of execution, Fuller explained that the exploitative commercial intent of the Fair paralyzed the "continuing evolutionary integrity of scientific insights" of his geoscope.[221]

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[214]Ltr.7/1/56 RBF to James Harr (Actg. Chief, Chart Research Division, Aeronautical Chart & Information Center, Washington DC) in BFI-CR178.
[215]Ltr.12/6/57 P. Floyd to C.J. Mauro (U.S. Department of State) in BFI-CR191.
[216]See "R. B. Fuller Conning Tower Program," May 1, 1960, in BFI-?.
[217]Ltr.9/16/60 D. Moore to W.L. Le Page, Franklin Institute in BFI-G85.
[218]Ltr.1/14/60 J.W. Fitzgibbon to RBF in BFI-CR206.
[219]Ltr.12/28/59 RBF to J.W. Fitzgibbon in BFI-CR206.
[220]Ltr.12/29/59 H.E. Strub to RBF in BFI-CR206.
[221]See Ltr.4/20/61 RBF to R.W. McLaughlin in BFI-CR219.

Instead, in 1961, Fuller quickly turned around the lost opportunity into a symbolic chariot of his UIA World Design Decade initiatives, beginning with the inaugural geoscope at the University of Colorado. The Colorado geoscope model was probably executed in April 1961 as part of Fuller's annual pilgrimage to the liberal forum, the World Affairs Conference. It was a six-foot icosahedral of light steel tube with twenty transparent panels. Film transparencies were placed between hinged panels to allow for overlays and comparison on and through the surface plane. The entire contraption was mounted on a stand which revolved around a circular track under manual control.[222]

The second geoscope model which followed was J.P. Ford's 6-foot diameter geodesic sphere built at the University of Nottingham[223] [Fig.4.21d-e]. The plastic film of the dome contained a crudely-painted map of the world with data of resources coded in a series of visual symbols. It represented a larger 200-ft Minni-Earth which would be undertaken as a project by students of architectural schools of IUA-affiliated countries.[224] Both internal and external surfaces of the geoscope, acting as a multi-directional screen for a "24-hour visual phenomena," would be symmetrically covered with ten million variable intensity light bulbs actuated by a computer. Fuller again proposed that it could be in a major world city or be returned to the earlier UN site in New York City "to serve as a constant confronter of all nations' representatives of integrating patterns, both expected and unexpected, occurring around the face of man's constant shrinking "one town world."[225] As an emblem of centralized control, Fuller described that the Minni-Earth/geoscope would hasten "a unified realization of man's inexorably developing one world town citizenship."[226]

Wigley presents the geoscope as Fuller's attempt "to produce an occupieable image, a fabulous and comfortable picture window" in the face of the dissolution of form in the electronic age.[227] Using the domestic as a trope, Wigley spun these generalizations of Fuller's work -- his view that the human brain was "a thoroughly domestic space"; the World game was "an extension of Fuller's domestic design" and that the "endgame" of the Geoscope "remain(ed) as domestic as the first move." Finally, Wigley offered as a conclusion the meaning of geoscope:

[222]For more details of this project, see "An Experimental Design Problem," University of Colorado, ca. 1961.
[223]C. Fournier, "Buckminster Fuller's Lectures and Exhibition" UIA - Review of the International Union of Architects, #36, July 1961.
[224]R. Buckminster Fuller, "IUA - International Exhibition Among Students of Architectural Schools," ca. July 1961.
[225]Ibid., p.3.
[226]Ltr.2/11/60 RBF to H.E. Strub in BFI-CR208.
[227]Mark Wigley, Ibid., p.17.23.

> The redesign of the planet into a single domestic space is bound to a specific redesign of the family house. The first conception of the house as a mobile networked spaceship underpins the final conception of the Space-Ship as a house. Indeed the idea of the Geoscope is embedded in the very thinking behind Fuller's first designs ... *The Geoscope is a domestically centered philosophy of design long before it is a particular design*. Simply put, the Geoscope is the ultimate house, the drawing of a domestic space out of computer networks.[228]

While this summary is accurate, his overall thesis overvalues the thematic significance of Fuller's ideological domestic-space and image of the house. Fuller's projects, even narrowly confined to the geodesic artifacts in this study, were multi-faceted and were constantly transformed relative to and complicated by Fuller's own presentations, representations and the reciprocal public desires engendered in the processes. The domestic space was surely a heuristic device to productively think through the meaning of external transformations relative to what Fuller viewed as an imperial and scared space for the self. He did not selectively elect to challenge the niceties of things domestic and local; rather, he was convinced that physical globe-trotting and greater mobility of humans and resources rendered the idea of a permanent home problematic and material hoarding, obsolete. Thus, while the counter-culture dome experimentations were persuaded by the ascetic image of Fuller's concept of "less with more," in Fuller's private sky, skybreak and geoscope, the consumptive intent enabled by centralized technology had receded into the background, invisibly and uncritically naturalized.

4.4.1.5. The American Pavilion as a Geoscope

How did this ideological and corporate view of the world, enabled by the geoscope, coincide with the pavilion design? In what ways were this analog of earth and a prosthetic projector of human activities relevant to the Exhibition program?

While the American public saw the pavilion design a foremost opportunity for the country to put its best foot forward, Fuller saw it as a opportunity to convey a vision in the geoscope that he had long nurtured.[229] This entailed a visual representation of the manifest destiny of America as a world society. For Fuller the emergence of a one-world society and the world-man stemmed from the economic development of world industrialization, namely through the world corporations.[230] For this reason, though thrilled with the idea of an exhibition, the idea of a national pavilion, however, was, for him, anachronistic. Fuller believed that the world was drawing closer to the experience of material abundance, promulgated by techniques of mass-

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[228] Ibid.

[229] 23rd Report of the U.S. Advisory Commission on Information, on the activities of USIA, cited in Ltr.4/9/68 J. Masey to RBF in BFI-CR323.

[230] Ltr.2/24/65 RBF to D.W. Robertson in BFI-CR267.

production. Thus, it was compelling for America to realize its appointed role in communicating the meaning of a new citizenry shaped by the economic realities of a multitude of world corporations.

Despite recognizing a long-standing USIA tradition to split the commission for its Fair projects along two components – namely, the exhibit and its enclosure, Fuller nevertheless defiantly offered his scheme as a total integrated exhibition. He recounted his defiance later:

> I proposed that the exhibit consists of a miniature Earth, at the center of the structure, with remote balconies surrounding it. In the balconies individuals would be able to participate in a computerized game of 'How to make the World Work' successfully for all of humanity. The game was to be played with the data from our Southern Illinois University fundamental Inventory of the World's Resources, Human Trends and Needs. I said that by the time of the 1967 World's Fair, I felt that the *United States might be at its lowest point with respect to world esteem*, and that for visitors to be able to play an open game independent of political ideologies and national ambitions might turn the tide by bringing about a new favor for world man as he is now developing on the North American Continent. The U.S.A. is not a nation. It is cross-breeding world man at its most advanced state[231] (Id., my emphasis).

Fuller's large ambition for the project was the heart of the ensuing contention between him and Cambridge Seven Associates, the designer of the Fair's exhibit. Calling Fuller a "publicity grabber of genius," Serge Chermayeff offered his account of events leading to the subsequent flare-up between Fuller and Peter Chermayeff, his brother and partner of Cambridge Seven:

> Bucky tried to grab the whole job *after he was invited by the Architects (Cambridge 7, who got the job) to produce an octet truss umbrella for their exhibit.* This became a dome after it became obvious that the cost of the proposed BF(sic) structure was going to be prohibitive. The cost of the dome in any case, as always with Bucky, was infinitely more than his estimates.[232]

While Serge Chermayeff was probably accurate in recording Fuller's attempted coup, he clearly erred in suggesting that the architects "invited" Fuller's participation. In all likelihood, Jack Masey, then appointed Chief of Design and operations of the U.S. Exhibits at the Montreal World's Fair played a pivotal role in lobbying for Fuller's participation. Masey even enthusiastically suggested that Fuller's structure would be a "breakthrough of major proportion and significance" in the company of Crystal Palace and Eiffel Tower.[233] Masey was neither a

[231]Ltr. 11/29/66 RBF to Ben Hellman (Publisher, *Contract*) in BFI-CR291(Section of this explanation was reproduced in "The Geoscope" in *Critical Path*, pp.165ff).
[232]Ltr.4/27/67 S. Chermayeff to P. Blake in BFI-CR301.
[233]Ltr.12/16/64 J. Masey to RBF in BFI-CR265; and Ltr.12/10/64 J. Dixon to RBF in BFI-CR265.

new-comer to the Fair scene nor was he unfamiliar with Fuller's work.[234] Since Fuller's first seminal Kabul Dome project, Masey, described by *Architectural Forum* as "a highly improbable bureaucrat" in USIA, was responsible for advancing Fuller's domes on the international arena. On the account of Masey's experience with Fuller from these early beginnings, Blake challenged bureaucratic-political impression of Fuller's commission of the U.S. Pavilion "as an absolutely hare-brained notion."[235]

The tacit underpinning of Fuller's proposal was that the geoscope would visualize the meaning of "world industrialization economics" produced by world corporations. In this case, Fuller even intended the pavilion to be manufactured by a world corporation, which included any one of the great California prime armaments contractor like Lockheed, Boeing, Douglas, North American, to be flown to Montreal.[236] There were no ideological contradictions between Fuller's transnational agenda and the public's patriotic-nationalistic agenda. While the national pavilions celebrated cultural and political diversities, Fuller intended for the American Pavilion to be an ideological equalizer -- to show the commonalty, the utopic universalist agenda of the Fair itself. Appropriately, the theme of Montreal Expo'67 Fair was to celebrate the kinship between peoples at a time of great ideological divisions among many countries.

Fuller's intentions for the American Pavilion were ideologically consistent with the broad themes of American fairs in general. Firstly, up until the Kabul Dome, the federal government played a minor role. The tacit message was that the representation of national prosperity was better achieved through private initiatives and unfettered private enterprises rather than through state-sanctioned programs. Secondly, its emphasis on benevolence and peace, and the reluctance to display technology aggressively was paradoxically intended to highlight the benign nature of technology in American society.[237] In 1967, when the American Pavilion opened for public viewing, Fuller's concerns seemed at odds with the receptions of the American public.

4.4.2. A Revision in Design. The Geoscope Became The American Garden of Eden

Fuller's ideological project was to be accomplished in a large-scale rectangular flat geodesic-space truss (500 x 400 feet) supported on four pylons under which were placed smaller

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[234] J. Masey began his career as a member of the editorial staff at *Architectural Forum*, ca.1947. He subsequently joined USIA as a trade show designer in the Exhibits Division of USIA; crowning his career achievement as Chief of Design with Expo '67 at Montreal (See "Expo '67- Drop-out," *Architectural Forum*, June 1967).
[235] P. Blake, *No Place Like Utopia* , p.221.
[236] Ltr.2/24/65 RBF to D.W. Robertson in BFI-CR267, p.3.
[237] For di...ussions of the place and space of American ideology at the fairs, see David E. Nye's *Narratives and spaces: Technology and the Construction of American Culture*, New York : Columbia University Press, 1998.

exhibits. Fuller-Sadao's early drawings from October-November 1964 showed such a proposition [Fig.4.17a]. In December, a fiery meeting ensued with the exhibit architects, Cambridge Seven Associates, when Fuller-Sadao advanced three structural options for consideration, in which a revised truss made of tensegrity octahedrons took a premier position.[238] The truss consisted of four large discontinuous octahedrons arranged to form a discontinuous structure. The octahedrons consisted of compression booms stayed in place by guyed masts [Fig.4.17b]. The two remaining options consisted of the initial flat octet-truss proposal, and a 400-feet diameter eight frequency geodesic sphere. In the first two structural schemes, the exhibition space consisted of two suspended floors contained in the truss.

Chermayeff probably objected to the untried "tensegrity octahedron" scheme because it threatened the potential project budget. For this reason, Cambridge Seven Associates maintained that a flat octet-truss, 250-feet by 250-feet would be the basis of U.S. Pavilion. This was clearly a down-sized and simpler structure. The issue of design framework would have directly affected the dispensation of the design budget covering the pavilion structure and exhibits.[239] Further, the rivalry between Cambridge Seven and Fuller's associated architects revolved around the obvious stake of world-wide publicity involved in such high profile project. Thus explained P. Floyd, Fuller's associate:

> The Cambridge Seven (architects) ... are continuing to plug the line that he Pavilion is just an anonymous enclosure - the plastic packaging for all important contents - their platforms and exhibits. We have always wanted the Pavilion to have an ulterior function in its own right and believe the one ('environmental valve'/'Garden of Eden') stressed in the (press) release is both independently important enough, as well as sympathetic to the exhibition use of the Pavilion.[240]

By early January, primarily out of budgetary constraints, Geometrics Inc. opted for the third alternative, and worked out two variations of geodesic dome structures based on size and cut-off.[241] Floyd highlighted that the budgetary estimate for the American Pavilion project at Montreal, based on expenses of the 1958 Brussels Fair, was grossly insufficient; and that the overall program was "unrealistically ambitious in terms of resources available." The option was to increase the budget or scale down the project to sixty-percent. Perhaps out of defiance, Geometrics Inc. continued to propose a geodesic dome based on the "tensegrity octahedron."[242]

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[238] Ltr.12/29/64 P. Chermayeff to RBF in BFI-CR265. See also _, Memorandum of Cambridge Meeting, 12/29/64 on U.S. Pavilion for Montreal 1967 World's Fair in BFI-CR265.
[239] See Ltr.1/15/65 J. Masey to P. Floyd in BFI-CR266.
[240] Ltr.5/25/65 P. Floyd to RBF in BFI-CR269.
[241] Ltr.1/13/65 P. Floyd to J. Masey in BFI-CR266 (See cost estimates for a 3/4 sphere of 275-300ft diameter and a 350-ft, 2/3 sphere).
[242] Ltr.2/26/65 P. Floyd to J. Masey in BFI-CR266.

While the new proposals were smaller than the October scheme, they nevertheless covered more area and were higher than the one described by Chermayeff. These changes, Floyd proposed, would obtain a "total statement in terms of perceptual expansion rather than physical scale"[243] [Fig.4.17c].

For Fuller, these changes caused by budgetary constraints undermined what he perceived as a "mandate" for demonstrating a structural breakthrough, implicit in the USIA commission.[244] To avert the "ruinous" eventualities of the decision, he privately appealed to inner circle of President Johnson for a meeting to advance his case, but to no avail. Ward suggested that the theme of the exhibition changed Fuller's pavilion design.[245] This is rather unlikely since Chermayeff, despite his objections to the tensegrity octahedron structure, was prepared to accept the flat octet truss structure and at one point even suggested that it "seems to work out as a very clean and complimentary (sic) relationship" to their exhibition design."[246]

The more likely reason for abandoning the scheme was the untried factor of the tensegrity octahedron truss. It posed unwarranted risks and budgetary uncertainties, both heightened by the tight deadline for presentation of preliminary project estimates to the Bureau of Budget and Congressional Committee on Appropriations. Shoji Sadao, Fuller's primary associate on the project, professed that he had abandoned altogether the dome structure based on tensegrity basically because it entailed an added complication of pre-stressing with no perceivable advantage in weight reduction.[247] Wainwright similarly explained that the tensegrity structure was abandoned because it proved unfeasible.[248] By January 1965, Masey settled quite comfortably into a budgetary plan split equally between the structure and the exhibits, with the former assuming the form of a 275-ft diameter, 3/4 sphere reaching 200 feet high.[249] At the same time, Masey also settled on the exhibition content and its theme, "Creative America."[250]

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[243]Ltr.1/13/65 P. Floyd to J. Masey in BFI-CR266.
[244]Ltr.2/14/65 RBF to Jerome B. Wiesner (President's Advisory Committee on Science, The White House) in BFI-CR267.
[245]J. Ward, ed., *The Artifacts of R. Buckminster Fuller*, Vol.4, p.55.
[246]Ltr.12/29/64 P. Chermayeff to RBF in BFI-CR265.
[247]Ltr.7/12/66 S. Sadao to Mr Thayer in BFI-CR289. See also reference to report on tensegrity by the engineers, Simpson Gumpertz & Heger, Inc. mentioned in Ltr.6/2/66 S. Sadao to RBF in BFI-CR285.
[248]Notes from Author's Interview with William Wainwright, Boston-Mass., 4/19/95
[249]Ltr.1/15/65 J. Masey to P. Floyd in BFI-CR266.
[250]See J. Masey, "United States Commission Montreal World's Fair 1967 - Design and Content of USIA Participation," 1/11/65, copy in BFI-CR265.

In July 1966, a slightly smaller dome of 250 feet made from steel pipe and cast steel hubs welded together to form a 3'-6" deep space frame truss was finalized.[251] The enclosing system consisted of tinted transparent acrylic sheets molded like a free blown bubble into a hexagonal configuration. Rather than using thermostatically-actuated mechanical sunshades, six programmed routines on punched tape based on variations in altitude of the sun actuated motors using relays[252] [Fig.4.18a & Fig.4.18b].

4.4.2.1. Public Receptions and Interpretations

The American Pavilion was also intended to be a *Garden of Eden* to highlight American technology working with the grain of Universe. However like the Climatron, it was plagued with many problems which tugged at the heart of its claims as an environmental valve. The Pavilion leaked after desperate efforts to caulk the joints of the dome-skin.[253] The differential solar load on the spherical surface coupled with the unequal expansion of hexagonal panels probably exacerbated the opening up of the joints. Baldwin suggested that the rubber gaskets for the acrylic panels were carelessly stored during the construction phase, and that because they freeze-damaged, their integrity was compromised.[254] The sunshades for the dome were generally inoperative from motor stalling and foul-ups in the running riggings.[255] Besides under-powering, the details of the rigging design failed to consider carefully the direction of the coil.[256]

The Pavilion's exhibits received the harshest public criticisms [Fig.4.19a-d]. Both political and cultural conservatives were enraged by the exhibits which they viewed as cheap, trivial and tasteless. Tying representation to public accountability, the conservative backlash also stoked jingoistic reactions and claims that a liberal ploy to make "the U.S. silly" had damaged the image of America.[257] In opposition to the caustic remarks of the mid-cult America, the

[251]For discussion on the structural behavior of the Pavilion, see Z.S. Makowski's "A History of the Development of Domes,"p.44.
[252]Ltr.4/11/66 S. Sadao to RBF in BFI-CR300.
[253]See Fuller & Sadao Monthly Report, 3/8/67 in BFI-CR299
[254]Notes from Author's Interview with J. Baldwin, Santa Barbara-CA, 5/5/95.
[255]See Fuller & Sadao Monthly Report, 5/5/67 in BFI-CR302.
[256]Notes from Author's Interview with J. Baldwin, Santa Barbara-CA, 5/5/95.
[257]See State, Justice, Commerce, the Judiciary and Related Agencies Appropriations [Senate Hearings] H. R. 10345, 90th Congress, First Session, 1968, pp.410-416); also "Letters: Divergent Views About Expo 67," *New York Time*, 4 Jun 1967; Richard Starnes," But like all Bubbles, It's Empty," *The Washington Daily New*, 5 June 1967; Republican representative [North Dakota] Mark Andrew's reaction in "Disaster or Masterpiece?" *Time*, 2 June, 1967, p.47; See Romney's [Gov. of Michigan] remarks in "Heigh Ho! Soft Sell at the Fair," *LIFE*, 16 June, 1967.

architectural community was generally positive about the ebullience of the young designer's "high-camp" and the "daring" geodesic structure.[258]

Despite these setbacks and the dichotomized views between the public and the art community, the jewel-like American Pavilion was, by many accounts, sensational. In a Gallup poll findings of approximately four million American adults who attended Expo'67, of which "more than a third rated U.S. Pavilion 'excellent' while another third ranked it 'good'."[259] While the basis for comparing the Pavilion design and its exhibits is tenuous, such comparisons nevertheless consistently formed the opening lead in most discussions of the American fair entry. The Pavilion either "literally overwhelmed the exhibit" or its "glorious presence" redeemed the "cheap and vulgar" exhibits.[260] Most hoped that the grandeur of the Pavilion would somehow rub off on the contents.

The distinction were often cast in the simplistic dichotomy of high versus low culture - presumably the virtuosity of control of the former versus the frivolity of self-indulgence of the later. Nevertheless, generally, the more critically observant public concluded that the lower end of the cultural spectrum was no more a "purer Americana." The four components of the American exhibit included displays of small objects American had made over the years, the space show, Hollywood nostalgia and recent paintings. These exhibits softened America's technical edge. The nostalgia of a good life rectified the excesses of youth culture, and overall the exhibition of patchworks to apple corers, as evidence of everyday life, was "genuinely in the spirit of creative America."[261]

Personally, for Fuller, despite failing to realize his original geoscope idea, the project remained an achievement. The Pavilion, he explained, was:

> a dream world ... (T)he dome is the dream....
> The contents reflect a 'pure' United States. Critics throughout the world are so hard on the United States because *everybody knows we represent World Man. Our Pavilion is World Man - and we haven't even tried to show off in it.*[262]

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[258] See "Expo 67- Drop-out," *Architectural Forum*, June 1967; George McCue "Art and Technology at Expo'67," *Sunday Post-Dispatch* -St. Louis, 4 June 1967; also Jean Labutat's views in Mark Starowicz, "Habitat and Geodesic Dome Said Architecture Landmark," *The Gazette* (Montreal -Quebec), 14 June 1967.
[259] 23rd Report of the U.S. Advisory Commission on Information, cited in Ltr.4/8/68 J. Masey to RBF in BFI-CR323.
[260] Ltr.9/8/67 Senator J.K. Javits to RBF in BFI-CR308; Ltr.9/18/67 H. Welling to RBF in BFI-CR308.
[261] See Paul J.C. Frielander's "A Citizen's Eye-view of the U.S. Pavilion at Expo'67," *New York Times*, 2 July 1967.
[262] Stan Fischler, "Architect Fuller Blasts Habitat but Pats Himself on Own Dome," *Toronto Star Daily*, 17 June 1967.

The charm war at international fairs since Kabul Fair had almost become a media-staple. Still, there were openly expressed hopes that the World's Fair would thaw the Cold War political antagonism.[263] At Montreal, this was dramatized by the tenuous separation of the American and Russian pavilions across Le Moyene Channel linked by a wooden bridge, *The Cosmic Walk*. However, the ground-swell of American public opinions and sentiments expected nothing less than a polemic demonstration of America rhetorical opposition to the USSR and those of its satellite nations in particular, and other nations in general [Fig.4.20a-e]. In this modern-day pot-latch, dubbed as the "Great Pavilion Race," by one journalist, the Russian pavilion was a "Tower of Babel" while the Cuban exhibits was "high noon in a madhouse."[264] Another American journalist alluded to the sweeping structural calisthenics of the massive Russian pavilion crammed with "impressive oppressiveness of the USSR's phalanxes of machinery."[265] Fuller's dome, on the other hand, appeared easy and effortless and its exhibits, light hearted and frivolous.[266]

Still for a land that perfected the billboard and the singing commercial, the "soft-sell" theme of the American Pavilion and its contents, Kappler noted in *LIFE*, was not only unique at the Expo, but was deeply un-American. In this respect, he suggested that while "emergent nations" aspired the American way of life in "their own air-conditioned jungle headquarters," America's charm was its naturalness and non-pedantry:

> The only international pavilion at Montreal Expo'67 that does not seem to be hard-selling the American way of life is the U.S. Pavilion ... The technology-obsessed, thing oriented society that people reared in less materialistic cultures have previously considered uniquely American is now on exhibit all over the lot....
> Maybe we want to show that we don't have to show anything.[267]

This Euro-American centric view was also advanced by another observer when he concluded that pavilions of the "underdeveloped nations" and communist blocs were materialist and didactic-political respectively, in contrast to the western nations which displayed "imagination and even a sense of humor."[268] The civility and sophistication of the American entry, another commentator proposed was proven by how successfully it avoided the "neurotic compulsion to flex (her) muscles in public or try to compete with the Russians in showing off (her) gadgets and (her) hardware."[269] Rather than the chauvinistic Russian propaganda of a

[263]See F. Kuchinchuk's "Cold War is Thawed at Canada's Expo '67," *New York & Brooklyn Daily*, 19 July 1967.
[264]R. H. Johnson, "'Expo is Designed to Inform, Not Sell'," *Decatur Daily Review*, 2 June 1967.
[265]Ted Turpin, "Expo '67 lives up to Advance raves," *Tuscon Daily Citizen*, 1 July 1967.
[266]"Letters: Divergent Views About Expo 67," *New York Time*, Sunday 4 June 1967.
[267]Frank Kappler, "Heigh Ho! Soft Sell at the Fair," *LIFE*, 16 June 1967.
[268]Barry Bingham, "EXPO," *The Courier-Journal & Times Magazine*, 17 June 1967, p.50.
[269]G. Higgins, "U.S. Pavilion Happily Void of Propaganda," *The New World*, 16 June 1967.

projected future, America proffered the ides of "now" as its ideological success. Thus summarized Jack Masey of the American entry:

> The idea of the exhibit is not to impact information, but to create a feeling or a mood, or a sensation....
> What we hope to accommodate is the creation of a symbol which is expressive of the daring experimentalist nature of the country ... a 'now' country if you will.[270]

4.4.2.2. The Effortlessness and Weightlessness of American Technology

Ironically, all the criticisms raised against the American Pavilion and exhibits -- its emptiness and understatement, were the entry's fundamental strength and potency. One reporter observed that despite its "emptiness," "gawky self-consciousness" and "relaxed, soft-sell interior," all of which missed the opportunity to "show off America's strength and prowess," the Pavilion and its exhibits nevertheless epitomized an understated American confidence.[271] This understatement, one is to understand, eschewed chauvinistic propaganda and competitiveness. Along the same lines, a thoughtful Canadian visitor to the U.S. Pavilion proffered America's concern with "spirit" beyond its established status of wealth, and its concern with a "different and individual way of living."[272]

Despite the public sense of disappointment in the American fair entry, one could say that the purposefulness of USIA in underplaying America was entirely becoming. The lacy metal-acrylic filigree of the U.S. Pavilion poised weightlessly on Sainte-Helene appeared all so reassuring to Americans. As a three-quarter sphere, it had a lifting quality variously described as a "bubble" and "balloon," unlike the earlier hemispherical geodesic fair structures which hugged the ground. The net effect of effervescent lightness and near-perfection appropriately conveyed an image of transcendence rather than the entrapment of material accumulation. This was in contrast to the weighty Kaiser-type hemispherical geodesic dome used at the Centennial exhibition, "Alaska-67" which happened at the same time as Montreal-Expo'67. That dome, similar to the one used at Moscow, was painted gold to symbolize a nugget, the ethos of the founding of Alaska.[273]

Though rendering weightlessness negatively, its presence as a leitmotif from the "bubble" dome to the exhibits was perceptively observed by no less than a Russian observer. Kondrashov

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[270]Bill Hosokawa, "Expo 67 ... nothing like it in this century," *Empire Magazine* in *The Denver Post*, 4 June 1967, p.18.
[271]George Higgins, "U.S. Pavilion Happily Void of Propaganda," *The New World*, 16 June 1967.
[272]Ltr.(n.d.) E. Calverley to (Anon. Russian) in BFI-CR314.
[273]See "The Way North," *Time*, 2 June 1967.

rendered the dome's "weightlessness" as emptiness and frivolity and further suggested that this strive for "sophistication" was exaggerated and "not natural to the American." He added:

> But beyond the limits of the (exhibits on the) cosmos - is the earthy weightlessness of 'Creative America.'[274]

In defense of the 'Creative America,' Leonard Marks, the Director of USIA, argued that the exhibit was a "very effective way to show the democratic process in action, and it show(ed) it has been going for a long time."[275] Despite the power of the emptiness, descriptions like "tasteful but austere" continued to betray an overall ambivalence.[276]

4.4.2.3. The Transparency of Information not Propaganda

More than just soft-sell, many American reviewers proposed that America was presenting the real. In other words, against the boastful Russian proffering of propaganda, the American restless spirit countered with information since it considered propaganda unnecessary. As an example, one writer contrasted the supposedly unused chromium plated Sputniks to the scorched first U.S. manned space capsule used by astronaut Alan Shepard as evidence of it having "been out there and back."[277] Another described the Russian building as "modernistic" rather than "modern."[278] A third writer explained that despite the Russian theme of "Everything for the sake of man and everything for the good of man," there were few people or even images of its people; while America's "other-worldly" Hollywood contained photographs, big and small, of real people.[279]

The transparency of American information, projecting from the real to the imagined beyond rather than from a created beyond masquerading as real, was the distinctive difference in ethos separating the American way from the Soviet. Thus, the Russians were, in this ideological characterization, caught in seeking ways "to improve its image"[280] and succeeded in a "huge public relations" exercise.[281] On the other hand, the American Pavilion was deeply human and

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[274]S. Kondrashov, "Earth & People" Notes on Expo '67 in *IZVESTIA*, 12 May 1967 (translated by H. Marshall, copy in BFI-CR314).
[275]State, Justice, Commerce, the Judiciary and Related Agencies Appropriations [Senate Hearings] H.R. 10345, 90th. Congress, First Session, 1968, p.414.
[276]G. Walker, "Soviet Exhibit Outshines Our Lovely Empty Attic," *The Detroit Free Press*, 10 Apr. 1967.
[277]"Russians in Role of Boastful Salesman at Expo'67; United Uses 'No-Sell' Kind of Presentation," *Watertown (NY) Daily New*, 29 May 1967.
[278]Barry Bingham, "EXPO," *The Courier-Journal & Times Magazine*, 17 June 1967, p.50.
[279]C. Smith, "Man About Town," *Evening Journal* (Wilmington, Delware) 17 July 1967.
[280]Gerard Loeb, "Impact of Expo'67 To be Widespread," *The Record Hackensack* (NJ), 17 June 1967.
[281]G.H. Koenig, "Soviet Pavilion Outshines That of US at Expo 67," *Waukesha Freeman* (Wisconsin), 15 June 1967.

true to its own nature, it presented a process rather than an end-product.[282] A reporter quoted an official USIA statement in support of this position:

> We're mature enough where we don't have to brag about it (U.S. progress) anymore ... Ours is one of the few exhibits that followed the request of Expo officials. They asked that it not be a product show. We chose the theme 'Creative America.'[283]

This process, chronicled in everyday objects, was offered as transparent information and evidence of life without the surveillance of the state. In an ironical twist, it was the denotative aspect of the transparent object that stood in for the connotative aspect of propaganda.

Curiously, Umberto Eco, a keen observer and visitor to the Montreal Fair, was not persuaded by the denotative aspect of the American exhibits. Instead, he argued that the immediacy and directness of the exhibits were at the cost of "exaggerating the obvious, and reducing the 'information', the surprise, the unexpected."[284] Alluding to the situation of sameness emerging, the Fair, according to Eco, was about the exposition of uniqueness rather than the denotative significance of the objects. Citing the Russian dependence on displayed objects, Eco noted that America used objects as "a means" and as "a pretext to present something else," namely, some qualitative value. That value, he concluded, was "of a culture (and) the image of a civilization." In this respect, the Fuller's dome was, in his opinion, a phenomenal success:

> The dome "reflected its surroundings and at the same time revealed something of what was happening inside. Inside it was virtually open, but the objects and interior structures were still enclosed in a dome of light. Mystical and technical, past and future, open and closed, this dome communicated the possibility of privacy without eliminating the rest of the world, and suggested, even achieved an image of power and expansion...
> The only element that did not communicate what we already know, but added something new, even if intangible and ambiguous, was the Fuller dome. In other words, the dome was aesthetically the strongest element of the pavilion, and it was so full of nuances, so open to different interpretations, that it affected the symbols inside and added depth to their easily identifiable, more superficial qualities.[285]

Despite the phenomenal success in terms of the number of visitors to the Montreal Fair, Eco proposed that it marked the end of the "stationary exposition" and offered a future possibility of its role -- one with a startling similarity to Fuller's first geoscope for the American Pavilion. Eco proposed that the new Fair should be "an organized teaching machine to all peoples of the

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[282] Bingham reported of the perplexity of some reviewers of America: "Why these people (Americans) are humans after all!" (See "EXPO," *The Courier-Journal & Times Magazine*, 17 June 1967, p.50).
[283] Isabelle McCaig, "Expo Critic Spur Pamphlet," *Everette Herald* (Washington), 8 July 1967.
[284] Umberto Eco, "A Theory of Expositions" in *Travels in Hyperreality* (trans. William Weaver), London: Picador, 1987, p.300.
[285] Ibid., pp.300-302.

world."[286] For Fuller, the exclusivity of the users or the triviality of the exposition materials were not issues since the primary objective of the geoscope was not cloaked in the dichotomy of art versus non-art, or between the personal-expressive versus the mechanical, or between the trivia of camp versus authentic. Rather, it was meant initially to be a didactic tool for its participants, giving visual fonn to changes and most importantly, staying above political and cultural forays. It was an act of making the invisible visible, to constitute some form of navigational control. In this sense, Barrie Hale's cryptic McLuhan-slant on the use of plastics at the Fair as a desire for "some kind of nice skin that will protect the corporate body without demolishing the individual"[287] applied aptly to the American Pavilion.

Non-American visitors complained that the American exhibits were not "aggressive" and "should have represented especially the aggressive attitude of the fighting in Vietnam."[288] However, the architectural historian, Francoise Choay, who had adverse views of American social unrest and participation in the Vietnam War was taken by the "civilized" effort, wittiness, sophistication and "avant-garde" stance of the American Pavilion and exhibits.[289] The use of the Pavilion and its popular exhibits to detract from the realities of the Vietnam War were not unusual. The tradition of fairs in America, David Nye explained, had been to detract its visitors from the harsh realities of the real world, and this was a practice since the Chicago World's Fair 1933.[290] Thus, one observer described the American Pavilion as a relieve in an "overcast age." It emanated the idea that "technology could still be used almost as a toy, to create a climate of lightheartedness rather than dread" and established Americans as "masters of (its) technology."[291] In a similar vein, Terry Rakine of Cambridge Seven, designer of the exhibit, commented its conceptual thrust:

> We wanted (the design) to be low key, not full of *chest-beating technology* ... (and) that it should not be a trade fair. We wanted to show the craftsmanship, inventiveness and creativity of the American people (Itl., my emphasis).[292]

The American Pavilion and its exhibits nevertheless calmed the surging turbulence of a harsh summer of antiwar demonstrations, racial riots in Detroit and the escalating war in Vietnam. It mustered a powerful symbolic closure to American optimism. Collectively, through

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[286]Ibid., p.307.
[287]Barrie Hale, "Plastic (The Medium As Expo's Message)" in *The Telegram, Toronto Star*, 29 April 1967.
[288]P. Frielander, "A Citizen's Eye-view of the U.S. Pavilion at Expo'67," *New York Times*, 2 July 1967.
[289]P. Blake, *No Place Like Utopia*, p.220.
[290]D. Nye, *Narratives and spaces: Technology and the Construction of American Culture*, New York: Columbia University Press, 1998, pp.130-131.
[291]Victor McElheny, "The Joyful Toys of Technology," *Boston Sunday Globe*, 25 June 1967.
[292]*Time*, 2 June 1967.

the Pavilion and its exhibits, American technology was sublimated and its softening assisted a collective reprise towards the creative as opposed to the destructive. In spearheading the creative, America offered the spirit of mastery over technology. Thus, at a point in American history which Fuller ominously billed as its "lowest point with respect to world esteem," the American Pavilion and its exhibits rendered the optimism of Johnson's "Great society" in a reassuring placid, stoic image of control.

4.4.2.4. A Phenomenal Success and Finale

During the first ten years in the public life of the geodesic structure, its presentation and representation by Fuller had oscillated from a logistics ordnance to an object of peace, from an ecumenical functional object to a propagandistic object of American industry and genius. Through the sixties, as geodesics gained public acceptance, Fuller increasingly proffered it as the universal model of the structure of matter, forces and thought; while a segment of the American public appropriated it as an object of self-control for stoic and therapeutic reasons. While the use of geodesic domes in overseas fairs was driven by the logistic issues of quick assemblage and the problems of unskilled labor, its choice once more to grace the Fair scene at Montreal, albeit the budgetary constraint mentioned, begs explanation.[293]

One obvious explanation is the proven record of accomplishment of the geodesic in awing foreign spectators at such fairs. This was the account offered by P. Blake.[294] Blake described Masey's confidence in the capacity of the dome to continue to awe foreign spectators with American "technical virtuosity" and "esthetic sensibility." Thus, it was highly appropriate for the dome again "to house the proof of American creativity." However, Blake was ambivalent about the wisdom of appointing Fuller, an older American, for this momentous commission. Fuller's commission foreground the apparent absence of "design creativity" among the younger architects.

A second reason, suggested by a reviewer, was that the formal directness and simplicity of the geodesic sphere was a most satisfactory solution to "a purely architectural problem" of pavilion design because it naturally abated potential "aesthetic virtuosity" or "orgiastic imagination" which often detract attention from the exhibits.[295] In contrast, the public relations

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[293]T.C. Howard suggested that for all intentions and purposes, the geodesic dome had become tiring and a passé in the fair circuit; and that the commission was awarded as a political payback for Fuller's high-profile activities and campaigns to re-elect President L.B. Johnson (Notes from Author's Interview with T.C. Howard, Raleigh-N.C., 4/26/95).
[294]P. Blake, "Bucky's Biggest Bubble," *The Architectural Forum*, June 1966.
[295]Satish Dhar, "The American Pavilion at Expo '67 - An Architect's View," *Gazette*, 13 May 1967.

community gave the American Pavilion low scores for its performance. While it saw architecture as a "PR tool," Fuller's dome was distractive – the "views through the windows," the public relations pundits complained, were "constantly diverting."[296]

The third reason was the ideological significance of the geodesic dome itself, seen in relation to Fuller's carefully crafted presentation of it as a personal yet universalist artifice. Especially in the context of the theme of creativity, Fuller's geodesic structure was seen as a germane culmination of his life of tinkering and self-reliance. They were synonymous with the American creed of make-do. In contrast, O. Gueft was careful to point out that the architect of the Russian pavilion, M.V. Posokhin had relied on Italian engineers, and had dotted their restaurants with Saarinen chairs and impeccable Knoll-type furniture.[297]

Finally, against the odds of corporate monopoly of inventions, Fuller's geodesic dome stood as firm evidence of individual resilience and triumph. One commentator even proposed that the dome was "one big mouse-trap," an apotheosis of the Great American dream once illustrated by Emerson:

> (It is) the right kind of exhibit hall for our spiritual wares. It is a vast, transparent geodesic dome ... and symbol seekers can easily describe it as a superstructure of the openness of American Society, where the citizen has nothing to hide and which provides an atmosphere of freedom in which he can achieve anything he sets his mind to.[298]

Besides likening the dome to a symbolic object that was "dream-like and out of another world," Gueft described the conceptual collapsing of the American dream and of Fuller's own in briefing accounts of the Pavilion's official guides:

> For once the United States is being described in something other than materialistic terms, with the guides all discussing the American 'philosopher-scientist, Buckminster Fuller.'[299]

In this way, the American Pavilion project was, personally, a finale performance for Fuller but belatedly a closing moment on a nostalgic phase of American history in which lone inventors reigned supreme. Its success as a powerful and poetic image occasioned a poignant summary from Ed Applewhite to Fuller:

> You have redeemed your generation in this country.[300]

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[296]See "Letter to Subscribers" *Public Relations News*, Vol. XXIII, No.26, June 1967.
[297]O. Gueft, "A Place Called Expo," *INTERIORS*, June 1967, p.116.
[298]D. Stolberg, "In Defense of Superbubble" *Rocky Mountain News* (Denver Colorado), 2 July 1967.
[299]Olga Gueft, "A Place Called Expo," *INTERIORS*, June 1967, p.118.

4.5. Conclusion

In the sixties, the geodesic structures exceeded the scope of functions and practices which Fuller and his collaborators had painstakingly tackled and established. More than just a legitimate functional object, the geodesic dome graduated into a legitimate public image and assumed a new urgency in confronting emerging urban and social problems. At the heart of this transformation was a return to the source of the geodesic structuring; namely, it being conceived in terms of natural technology.

The geodesic structure became a palpable model for "valving" energy, and despite this narrow agenda, it was offered and received as a model for solving ailing American cities and their attendant urban problems. In the high-tech OMR City & Charas urban home-steading projects, Fuller's earthly Eden straddled two extreme scales of urban visions -- between a high-technological organization of the urban poor and a new form of frontier home-steading. As illusory as both moments were to the temporal reality of American urban ills, they remained instructive of the potency of the geodesic image. It provided a moment of reprieve for a sector of the disenfranchised urban poor, as Fuller's vision contained a broader image of communality beyond social panaceas.

Fuller's success was supported by the ground swell of youth support and the apparent scientific vindication of his geometrical-structural investigations. He cultivated his new audience at two levels. Through a transnational organization like the UIA and the architectural schools, he expanded his mission as "design science" and called for a "design revolution" to produce a "world society" with "world architects, led by the world architectural students." Through the American youth culture, Fuller offered a rear-guard apolitical alternative agenda to realign incendiary, radical, and political actions. "Design-in" would replace "Sit-in." In particular, *The Whole Earth Catalogue* movement, as a segment of the counter culture appropriated Fuller's ideology of technology, and transformed it into an emblematic form of personal technology and control. In addition, under the aegis of counter culture, the geodesic structuring became a didactic tool for instructing a broad range of holistic practices. Among both the disenfranchised urban poor and the counter culture, the marginality of the dome artifact was seen as its redeeming value.

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[300]Ltr.9/8/67 E.J. Applewhite to RBF in BFI-CR308.

Fuller's project was also susceptible to and openly engendered unscrupulous religion-cultist and scientistic appropriations. The cult-value of Fuller's geodesic artifacts followed upon the heel of his heightened persona as a public philosopher; his revivification of *EG* into *Synergetics* and his concurrent representation of it as an expansive tool in the physical and the mental landscapes. While Fuller's geodesic artifacts previously oscillated between war and propaganda, it now looms between questionable personal and communal therapy.

The symbolic significance of Fuller's geodesic project received its highest profile as the American Pavilion at the Montreal Expo '67 World Fair. Fuller intended the project to be a geoscope to illustrate the prospects of a framework for personal control through industrial and natural technologies. The geoscope as an exemplar of geodesic dome application would have collapsed Fuller's personal vision of the manifest destiny of America as a world society. Still, the revised design achieved this goal, and more. At a moment of domestic turbulence and international strife, the nation revisited some of the symbolic tropes of Fuller's earlier Fair domes, namely: that of sublimation, understatement, transcendence and wholeness. These elements were again rallied in a Cold War affront to the Soviet world posturing and presentation.

Ch. 5 A Life and Artifact Entwined – An Appraisal of Fuller's Geodesic Enterprises

Call me TRIMTAB.

- Epitaph on Fuller's gravestone in Mt. Auburn (Massachusetts) cemetery.

Fuller passed away on 1 July 1983, at the age of 87 in 1983, a few days before his wife Anne Fuller. The three words forming the epitaph on Fuller's gravestone are a succinct summary of how Fuller viewed and represented his creative life.

A trim tab is a quintessential object of supra-efficiency [Fig.5.01]. Rather unassuming in appearance and size, it affects the maneuverability of the rudder under the slightest of pressure. Though never addressing himself directly as a human trim tab, Fuller suggested that his work and experiences were metaphorical embodiment of a tool to arrest Spaceship Earth, the metaphorical "environmental ship," that was going astray. Fuller proffered the connection in this way:

> I can't help but think in those physical experiences (and)... reduce (them) to working practice... as 'trim tab'.[1]

To understand Fuller's confidence in his artifacts in general, and his geodesic technology in particular, one need to return to Fuller's view of and confidence in technology.

For whatever reasons, whether they were naive, idealistic or ideological, Fuller faithfully believed that industry somehow would remain chaste amidst the excesses of finance, business and politics. The fervent intensity of new industrial forces to be released in consumption would be socially redemptive. Part of this confidence was sited in the nature of his industrial apprenticeships. In his own terms, at least, they were characterized by distancing. He saw the products of industry with detachment and operated on them with scientific scrutiny. Such was his abstract rendition of industry:

> Industry represents the scientific inter-service of all people. Industry has through scientific economy and inanimate power harnessing established an infinite credit. The kernel

[1] Author's Transcript of "Fuller Structure of the Universe," Videotape of Fuller and Maharishi Mahesh Yogi at The First International Symposium of the Science of Creative Intelligence, Univ. of Mass., Amherst, July 21, 1971.

of government truly representative of the people, through press unified industry, has harnessed permanent credit which need never be 'paid up' and therefore need never be 'bonded.'[2]

Under such objectification, it is not difficult to see why Fuller equated the efficiency of Ford the man with the way technology instrumentalizes the efficiency of natural phenomena. Thus, Fuller proposed that, in principle, Ford's enterprise is a "thermionic valve."[3] Metaphorically, Ford's car-manufacturing regulated flows of matter and energy. Thus, although industry is a potentially social liberating force, Fuller explicated its effect on humans in a matter-of-fact manner.

In this sense, the ambivalence of the geodesics as simultaneously an artifact of peace and war was rooted in this objectification. Fuller's own experience of both World Wars was, to say the least, placid and distant. However, he had attempted to sketch how he was either in the thick of the conflicts or was an eye-witness.[4] If he did experience conflict it was from a remote distance, mediated by the inanimate senses of the wireless and the radar. For Fuller, war was an evil necessity, part of a human evolutionary process, albeit a momentary failure of human vision. Despite the growth of man's productive abilities, Fuller posed:

> Has man the mind, imagination and brains to cope with his over all potential in such a manner as to afford a peaceful world interplay of his magnificent productive ability? Is it not precisely a lack of such ability to date that essentially caused both Word Wars I and II?[5]

Wars were, for Fuller, harbingers of higher trends unknown to or unseen by the perpetrators, beyond the tragic appearances of maim and death. His own intellectual distillation of bloodletting was to produce a message of hope. Still, in offering "mortal world emergency"[6] as a euphemism for WW I, Fuller significantly de-politicized the war, considered by radicals and progressives of the period to be a conflict of imperialism.

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[2]R. Buckminster Fuller, "Unprinted Appendix to 'What is the Future of Architecture?'," *Architectural Forum*, August 1932 (Copy in BFI-CR43).

[3]R. Buckminster Fuller, "Motion Economics and Contact Economy," May 1943, BFI-MSS, p.92. Henceforth as "Motion Economics."

[4]Besides the "patriotism" of Fuller's camp days at Plattsburg-New York, one biographer described the intensity of emotions welling as he witnessed the fateful Cunarder Lusitania embarking on its fateful voyage to England (A. Hatch, *At Home in the Universe*, p.47). Fuller personally chronicled that the USS Eagle#15 which he commanded, was "officially credited with sinking (a) German sub off N.Y. approaches in 1922" (See "Memorandum of Activities - R. Buckminster Fuller," in *Dymaxion Index 1927-53*, ca.1953, p.1).

[5]"'Life' of R. Buckminster Fuller," BFI-MSS, Dec. 1941-Jan. 1942, p.10.

Fuller's general ambivalence towards war throughout his life contained three of the elements as which James Robertson identified, form the modern American mythology of war.[7] First, Fuller saw war as an instrument of American progress, bringing unity, efficiency, prosperity and security. His Navy experiences in WW I bore testimony to this, and it was the sensibility which connected Fuller to his subsequent "technocratic persuasion." Technocracy, ensuing from the experiences of the war, promised to change America from an unruly democracy. Second, war was viewed as chaotic and destructive, thus perverting American destiny in the world. This was evident in Fuller's pacifist position, modeled almost after Henry Ford, during the Dymaxion years. Finally, war as a parenthetical experience was also viewed as outside and removed from normal, peaceful, non-military democratic lives. Thus, Fuller offered the DDM-Fuller House project under the prospects of new demographic patterns, increased marriages and babies and returning GIs in the midst of WW II.[8] Similarly, *EG*, before the start of the geodesic project was cited in the logistic potentials for the Navy Department.[9] In the early fifties, Fuller's collaborator, D. Stuart, offered to the Air Force the use of *EG* as a graphic analyzer to generate a "specially constructed map overlay which would furnish answers to various interception problems by visual inspection." This tool would "aid in the analysis of air defense systems by relieving the analyst of numerous calculations and manipulations."[10]

Fuller's propensity for objectification was not new. This practice gradually emerged from his early industrial apprenticeships. First, there was his "generalist" education of the Navy (1917-1922). Earlier, there was a nine-month stint, among a community of toilers, at the Canadian-Connecticut Cotton Mills in Sheerbrooke-Canada (1913-14).

Fuller publicly used his apprenticeship in the Navy as a paradigm of education to contradistinguish the gentility and the old-style of his Harvard education. The new elites of Harvard were specialists in contrast to the generalists nurtured by the Navy. Fuller explained the significance of his informal education:

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[6] R. Buckminster Fuller, "Designing a New Industry," p.18.
[7] See James Robertson, *American Myth, American Reality*, New York: Hill & Wang, 1980, p.325.
[8] R. Buckminster Fuller, "Designing a New Industry," p.19.
[9] Ltr.6/11/46 RBF to W.W. Rankin in BFI-HEv4. See also E.J. Applewhite, "An Account of R. Buckminster Fuller of His Relation with Scientists during the Development of His Energetic Geometry," n.d., BFI-MSS 74.09.02, p.4.
[10] Ltr.n.d. D. Stuart to G. Cox (Dept. of Mathematical Statistics, Univ. of North Carolina) in BFI-EJA Green.

They had to get you absolutely comprehensivists. I found it absolutely exciting -- that they have Harvard and the land Universities going in for specialization, the Navy went in exactly the opposite direction, they picked out the very brightest of every class, and first they sent them to the Bureau of Ships -- which is a series of ships itself, and they did everything they could to make the naval officer a COMPREHENSIVIST.[11]

However this general enthusiasm for group work and a bias towards romantic communal spirit in later life are in contrast to the discomfort that Fuller expressed while training at Annapolis:

> This (is) a huge class. The last one was only 300, but this one has 550 Deck affairs, 150 Engineers and 200 paymasters, total 900. I felt rather lost.[12]

Indeed, both the Navy and the mill were sites insidious authority and hierarchy. The authority of a ship's captain took the form of logistical reconnaissance, geologistics and control; that of the millwright in the coordinated inter-workings of the machine parts in the mill. In his softened portrayal and deep abstraction of the Navy especially, Fuller also ably subdued its imperial and militaristic legacy. Even as the supremacy of these institutions was eventually phased out by radio communication and competitive man-made fabric respectively, they were seminal sources of tutelage in authority.

Fulle , remnant "collectivist" sensibility in his one-world town, presented as "world commonwealth" in *4D Timelock*, was shaped more by the promises of the technological fruit rather than a critical evaluation of its cause. In any case, for Fuller, industry as an all-encompassing order was a better form of human institution than politics. Fuller's positive analysis of industry and the military thus omitted other significant factors which, as identified by the historian David Noble, had fostered the bonds of technology-corporate capitalism. These included America's increasingly dominant military position in the world which enabled her access to global markets and industrial resources; the politicization of her economy and the importance of the state as its stabilizing force; and finally, the deliberate creation of a consumer culture, through advertising, to absorb and defuse potentially revolutionary energies.[13]

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[11]R. Buckminster Fuller, "Everything I know," Transcript of Tape 13A, n.d. (ca. 1970s), BFI-Archives.
[12]Ltr.6/12/18 RBF to Anne Fuller in BFI-CR74.
[13]David F. Noble, *America by Design (Science, Technology, and the Rise of Corporate Capitalism)*, New York: Alfred A. Knopf, 1977.

To understand Fuller's rendition of technology, it is instructive to return to his rendition of the legacies of Henry Ford.

5.1. A Fordist Sensibility towards Technology

Fuller had a sophisticated appreciation for the technical implication of the industry that Ford initiated. This appreciation was markedly different from the instrumental or ideological Fordism that had captivated the European socialists. Ford, Fuller wrote in "Designing a New Industry," created a "mobile (material) inventory."

With the perfection of industrial techniques, Fuller recognized that the critical facilitating factor in mechanical production was one of control. This entailed the monitoring of movement in information on production and distribution. For Fuller, this responsive industrial control was a vivid form of self-reliance and a large-scale model of autonomy and orchestration. For this reason, Fuller suggested that the totality of Ford's industry - this capacity to encompass all the industrial stages - qualified Ford "not only (as) a machine-symphony-composing-genius ranking with the greatest of musical composers but...also a conductor."[14] Fuller was among the first to recognize that after Ford, the sacrosanct necessity for the centralization of production had been eclipsed, and that the decentralization of industry and consumption had radical implications. For Fuller, this meant a "death-blow" to warehousing and its associated festering interests, including real estate and the politics of local market.[15] Ironically, Ford's own decentralizing agenda was buoyed by his interest in a "village industry" to remove the hovel in living conditions caused by the big business of concentration. Ford also argued that slow transportation had detrimental effects on modern business and modern life; and thus, there was a necessity for "floating" both finished and raw materials.[16] The ensuing logistics demand heightened the need for standardized parts to take advantage of the lowest freight classification.

Like Ford's industry, the design impetus in Fuller's enterprises from 4D-Dymaxion House, DDM-Fuller House to geodesic structures was driven by a "world wide motion."[17] The flyable and portable geodesic structures epitomized independence from available material and the potential, long term commitment of resources. Likewise, *EG* as his purported blueprint and

[14]R. Buckminster Fuller, "Motion Economics," p.28.
[15]R. Buckminster Fuller, *Nine Chains*, p.220.
[16]H. Ford, *Today and Tomorrow*, p.119.
[17]R. Buckminster Fuller, "Designing a New Industry," p.26.

template for replication of nature's principles which took the abstractions of chord factors and central angles, could be conveyed everywhere. This last strategy echoed Henry Ford's technique of design control. Measurement, as in the use of precision as a standard, allowed manufacturing to be decentralized and assemblage to occur at many places. Ford described how the necessity to make gauges within reach of every machine shop and toolmaker prompted him to acquire the manufacturing rights of Carl Johansson's "solid master block gauges," which enabled the nearest possible to a perfect theoretical plane.[18]

5.1.1. A Puritanical View of Industrial Capitalism

> (Most inventors) go & save a lot of time for the world & then go & cash in on it by selfish indulgence, which is so wasteful of the all Mighty fine Machine which God has placed in our safe-keeping - the human body. Ford & (Carnegie) haven't cashed in at all & they are in command of capital, acquired command by thinking & saving for the world.[19]

For Fuller and most Americans, Henry Ford was a representative man of American civilization, a man full of integrity.[20] He inherited Ford's disdain for financial-speculative capitalism and unionism. It also highlighted the idealism of his own puritanical roots. While praises were reserved for Ford as a systematizer of industry and as a man with the "macroscopic view," Fuller held in disdain J. P. Morgan, who for all intentions and purposes shared similar attributes with Ford.[21] Yet since the late nineteenth century, industry expanded largely because it was increasingly entwined with business and speculations. How was it possible that Fuller saw these activities as separate?

One could suggest that this purposeful distinction was a form of self-denial. It established a high moral ground for his project and justified his failed enterprises starting with Stockade, followed by the General House coup, the DDM-Fuller House projects and the geodesic enterprises. Thus, speculative interests were continuously raised to explain how his creative works were subsumed, manipulated or compromised by others. Fuller consistently maintained that business was parasitic because it drew its surplus from industrial activities, and exploited the

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[18]H. Ford, *Today and Tomorrow*, pp.81-84.

[19]R. Buckminster Fuller, "4D File Manuscript MSS 28.01.01, Folder IX," [Group IV notes] in BFI-CR64.

[20]See also L. Steinman, *Made in America (Science, Technology and American Modernist Poets)*, New Haven: Yale University Press, 1987, p.64.

[21]Both *SHELTER* and *Nine Chains* are replete with criticisms of J.P. Morgan and speculative capitalism. According to Hatch, Fuller had a direct encounter with Morgan's excesses when Morgan phased out Kelly-Springfield Trucks in 1922, despite Fuller's efforts to bring in more business (A. Hatch, *At Home in the Universe*, p.71).

fragile prototyping processes, like his own, in the early stages.[22] However, profit per se was not bad -- since like Henry Ford, Fuller viewed this as evidence of "public trust." It illustrated the reciprocal support by public, and showed the redeeming social benefits of industry. Henry Ford expressed the connections this way:

> The public built our industries through buying our product. The public subscribed, not through stock or bonds, but by purchasing the commodities which we manufacture and offer for sale.
> ... The money is the public's money, and the public, having confidence enough in our product to pay the money to us, is entitled to benefit by its confidence. We have no right to charge the public with interests on its own money.[23]

For Fuller, J.P. Morgan's practice was a holdover of the "old" business that depended on the "static of the past." Ford, on the other hand, represented a new business based on science and industry. Vision rather than awaited instructions or opportunities drove it on how to act. While J.P. Morgan was a prophet with a vision of a new organized America, Ford extended that vision across national boundaries. The industry of Ford ended social isolation and access to more amusements for restless American youth and African Americans; provided cheaper transport of crops for many farmers and white-collar working men of low-income. Ford, as industry personified, was emancipatory, even if the unions and skilled mechanics continuously criticized the joyless tedium in industry and the factory-line of mere robots. With these views of American business, Fuller surmised that the Morgan-type business was leading American middle-class society down the path of self-annihilation unless it redeemed its course in industry. Ford demonstrated his project in tangible physical artifacts and his industrial operations straddled American ingenuity of rapid make-do, ad hoc invention and the new methods of careful technological planning.

Fuller viewed his enterprises as nascent industries, and even if they were premised on venture capitalism, they were moralistic because it built upon the wealth provided by honest industry. He selectively viewed the base of financial capitalism (Wall Street) as the recirculation of old land-based wealth through railroad securities, government bonds, currency and precious metals; and thus the whole process represented an apogee of profiteering. Fuller assumed that the new industry would remove the middleman and the parasitic agents of financial capitalism and commerce. For this reason, from 4D-Dymaxion projects to his geodesic enterprises, Fuller

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[22]R. Buckminster Fuller, "Unprinted appendix to 'What is the Future of Architecture?'"p.2.
[23]H. Ford, *Today and Tomorrow*, pp.36-37.

implicitly supported a vertical integration from production to merchandising and servicing, and condoning the corporate control of everyday life.

In extolling the virtues of industrial capitalism, Fuller quietly denied the dominant role of finance capital as an agent for merger for the consumer-industry. Yet it was the attractiveness of industry as a market that prompted enthusiastic merger movements and the active roles of finance capital in raising capital for merged businesses. The large volume production, based on less skilled but efficient factory practices and the dependence on machinery, required tremendous capital resources; often affordable only through the consolidations engineered by financiers.[24] Up to the mid-sixties at least, Fuller was silent on big business and provided no extended criticism of its activities per se. Rather, Fuller recognized that most of them grew out of the availability of capital, mostly through corporate bonds and stocks, drawn from wealth accumulated in commerce.

In pursuing his geodesic enterprises, Fuller's tirade against the state and big businesses was carefully chosen only when he felt short-changed of his dues or when he discovered that they had infringed on his proprietary rights. In the mid-sixties, writing to Greenleaf, an old associate of his Sheerbrooke Mills' day, Fuller confided:

> I am tremendously interested in the possibility of getting myself merged with a major corporation having general world interest. During the last decade I have had a gross income of several million dollars but have been unable to net any important amount of it. I have, however, invested several hundred thousand dollars in taking out world-around patents on a number of my inventions, that is in all but the Communist countries. A world-around patent costs about thirty thousand dollars to take out and many thousands to maintain. I have felt that the shrinking of the earth made local patents of little worth, i.e., U.S.A. only. I felt that world-around patents covering not only my land structures but my Submarine Island and potential space structures together with my patents on cartography and other items *might have important tactical value to the major American corporations who are now setting about to develop world positions or already have world positions*[25](Itl., my emphasis).

Greenleaf was not an ordinary friend. From Fuller's praises of him, Greenleaf had played a pivotal role in the recent Martin-Marietta[26] corporate merger, which Fuller characterized as "a

[24]Walter Licht, *Industrializing America*, Baltimore: John Hopkins University Press, 1995, pp.160-161.

[25]Ltr.11/22/63 RBF to N.B. Greenleaf (Pompano Beach-Fla.) in BFI-CR249.

[26]The Martin Co. merged with American-Marietta in October 1961, forming the Martin-Marietta Corpn. From the sixties through the nineties, the corporation was one of the leading U.S. defense contractors and was the principal industrial contractor for Project Viking in 1969. In March 1995, Lockheed Corpn. and Martin Marietta Corpn. merged to form a $23 million company called Lockheed Martin, employing approximately 170,000 people nationwide (See *Buildings On Line Magazine*, Sept. 1996, http://www.buildingsmag.com/magazine/nov.1996/article109.html).

major twentieth century work of art." Despite professing the snags in his dome enterprises, Fuller offered that there were "healthy indications" that the "mass production phase" of the geodesic dome was imminent. Fuller cautiously broached the possibility of a Greenleaf-led initiative to buy over his assets:

> I am now 68 years old and if I was to die, the royalties on the domes and on my books would run for a while but, in addition to minor real estate, our home here in Maine payed(sic) for and no mortgages; I have been unable to accumulate any important estate except in the form of several hundreds of domestic and foreign patents. I have accumulated these with the intuition that before I die their existence would prove of *tactical advantage to some world operating corporation or a merging corporation whose general morality, aspirations and concept of service might inspire me to vest my advantage with them* ... (B)ecause I have felt that the Martin Marietta Corporation constituted *a potential in the direction of just such a world development,* I am relating my situation to you. Because you have mentioned the merger subject and have asked that I have your merging capabilities in mind, I'd not feel that I am transgressing my own non-promotion principles in responding to your letter in this manner[27] (Itl., my emphasis).

It is not clear if Greenleaf made or could make any counter-proposal that would have been satisfactory to Fuller. Nevertheless, Fuller's confidence in responsible world corporations to redeem his project remained, unabated. He explained to Robertson that this was the basis for the fortification of his "vital world patent portfolio," even in the middle of his financial crunch:

> I do not wish to let any of the protection subside for lack of payment of the maintenance taxes and foreign attorney fees in any of the countries until I have had a chance to disclose this patent array to responsible executives of the major corporations now expanding in world activities.[28]

Fuller's offer to Greenleaf illustrated his enthusiasm for world corporations to advance his project. It also affirmed his acceptance of their legitimate existence as a public-service corporate system. While Fuller had envisioned that the 4D-Dymaxion project would create an industry and a worker's commonwealth without castes and specialties, his geodesic technology promised, at least among counter-culture practices, to surmount extraneous specialties or technical castes in building. Both phases of his enterprise respectively represented projects for self-actualization in the dawn and in the thick of post-industrial America.

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[27]Ltr.11/22/63 RBF to N.B. Greenleaf (Pompano Beach-Fla.) in BFI-CR249.
[28]Ltr.2/24/65 RBF to D. Robertson in BFI-CR267.

5.2. Tools, Frontiers and Abundance in American Culture

> No great scientific discovery was ever evolved by formula. But by observation, reason & thinking applied to everyday facts ... Steam– (lead from) the kitchen kettle.... (Benjamin Franklin's) almanac (is) nothing but an unbottling(sic) of the truth, that it might flow majestically from him.[29]

By citing Benjamin Franklin, Edison and Burbank as exemplars of "New World artists," Fuller continually pursued the theme of a self-taught tinkerer versus the trained technician working along formulaic lines. With Fuller, the old-fashioned Yankee ingenuity was transformed into visionary futurism. Betty Franks thus argued that Fuller exemplified "faith in the individual whose genius would provide the knowledge necessary to alter the future." This category of futurism contrasted with the humanist variety that treated "utopia" as an objective to be achieved through "personal transformation."[30]

5.2.1. A world of Neutral, Transcendental and Redemptive Tools

For Fuller, the knowledge necessary to alter the future was embodied in tools. Collectively, tools represented a form of immortalized human agency. Besides his confidence in his self-agency, Fuller believed that his artifacts would produce a new world which bypassed politics and social reforms. He elevated and redeemed his world of artifacts as evidence of "direct contact with realities."[31] Because tools encapsulated "generalized principles," Fuller assumed that they were neutral, and by extension, an egalitarian world could be created from their products and organizations as such. Parenthetically ahistorical and distilled across time and place, Fuller's own tools, whether as 4D-Dymaxion House or his geodesic artifacts, were evidence of the adeptness of technology. Because they tapped universal principles, they also defied exhaustion. Rather than seeing tools as mere ends, Fuller noted their reproductive capacities:

> Technology was a basic resource that improved, or self-multiplied, with each repeated opportunity of its application.[32]

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[29] R. B. Fuller, "4D File Manuscript MSS 28.01.01, Folder VI," BFI-CR64.

[30] B. Franks, "Futurists and the American Dream: A History of Contemporary Futurist Thought," Doctor of Arts Dissertation, Carnegie-Mellon University, 1985, p.216.

[31] R.W. Marks, *The Dymaxion World*, p.17.

[32] R. Buckminster Fuller, *The Buckminster Fuller Reader*, p.45.

The attractiveness of tools as agents of social change was both personal and cultural. Fuller cultivated a belief that the world of objects and things continually redeemed his moments of personal dismay and gloom. For instance, Fuller recast the significance of his trophies in athletics from his Milton days:

> 4th July 1910. 1/2mile winning which gave Bucky great confidence in the summer in which his father died.[33]

After his Harvard debacle, he recalled how the magnificent orchestration of machines at the Sheerbrooke mills was instructive of a type of moral education. Through its design, it showed the prospects of transforming "inherent failure" of mankind into "inherent success."[34] Fuller also felt the tangibility of all thoughts was in the objects of the physical world. His panpsychic trait was first revealed in a 1932 letter to his wife Anne, written during his distressful experience with the Pierce Foundation in Buffalo:

> All our sorrows' perplexities, inspirations seem to wait me at the outer of that bridge (Brooklyn). From that center the city on all sides has changed greatly, our lives even more. The bridge has never dwarfed however during those changes as so many of the landmarks of our memory do.[35]

Writing six years later, Fuller recalled, in second person, the meaning of the Brooklyn Bridge:

> In (Fuller's) most distressed moments, he goes to the center of the Brooklyn Bridge and stands there, because it so intelligently wrought, and because it gets you high up above unintelligently-wrought structures. He likes to feel its animation. The plate at its central joint is greased. Standing on it, he can feel it spread as a train passes. The bridge is ALIVE.[36]

In the seventies, Fuller reported that Brooklyn bridge "was a cathedral to him," and "the place where (he) could get closest to the Almighty."[37] Besides calming his private tribulations, the transcendence of tools dwarfed the temporality of all known social reforms. He expressed their efficacy and immortality in these terms:

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[33]Undated Notes on photograph (verso), BFI Photo-file FA-2, ca.1910.

[34]A. Hatch, *At Home in the Universe*, p.35.

[35]Ltr.8/22/32 RBF to A. Fuller in BFI-CR73.

[36]R. Buckminster Fuller, "'Notes' (to Joe Byrant)," ca. 1939, BFI-CR46, p.1.

[37]*New York Times*, ca.1971, quoted in K.M. Conrad's "Technocratic Persuasion," p.191.

> I thought there might be some times when the invention might be a mathematical formula. *But it was something outside of you -- something you could leave behind -- you could go out of the room and nobody would ever know who you were if you had been there,* but if they used it they would get results[38] (Itl., my emphasis).

Tools, as extensions of man, according to Fuller, were transcendental. By coordinating these tools in industry and other settings, fragmented human tasks could be translated into "organic workable complex(es)" and produced the external organisms of man. Fuller's theory of the social effects of tools as an "extension of man," preceded Marshall McLuhan's variety, in the theory of media (*Understanding Media*, 1965). This aspect of Fuller's ideas about tools or his influence on McLuhan is generally not recognized. Even McLuhan's "global village" of social-political implosion and "heightened human awareness" enabled by electronics was prefigured in Fuller's "One-World Town" of 1938.

Fuller explained that the success of tools among man was teleological -- they augmented man's "middle size" in the universe of things by extending his perceptual and conceptual range. More than a complementary relationship, Fuller further suggested that tools co-evolved with man. Fuller described the reproduction of tools as the reproduction of man in this way:

> If the ingenuity of the individual is realistically nurtured a whole new pattern of social evolution will be added to human history. As fast as individuals are displaced as physical production machines by the far more effecting processes of automation, they and ... their progeny will be employed in the increasing ranges of research and in developing...improved prototypes of mechanized functions ...[39]

Thus, contrary to Conrad's thesis linking Fuller's technological determinism to technocracy, Fuller's project escaped the narrow technocratic premise that social ills were solvable only by tools.[40] Still, Fuller, throughout his life, advanced many "technocratic" type statements – including one, in which he painted a scenario of dumping all the machinery into the sea, resulting in two billion people dying of starvation.[41]

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[38] R. Buckminster Fuller, "San Quentin Speech," Transcript of Speech, n.d., (ca. 1958) p.13.

[39] R. Buckminster Fuller, "Initiative of the Individual in World Industrialization," BFI-MSS in CR153.

[40] K.M. Conrad, "Technocratic Persuasion," p.140.

[41] See "Transcript of Speech at ICOGRADA Congress (Bled, Yugoslavia)," 1966, BFI-MSS 66.07.02, p.21.

5.2.2. The Efficacy of Tools and Machines

Fuller's romantic view of individual agency was supported, in no small part, by his own experiences among the burgeoning company of the well-meaning elites, which included technicians, professionals and managers. However, the centrality of tools to empower individual capacities and to effect social change was not a figment of his imagination. Rather, the idea has perennial echoes in American culture and traits. Fuller's own confidence in tools started with the heroic myth of Charles Lindbergh and his trans-Atlantic crossing. In his writings, he made numerous references to Lindbergh's legendary solo-flight, with the "Spirit of St. Louis," from New York to Paris.[42]

Fuller used Lindbergh and his machine to symbolically charge and instruct his own world-around undertakings at several levels. One, ensuing from James Robertson's study of American myths, was that Lindbergh and his machine represented a couplet in perfect balance. The machine created the role of the new pioneer and the new frontier:

> (Lindbergh's "Lone Eagle") made it possible for Americans to believe that the complex machinery of impersonal industrial society was at the disposal of, and dependent on, the virtues of the lonely, independent free American.[43]

Robertson further pointed out that Lindbergh's feat was a penultimate demonstration of escape "from institutions, from the forms of society, and from limitations put upon the free individual." Finally, in the man-machine nexus, there was also the "acceptance of the discipline of the machine" and "the achievement of the individual within a context of which he was only a part." For these reasons, one could say, that in his time, Lindbergh demonstrated vividly a new world-frontier, and the new discipline required of the new man.

Fuller's rejoinder to Lindbergh's achievement, using his broad cornucopia of artifacts, was to view the world first as an "air-ocean," and later as Spaceship Earth. The corresponding projects were to create portable shelter-machines for self-sufficiency of the individual, and a navigational manual out of his technological aphorisms. In the thirties, these were in the form of multi-deck 4D Towers for integrating "the inaccessible places," into a "One World Town." From

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[42]See *4D Timelock* (1970); "Cutting the Metabilical Cord," *Saturday Review/World*, 21 Sept. 1974 and Appendix II in *Critical Path*, New York: St. Martin's Press, 1981.
[43]J. Robertson, *American Myth, American Reality*, p.200.

the fifties and through the sixties, the geodesic artifacts, initially as flyable geodesic domes, and later as floating cities, were poised for colonizing all available world frontiers.

The fascination with the social efficacy of tools is a pivotal component of technological utopianism. In America, this optimistic view of tools was worked ideologically into a distinctive position to distinguish American historical destiny from the rest of the world. Under the rubric of American exceptionalism, America's destiny hinged on the fecundity of its landscapes where tools, and the ingenuity of its people in using tools, augmented nature's gifts. It was this abundance created by tools and landscapes, as a political ramification of American exceptionalism, which insulated the America populace from wide varieties of political struggles and revolutions that had ravaged the Old World.

The ideology of survival engendered by the frontier also underpinned American exceptionalism. Harvey Goldberg argued that it was "America's de facto philosophy of history" long before Frederick Jackson Turner's 1893 iconoclastic essay, "The Significance of the Frontier in American History."[44] Similarly, Ray Allen Billington evoked the frontier legacy to account for the transmutation of Americans from their European ancestors.[45]

Fuller explicitly believed in the exceptionalism of the American technological position, which would immunize it from class struggle. Utopia would result from evolutionary and not through revolutionary changes.[46] Further, he believed that America as the New World provided the vision of a new society rather than one based on preestablished cultural and linguistic bonds; and its national identity was constituted on a system of universal beliefs.[47] However, his antipathy towards politics was not rhetorical. His blueprint was intended to be actual; only made utopic in appearence by technological time-lag. In the late sixties, his geodesic artifacts and his boosterism for tools, respectively visualized and articulated a project for realizing the social potentiality in ones' marginality.

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[44]Harvey Goldberg, *American Radicals, Some problems and Personalities*, New York: Monthly Review, 1969, p.3. Henceforth as *American Radicals*.

[45]R.A. Billington, *America's Frontier Heritage*, Albuquerque: University of New Mexico Press, 1974, p.vi.

[46]See also H. Segal's discussion of the conservatism in technological utopianism in *Technological Utopianism in American Culture*, Chicago: The University of Chicago Press, 1985, p.6.

[47]R. Flacks, *Making History, The American Left and the American Mind*, N.Y.: Columbia University Press, 1988, p.99.

American exceptionalism, the American historian David Potter suggested, essentially bypassed and overlapped rather than solved political problems. Against European radicalism with a highly articulated rationale and a fully developed doctrinal system, American exceptionalism was "incredibly muddled, sentimental, and superficial." Rather than confronting a set of fixed social problems which required disciplined intelligence for a solution, the flux in American experiences created a new set of adaptations:

> And it is by this stratagem of refusing to accept the factors given, of *drawing on nature's surplus and on technology's tricks*, that America has often dealt with her problems of social reform.[48](Id., my emphasis).

Fuller's public discourses and construction of his practices as strategies for regeneration and recuperation of social lesions echoed these assumptions explicitly. He characterized the milieu of the late twenties, when he embarked on his Dymaxion projects, like that of a frontier:

> I came to maturity in the accelerating industrial frontier economy opening chapters of new magnitude upon the shores of the American continent.[49]

His speculative world history is an unadulterated version of American exceptionalism. Fuller believed that America was the natural heir to "the industrial frontier wave" because of its economic competitiveness. The original sources of this wave that had unfurled in Asia and Europe, was encumbered and compromised by regulations. In comparing America and Europe, Fuller noted how "the wide open land expanse" and the ensuing "vast capital expenditure" set the context for American franchises and private monopolies in transportation and communication. Though critical of this market arrangement, he was cognizant of its consequent world-around technological edge over the old-style European socialization and governmental control of inter-locality communication facilities.[50] Under the threat of world communism, Fuller proposed that the technological imperatives in American exceptionalism would reform the ideological limits of communism. It would replace its agenda of "agrarian era's revolutionary approach to serfdom" with the scientist's rules of progress and "science's leadership of the popular cause."[51]

48D. Potter, *People of Abundance, Economic Character and the American Character*, Chicago: University of Chicago Press, 1954, p.12.

49 *The Buckminster Fuller Reader*, p.60.

50R. Buckminster Fuller, *Nine Chains*, p.292.

51Ibid., p.269.

5.2.3. Geodesic Projects in a Restless Frontier

The physical and metaphorical frontier was a socially, politically and symbolically productive site for Fuller's rhetoric and artifactual productions. The geodesic structure was, in the first place, an offering of Fuller's proof of doing "more with less," thus perpetuating the social-political objectives of abundance in the physical sense. Programmatically as an "energy valve," the geodesic artifacts tapped directly into a universal energy source, unshackled by national boundaries or political affiliations. Visually, the lightness and transparency of geodesic artifacts simulated the reduction of waste and the dissolution of redundancy. Their portability and ephemerality also captured the motif of physical escape. They dramatized what architectural historian Vincent Scully identified as an American trait, a "primordial restlessness." Scully noted how, for example, the Dymaxion House, along with other recent industrial artifacts, reinforced the American ethos of movement:

> The high-pommeled saddle trappings of the Plain Indians and the fins of the 1950's (Plymouth) are not so far apart in effect and intention; nor are the wind adjusted flapped teepee of the plains and Buckminster Fuller's Dymaxion House rotating on its mast: mobile both, unfixed to the ground.[52]

Kenneth Frampton similarly reiterated how the domicile dome as a "free-standing implement" could be "readily associated with the American frontier tradition of rugged individualism."[53] But neither Frampton nor Scully, recognized as Potter did, that the perception, reception and social implications of mobility were socially situated, affecting native-born Americans differently from the new immigrants to America.[54] Nevertheless, for Fuller, in post-industrial America, the mass-produced consumer objects substituted for previously imagined vehicles of transcendence and escape.

Fuller himself argued that as the car assumed the status of a "migratory glassed-in porch" and the airplane became "a powered, high-speed room," individuals needed only to evaluate their existence by how effectively they "plug into the landscape."[55] These new spaces began to challenge the spatial and experiential roles previously fulfilled by architecture and the city. For this reason, Fuller's plea for architecture to be considered as tools and cities as portable

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[52]Vincent Scully, *American Architecture and Urbanism*, New York, N.Y.: Praeger Publishers Inc., 1969, p.19.
[53]See "I tecnocrati della Pax Americana: Wachsmann & Fuller," *Casabella*, Jan.-Feb. 1988, p.119.
[54]D. Potter, *People of Abundance*, p.95.
[55]"Personality," *Times*, 19 Jan. 1953, p.39.

environments found ready and popular audiences among which included British Archigram.[56] For Peter Cook and Cedric Price, the English arbitrators of Fuller's ideas and artifacts, the mass-produced components, the ephemeral tools and experiences provided a basis for their technological phantasmagoria and consumers' futurism. *Archigram 3* (Autumn 1963) rendered the geodesic structures almost iconic by deploying them generously in countless "expendable" assemblages. The geodesic structure was a representation of "user-habitat" which complemented the pervasive obsolescence in the "throw-away city" [Fig.5.02].

5.2.4. Prefiguring and Nurturing a New Culture

(The pioneer) was only incidentally living in the present. The future filled his mind.[57]

For Fuller, tools, their niches and the attending industrial creeds that surrounded them were prefigurations of a new culture. In Fuller's self-history, the contrast between his education at Harvard (1913-1917) and his apprenticeship in the cotton mill which he described as his "first informal separation," is significant. While he cast Harvard as "distant from the real," the mill was, on the other hand, a prefiguration of a different type of social relationship. In contradistinction to the gentility of Harvard, the mill represented an alternative world to the corrupt world of commerce. Among the "toilers," Fuller claimed he found an authentic way of making and adding value to tangible objects. The experience was:

> a dawning awareness of a major economic pattern factor-that of *effective 'addition of value (or wealth) by manufacture'*, effected between raw and finished goods, and gained by the rich synergetic admixture of technology and energy[58] (Itl., my emphasis).

The machine shops and laboratories were exemplars of a specially created new world of withdrawal. Here, as intensified niches of "outsiders," Hughes proposed, the hostilities towards and ridicules of new futures without revolutions were warded off.[59] Fuller similarly represented the site for his geodesic works by invariably calling them "architecture out of the laboratory," "live frontier undertaking" and "frontiers of creative thought."[60] His geodesic enterprises were

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[56]See Ltr.3/12/65 P. Cook (Archigram) to RBF in BFI-CR258: thanking Fuller for spending time looking at Archigram's works & commenting on them.

[57]D. Potter, *People of Abundance*, p.151.

[58]R. Buckminster Fuller, *Ideas & Integrities*, p.23.

[59]T. Hughes, *American Genesis (A Century of Invention and Technological Enthusiasm 1870-1970)*, New York: Viking Penguin, 1989, p.24. Henceforth as *American Genesis*.

[60]See Ltr.7/24/49 RBF to Lawrence Anderson in BFI-CR136 and also Ltr.9/18/48 RBF to K. Snelson in EJA-Green.

collectively his "frontier campaign."[61] Finally, with respect to the World Games conducted in New York City (June 1969), Fuller observed: "We were working at the frontier and each student was working at his frontier."

The ascendancy of the positions of the machine shops and laboratories in public consciousness stemmed from their supposed transparency, efficiency and objectivity. These qualities constituted a new sanctified morality, supposedly created from within and manifested outwards. Fuller himself had likened the history of machines and factory designs as "an inside-out radiant one" as opposed to the regressive "outside-in" of human shelters:

> Not understanding himself as physically a machine, man has failed to extend radiantly from his machine-self with efficiency that he has devoted to his industrial mechanisms, viewing which he has had greater perspective, and relative to which more daring in prophesy of use-satisfaction.[62]

Fuller's characterization echoed Henry Ford's myth of the factory:

> Just as a clean factory, clean tools, accurate gauges, and precise method of manufacture produce a smooth working, efficient machine, so clear thinking, clean living, square dealing make of an industrial or domestic life a successful one, smooth-running and helpful to everyone concerned.[63]

Adhering to a modernist narrative, the architectural historian Peter Blake portrayed Fuller and his contemporaries, Mies van der Rohe and Konrad Wachsmann, as "technological prophets" in a "chaotic, overpopulated, self-destructive" wilderness.[64] They were, he argued, urgently searching orderliness in a ruined world. However for Fuller, it was less the ruinous world than the romantic primitivism of the frontier which attracted him. Here he nurtured his self-appointed marginality, and accepted it because the role was virtuous and creatively productive. For example, Fuller transformed the lone inventor into a frontier pioneer, and left little doubts that the inventor as a "cosmic" type was the only social type poised to change the world. Fuller advised:

> (D)on't look to your engineers or politicians for leadership. Look to your inventors. The Wright Brothers, Bell, Edison and Marconi utterly changed the environment of man and thus

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[61]Ltr.11/10/54 RBF to W.D. Wenzlau in BFI-CR158.
[62]R. Buckminster Fuller, *Nine Chains*, p.160.
[63]Henry Ford, *My Philosophy of Industry* New York: Coward-McCann Inc., 1929, p.37.
[64]Peter Blake, *No Place Like Utopia* (Modern Architecture and the Company We Kept), New York: Alfred A. Knopf, 1973, p.96.

the lives of humanity on Earth. They had no commission, license, nor approval of politicians or engineers. Nothing in the engineers' textbooks or formulas predicted their inventions or that the inventions would work. The going engineering at the time of their inventions could seemingly prove that none of the inventions work. Politicians are needed but they are an 'accessory-after-the-fact.' They are the 'housekeepers' who must adjust the houses to all the new accessories produced by the inventors.[65]

Throughout his creative life, Fuller thus systematically forged accounts of his hardships, obstacles, and betrayals into resoluteness and optimism to support his appointed role. As an "anticipatory comprehensive designer," Fuller directly fulfilled the survival imperatives for forward planning and self-sufficiency in the frontier. Portraying his life as a "verb," an acting person, Fuller embraced the identity of an evolutionary subject, continuously revealed through future acts rather than through historical contemplation. This life-styling echoed the pioneer's ethos.

5.2.5. A Protean Frontier of Mobility, Rebirth, Vigilance and Abundance

The protean frontier motif was played up with tremendous sophistication by Fuller. Fuller used the frontier trope both as a conceptual space and a geographical entity. Cort observed that this heroic evocation of the frontier was simultaneously a personal and cultural choice. The "violent pioneer strain in three-fourths of the American people," he proposed, had naturalized the frontier as a place of discovery and self-renewal. For Fuller's generation, the choice of a frontier was a rite of passage. Arguing that the polar explorations in the gay-nineties had substantially curbed opportunities for discovery, Fuller's generation was left to discover the essential American characteristic and opportunities in the industrial landscapes:

> (T)he young men of America were obliged to stop looking for frontiers on the visible surfaces of the earth and to look, either inside themselves or inside the nature of life itself for their new frontiers. This was painfully different, for study of the non-visible, non-sensorial world demands self-discipline and brains, not merely lusty health.[66]

Fuller employed the frontier as a conceptual space for escape and to cultivate a new type of subject. Because he undertook research, he was already "on the frontiers of man."[67] While this role was marginal, it was productive. He explained this role to Doxiadis:

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[65] Ltr.6/21/67 RBF to J. McCarthy in BFI-CR300.

[66] D. Cort, "What This Book (No More Second Hand God) is All About," ca. 1940, unpubl. MSS in BFI-HEv36, p.1.

> Because *I live in the frontiers*, what happens to me usually happens to others later on. I have therefore powerful trend prognosticating experiences. It is part of my personal discipline to continue to try to making obsolete all the inventions which I have previously developed by designing more effective and efficient devices for solving the complex and comprehensive world problems.[68]

As a physical space, the frontier was a place for untapped resources and potentials; here, he created and located his artifacts. In this respect, Fuller's intended his "omni-medium" vehicle project, the Dymaxion Car (the DTU, ca. 1932) to be an omni-frontier object that would stream across air, land and sea. By the same token, his "Submarisle, Undersea Island" project (U.S. Patent #3,080,583, granted 12 March 1963) was quintessentially about colonizing the largely uncharted seascape. Publicly, Fuller cultivated the future as frontier with zeal; beginning with his seminal contribution to the research on "The U.S. Frontier" and "U.S. Industrialization," in the February 1940 issue of *Fortune*.[69]

Over the years, however, the frontier became a portable concept for promotion and boosterism of local pride -- the center was where Fuller went, and the frontier was where all future desires were directed. Such was Fuller unabashed characterization of Iran, in a poem dedicated to the Shahbanu of Iran for her patronage of the International Congress of Architect in 1970:

> IRAN-Positioned -- At geographical center -- Of all Earthian peoples --Has traversed by many -- Into and beyond -- The vanishing past -- And will be traversed by many -- Into unknowable future.[70]

In the light of Fuller's own "northwest-spiraling" theory of human civilization, California was a particularly portentous frontier: it represented the "contemporary westward frontier of world-man."[71] In addition, the West Coast of America was a "front line" with:.

> the largest telescope, most bathrooms/capita, airplane industry ... with handsome and young 'magnetically drawn there and eugenically(sic) providing an evolutionary inter-breeding

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67 "Just Give Me a Home in ... a Circle Dome," *The Toronto Daily Star*, 29 Apr. 1967.

68 R. Buckminster Fuller, "Letter to Doxiadis," *Main Currents*, March-April 1969, Vol.25, No. 4, p.95.

69 See "The US Frontier" and "Cure by Chemicals: Sulfanilamide" Sept. 1939, pp.75-77; "The US Frontier" & "Revolution in Radio," Oct. 1939, pp.84-85; "The US Frontier" & "Plywood -- Can Lick its Weight in Steel ...," Jan. 1940.

70 L. Bakthiar & L. Farhad, eds., *The Interaction of Tradition and Technology*, Ministry of Housing and Development, Iran, 1970, p.vii.

71 Fuller's Speech at San Jose State College, Calif., quoted in *WDSD Doc. V*, p.48.

stock', a 'world of abstracting industry and play' where a 'A new flip of the hair and hundreds of millions of woman follow suit.'[72]

The frontier as a category of human construction and American historical imagination was not only pregnant with possibilities of changes but it was also a harbinger of social-political virtues. In building upon the alluring quality of the frontier in the national imagination, Fuller's strategy was far from anachronistic. Fuller constructed the future as a shifting frontier, constantly perched at the edge of civilization. In the late sixties, Youngblood paraphrased Fuller's notion of the frontier as ahistorical, a place of evolution to escape historical process:

> Evolution never repeats history; *evolution is always at the frontier*... Today, however, young people everywhere are beginning to realize that man directly participates in the evolutionary process. Consciously or unconsciously, we now invent the future. Revolution has become radical evolution[73] (Itl., my emphasis).

Rather than ahistorical, the frontier myth of evolution, Cornel West argued, was historically sited. It was based on the "invisible basis" of American fascination with power, vision and newness. Thus, he argued, American imperial conquest and enslavement of New World "savages," or what he termed America's "internal imperialism," served as an antidote for intense class, racial, ethnic and religious antagonisms within the metropolis. Both enabled and constrained the utopian value of migration and mobility in America.[74]

Fuller also argued that the American frontier nurtured constant vigilance and, for that reason, it gave America, the "whipped, stripped outcast," an edge to supersede the imperial British and became a direct beneficiary of her "arrested development." Because of this trait, Fuller cautioned:

> Forgetting its virtues of intense frontiering(sic) activity and continuous trail blazing by covered wagon, railroad, auto, and plane, American society after each successive, new re-winning of liberty invariably and promptly has turned its back upon its future and re-shackled itself again with the strangulation economies and aesthetics of the ever treacherous, withering old world from which progressive immobilization it had, periodically seemingly escaped, and always just in the nick of time.[75]

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[72]R. Buckminster Fuller, "Ballistics of Civilization," ca. 1940, BFI-MSS 40.01.01, p.18.
[73]Gene Youngblood, "The Ecological Revolution," *Los Angeles Free Press*, 10 Apr.1970, p.1.
[74]C. West, *The American Evasion of Philosophy*, Madison, Wis.: University of Wisconsin Press, 1989, p.20.
[75]R. Buckminster Fuller, "Motion Economics,"p.42.

In Fuller's self-history, his family-owned summer-island of Bear Island in Maine bore the immediate appearance of his hypostatized frontier [Fig.5.04]. It was a site of informal self-education and an innocent laboratory of discovery and improvisation, unfettered by society's norms. Fuller skillfully dovetailed his personal experiences of Bear Island with the publicly rendered themes in *Synergetics*. He went so far as to suggest that the lessons of Bear Island were divine provenance to steer the survivalist Spaceship Earth.[76]

As a representation of technology at ground zero, Bear Island was a site of perennial technology. That perennial technology, issuing from the necessities of survival, promulgated the "parent technology" of boat-building [Fig.5.05]. As Sam Rosenberg described Fuller's earliest contraption, he also emphatically noted its symbolic significance:

> (Fuller) used to lie in his father's rowboat... and watch the marvelous movement of jellyfish. He observed that the jelly fish always looked forward, always knew where he was going, got there comfortably, and expended very little energy doing so.... So he invented a single oar with a leather attachment which opened and closed in imitation of the contraction and release of the tentacles of the jellyfish. The contraption permitted the rower to face forward in the direction in which he was traveling and it served simultaneously as propeller and rudder.... *This image of man going forward and facing to the rear has never left Bucky Fuller.* He spent the last 48 years since trying to persuade the humans with whom he has had to associate to turn around and face in the direction in which they are going. But, thus far, too few have had the courage to try it[77] (Itl., my emphasis)

Whether as sailing or fishing, it was the efficiency and ordered precision of place and thing in this natural technology which appealed to Fuller. Furthermore, the associated tools of this natural technology had an immediate relationship to natural elements and the forces. Thus, in Fuller's narrative, Bear Island was transformed into a mnemonic device to reconstitute the first principles of Nature as geometry and as coexistence. As "initial instructions in tension systems," Fuller argued that they revealed deeper meanings generally unfelt or disguised in the vagaries of land-based cultures.

Bear Island, however, presented several broad contradictions. As real estate, it was deeply contradictory to Fuller's own public pronouncements against sedentary life and land ownership. It was close to the playgrounds of East-coast ruling elites. Conrad so much suggested that Fuller's silence on this was a careful distancing ploy which disguised his bourgeois

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[76]See R. Buckminster Fuller, *Tetrascroll, Goldilocks and the Three Bears*, New York: ULAE Inc./St. Martin's Press, 1982.

sentiments of which he was never completely purged.[78] Similarly, Neva Goodwin, herself a Rockefeller and Fuller's patron in the seventies, remarked how Fuller's personal preferences for the nature and countryside of Bear Island, a "somewhat elitist experience," was at odds with his world or global visions.[79]

As a place of self-renewal, Bear Island also presented a heightened paradox with respect to his role as a prophet of industrialization. The "Bear Island story" allowed Fuller's biographers to illustrate a Janus-faced Fuller, namely a public Fuller apprenticed to industry and a private Fuller with nature as the first teacher. Gerber extolled the primitivist virtues of the island to construct Fuller's holistic approach.[80] On the other hand, Conrad's bent on casting Fuller in a technocratic mold, argued that Bear Island was the site of mechanical education, and that Fuller saw only its "mechanical nature." However, he was unable to resolve the dichotomy between Fuller's "discipline" in the mill-technoculture and the "freedom" of Bear Island.[81] Hatch directed the dichotomy of these formal and informal lessons to reinforce Fuller's enigmatic genius.[82] Finally, Tomkins noted that the island, rather than a quest for autonomous living, was primarily a compensation for a lonely childhood.[83]

Directly and indirectly, Fuller owed his ideas about the frontier to Frederick J. Turner. Fuller himself privately recorded that Turner's frontier thesis supported his "northwest spiraling" thesis of civilization:

> 'Essays on American History' Fred. Jackson Taylor(sic) (supports my N.W. spiral) according to Prof. J. C. Bailey Grad. Sch. Bus. AB Harvard.[84]

This theory with energy forming a determinant in world history, was an updated version of American manifest destiny. Human material progression, Fuller proposed:

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[77]S. Rosenberg, "The Man in the White Suit," BFI-MSS in BFI-CR164, p.7.

[78]K.M. Conrad, "Technocratic Persuasion," p.78.

[79]K. Simon & K. Goodman, Transcript of Interview with Neva Goodwin(for a PBS documentary "Thinking Out loud"), New York, ca. 1995, p.4

[80]A. Gerber, Jr., "The Educational Philosophy of R. Buckminster Fuller,"p.39.

[81]K.M. Conrad, "Technocratic Persuasion," p.78.

[82]A. Hatch, *At Home in the Universe*, p.25.

[83]K. Simon & K. Goodman, Transcript of Interview with Calvin Tomkins(for the PBS documentary "Thinking Out Loud),"New York, ca. 1995.

[84]R.B. Fuller, "Note," n.d., ca.1955, in BFI-CR172.

are always clockwise around east to west and spiraling up toward the North Pole. This spiral tends toward an integrating of the world populace by the industrial people of North America and North Eurasia over the Arctic.[85]

In this way there is a distinctive difference between Turner's frontier and Fuller's evocation of frontiers in his work and public discourses. Unlike Turner's thesis, Fuller's use of the frontier motif did not suffer Turner's sin of isolationism. Billington argued that the isolationism of Turner's frontier thesis "blinded a whole generation to the essential unity of the peoples of the western world" and "obscured the fact that a nation's basic institutions and values transcended national boundary."[86] For Fuller, America's new frontier was to be found in the landscapes of technology; and from these new places of escape, America's manifest destiny would be reforged to "repioneer" abundance and "truth back into the old world."[87] Fuller's frontier project was an expansive one. While it embraced kinship in an emerging "one world" in consumption; it also legitimized the leadership of America in the process.

In Frederick Turner's frontier thesis, the frontier represented the "outskirts of civilization" and functions as a "locus of maximum access to unused resources."[88] Fuller exploited both these two features by portraying his activities in a perpetual frontier, thus creating a space to escape the holds of traditional powers and simultaneously legitimizing his practices. The resistance and obstacles he encountered further enhanced his stature as an outsider. Turner nourished the agrarian myth of the frontier via the "ideal of agrarian democracy" to ameliorate the problems of industrialization.[89] Fuller redeemed his individual "frontier" actions by claiming that they perpetuated democracy as a principle against incursions of state and big business. Like Turner's frontier thesis, Fuller's technological project was neither alarmist nor pessimistic. Rather, both were rear-guard attempts to counter the changes and problems -- for Turner to counter the changes and problems wrought by late nineteenth century industrialism; for Fuller to establish a basis for new subject in the age of technological abundance. Perhaps more accurately, Fuller's updated and revivified the frontier thesis, and perpetuated what Goldberg called an

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[85]R.B. Fuller, *Nine Chains to the Moon*, p.131.
[86]R.A. Billington, *America's Frontier Heritage*, p.17.
[87]R. Buckminster Fuller, "Lightful Houses," p.36.
[88]Frederick J. Turner, *Frontier in American History*, 1920; see especially "The Significance of the Frontier in American History," "The West and American Ideals" and "The West and American Ideals."
[89]H. Nash Smith, *Virgin Land; the American West as Symbol and Myth*, Cambridge, Harvard University Press, 1950, pp.258-59.

"expansionist philosophy of history."[90] Thus, while national historical imaginations journeyed to the protean frontiers to re-enact the ideological beginnings of American democracy, Fuller turned his research activities into exemplars of continuous self-renewal and vigilance in one such frontier.

In the late-forties, Fuller redeemed his frontier myth in a practical way by preparing American industry for the larger promises which lay ahead - the world frontier of "two billion" customers. David Cort was particularly sensitive to the political implications of Fuller's world frontier in the American Post-war vision. He explained the meaning of a corporatized world:

> America knows that the future will not be made by this or that detailed plan, but by the inevitable impact of the product-for-use with which American industry can infiltrate 2 1/2 billion people after the war. World-wide distribution of products will make a worldwide new way of life. *The way of life produces the political system, not usually the reverse. As producers, no two men have productive equality.* But when all men everywhere have liberty, fraternity and equality as consumers, the planet Earth will be free[91] (Itl., my emphasis).

Fuller's bifurcation of Turner's frontier thesis in terms of abundance was a skillful and broader restatement of the original. Ideologically, it allowed him to set up Malthus as an ideological straw-man and dismantled the hidden fears of foreboding scarcity and apocalyptic world revolutions. With the geodesic artifacts, Fuller proposed that he had tapped the cosmic valve of eternal wealth in structuring; and with his repro-shelter project, he had found a way to avoid revolutions. The new frontier, thus, was infinitely more potent, since it was a new realm of unfathomable growth for corporate and industrial wealth, and yet without proprietors and national boundaries.

5.3. An Anthropocentric Project

Conrad summarized Fuller's life work as one "committed to the principle of technological determinism." As a form of pseudo-science, Fuller's project was a scientistic application of the facts of nature in a simplistic and reductive way to the affairs of man.[92] In contrast, Gerber proposed that Fuller was "committed to humanistic principles and used

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[90]Harvey Goldberg, *American Radicals*, p.5.

[91]D. Cort, "The Universe and Mr. Jones" (on B. Fuller Philosophy as set forth in Harvard 1917 by B. Fuller), ca. 1961, MSS in BFI-HEv36, p.11.

[92]K.M. Conrad, "Technocratic Persuasion," pp.212-15.

technological means to manifest that commitment."[93] The fundamental difference between these two readings was over the issue of determinism and human agency respectively. Both these characterizations of Fuller's projects as either "pseudo-science" or "pseudo-social philosophy," though ambivalent, were productive. Indeed, it was this ambivalence of determinism, human will and agency that made his work attractive to a wide spectrum of audiences.

For example, by defining tools as extensions of man, Fuller rendered man and his environment inseparable. Man is simultaneously subject and object of the things he creates; and as man expands upon his creations, they in turn augment his capacities and transform his nature. William Kuhns, a purveyor of technological optimism, thus suggested that contrary to the critic's fear of technological enslavement, a new agency is created by the world of tools. This new agency ... ocated the agency previously held by the human mind; creating a new awareness that spells an end to the age of anthropocentricism. For this reason, he compared Fuller's "ecological pattern transformations" to Julian Huxley's "social evolution" and Teilhard de Chardin's "noosphere." What unified these three grand propositions of all-encompassing reality, he argued, was the possibility of man escaping the structural condition of his existence by "consciously pattern(ing) his own evolution" and allowing technology to form "the new nerve fibers of an emerging super-organism."[94]

Kuhns' rendition directly undermined the anthropocentricity and the idealism of the human mind which Fuller called the "phantom captain." The identity of the "phantom captain," Fuller explained, was not altered by stages in the development of its mechanism or the extensions to the mechanism.[95] Man's identity, he continued, was located in his experiences and that was not a mere conduit of divine providence. Yet, Fuller proposed that the totality of human experiences, as a system of rational and necessary laws, exceeded the details of individual experiences. One could attribute this ambivalence to Fuller's suspicion for dogma of any kind which he characterized as "Messiah phenomenon" that threatened to by-pass the human mind.[96]

It is, however, equally pertinent to assess Fuller's project as an anthropocentric one; that is, one which promoted man as a central fact of the universe; and assumed man to be the final aim

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[93] A. Gerber Jr., "The Educational Philosophy of R. Buckminster Fuller," p.257.
[94] William Kuhns, *The Post-Industrial Prophets Interpretation of Technology*, New York: Harper Colophon, 1973 (1971), p.233.
[95] R. Buckminster Fuller, *Nine Chains*, p.28.

and end of the universe. For this reason, Fuller viewed and interpreted everything in terms of human experience and values. In the physical and metaphorical frontier, Fuller believed that tools entwine man in his destiny. His self-constructed theory of technology, thus, based on teleology of man created for "success," was fundamentally anthropocentric. Likewise, with his solipsistic argument that a comprehensive order of the Universe could only be obtained by "human-intellect-directed science."

To see the universe as technology is implicitly anthropocentric. In America, such a move is partly rendered plausible when the primary cultural-social ethos is built upon motive power. Fuller portrayed technology as an ordering of the universe. For Fuller, technology was regenerative:

> In terms of absolute principles, the more you used technology, the more it improved instead of wearing out; thus, balancing other factors of thermodynamics where you had some possible questions about the ultimate conservation of matter. Technology was not in that category. The more you used it the more it improved.[97]

In the mid-fifties, Fuller was convinced that technology, in the broadest sense, and his structures, in a narrow sense, demonstrated "synergy," a "behavior of whole systems unpredicted by the behavior of any of its parts taken singly or in subgrowths."[98] Fuller offered his "synergy" to counter the deep philosophical anxiety produced by entropy. Synergy united realities without creating cleavages between the physical world and the world of life or between the world of the soul and that of the mind. This optimistic rendition immediately allowed Fuller's generation to escape Henry Adams' vision of the universe, so terribly narrowed by the entropy of thermodynamics.[99] When Fuller moved gradually to portray the universe as technology or argued that "perfect technology (is) displayed by the universe,"[100] he was not merely inverting the popularly held precepts; rather, he was illustrating their inter-changeability. Thus, as Fuller naturalized the universe as an energy valve effortlessly, his geodesic structure assumed the status of the leitmotif of the universe:

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[96]See Minutes of SSA-Meeting, 12/9/31 in BFI-CR42, p.5.
[97]R.B. Fuller, "Designing a New Industry," p.11.
[98]R.B. Fuller, "Transcript -- Meeting of the Forest Products Research Society-Grand Rapids, Mich.," 5/7/54, p.1.
[99]Erwin Hiebert, "Thermodynamics & Religion," *Science as Metaphor*, p.175.
[100]L. Bakthiar & L. Farhad, eds., *The Interaction of Tradition and Technology*, p.107, and "Fuller Insists World can End Poverty Within 25 years," *The Christian Science Monitor*, 13 Aug. 1969.

I gave geodesics a new scientific definition as 'constituting the most economical relationships between separate event entities in loci in Universe.[101]

Even if one harbors doubts about the plausibility of Fuller's broad science claims, one cannot deny that he had participated in the broad "new scientific spirit" which Bachelard proposed, the Einsteinian paradigm offered.[102] This is definitely truer of Fuller's geodesic phase than any of his other artifacts, considered in total. In this phase, Fuller did not limit the research enterprises to conceptualizing the salient points of one particular experiment; rather, the works represented progressive attempts to conceptualize all possible experiments. In this sense, and in a broad stroke, one can characterize Fuller's geodesic projects essentially as a "thought experiment." Particularly through *EG*, the beginning of the geodesic project was one clearly devised and supported by imagination.[103]

In the wake of Einstein's popularity, Fuller, like many liberal Americans, sought in the symbolic rendition of his work, a way out of everyday life which had been increasingly defined by sectarian, corporate and urban-machinery politics. In Einstein's de-anthropomorphized science, Fuller found a mirror for his personal-political practice. Just as Einstein's conceptual experimentations, as a "free play of the mind," were demonstrative of a new power, the politics reflected in the method promised "free expression" in American democracy.[104] In coupling his popular rendition of Einstein with his emblematic reading of energy as a cultural cipher of civilization, Fuller also deployed his geodesic project to represent a symbolically and ethically charged system.

5.3.1. Certainty and Modelability of Reality in the State of Flux

Fuller, on numerous occasions, cited the gulf of realities between art and science in C.P. Snow's *Two Cultures*, and offered his own project as an attempt to recuperate this division. In the early sixties, in the course of writing *Synergetics*, Fuller elaborated this intention to Loeb:

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[101]Ltr.9/22/76 RBF to Art Coulter Jr., pp.2-3, cited under "Geodesics" in E.J. Applewhite's *Synergetics Dictionary* (Vol.II), p.138.

[102]See Gaston Bachelard's *The New Scientific Spirit*, Boston: Beacon Press, (1929) 1984.

[103]The notion of "thought experiment" was used by Robert Osserman to describe the pursuits of Georg Reimann, Einstein & Galileo. See *Poetry of the Universe*, New York: Anchors, 1995, p.79.

[104]See also Steinman's *Made in America*, which highlights the liberal tendency particularly among American poets to use the relativity theory and "desolidification" to illustrate the democratic factor and the "omni" distribution of equality.

(C.P. Snow) has declared so emphatically that the public is impressed to have become so vast that it is henceforth and forever unspannable. Snow says, in effect that there is a fundamentally dichotomy severing the human race which would have a large portion of so woefully science illiterate humanity that it fit only for devolution into monkeys or swift kindly disposition by hydrogen bombs.
If you and I do a good job (through *EG*), we can have ten-year-olds effectively out-exploring the fifty-year olds in nuclear physics, chemistry, et. al., within a decade. I am not interested in reforming the oldsters as I am in preventing the new ones form being paralyzed with the stingers of the old irrational, awkward, 90 degree, three coordinate system.[105]

For Fuller, the systematic unity of knowledge was not a contradictory development. What was needed was a unified way to describe recognizable and nameable wholes from the state of flux and differences among these knowledge systems. The geodesic project, for this matter, Fuller proposed, was such a tool to instruct the public of the reality beyond the sensory range of humans. This is particularly poignant especially when the existing ways for explicating the unseen had grown increasingly more abstract and less palpable. This project to model the unseen was fundamentally a desire to reconstitute recognizable and nameable wholes from the state of flux. Considered as "modelability," Fuller increasingly saw his project as an assurance of control over the representation of nature through technology. It reconstituted the invisible in the palpable, thus making reality humanly accessible again. Its anthropocentric desire was a sensual one. One could thus propose that Fuller's project achieved what Coloquhon described as the "eradicable urge" of any anthropocentric enterprise, namely, "to extract from the flow of events a token of stasis, a fixed point against which (man could) measure himself" and the setting of the flux "against the palpable tendency of the senses and intellect to see the world in the form of recognizable and namable wholes."[106]

While the geodesic projects and *EG* modeled and rendered the microscopic-macroscopic realities into physical and visual scales of nature, they are, collectively, more than a visual project. They affirmed the seamless, non-dimensional continuity of natural principles. When Fuller offered a seamless principle in the coordinates of geometry, he was effectively proposing a sign without culture. The geodesic projects and *EG* were meta-signs [Fig.5.10 & 5.08b]. Thus, there was also no fundamental contradiction between his reductionistic artifacts and their

105 Ltr.4/1/63 RBF to A. Loeb in A. Loeb's Private Collection of Letters.

106 Alan Colquhoun, "The Modern Movement in Architecture," *Essays in Architectural Criticism, Modern Architecture and Historical Change*, p.24.

refigurations into broad social projects. For this reason, the scope of his enterprise was summarily proclaimed as holistic.

The extant biographies of Fuller generally traced and reinforced his development as a holistic philosopher of technology. They collapsed the lessons he learned from a variety of industrial apprenticeships and the contexts of his childhood. Thus, the "big terms (and) big numbers" recognition in the Navy raised, Rosenberg concluded, a latent leitmotif from his childhood of visual impairment, namely, pattern recognition. Fuller's visual impairment became a "visual cannibalism."[107] Singularly, Gerber provided, though his reinterpretation of Fuller's systems approach, a most extended construction of his holistic philosophy:

> Fuller -- who also employed historical, geological, anthropological, chemical, and mathematical analyses in his research -- always additionally concerned himself providing useful physical and environmental artifacts, designs, and strategies for humanity which reflect and apply a holistic paradigm to everyday life.[108]

Privately and openly, Fuller himself received readings of his works in this manner. For example, he was receptive to the proposal of a young management executive to theorize organizational structures and mechanics of group dynamics along his geometrical constructions. This extension of his work into social problems, Fuller observed, was not far-fetched because he himself had "intuited that they should be so extendible because of their fundamental and general nature."[109] Extrapolating from his dome experiments and referring particularly to the Marine Corps Aviation employment of the tetrahedronal coordinate system in logistics and maintenance procedures, Fuller even proposed its divine connections:

> A Catholic priest, high in the high councils of Rome, identified my coordinate system with the High Council's interpretation of the Heavenly Host.[110]

For a similar reason, when a reporter described Fuller's geodesic dome as a "perfectly engineered structure," she also extolled the scope of Fuller's work as focusing:

> (o)ne eye on the moon, the other on his fellow man.[111]

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[107] See S. Rosenberg, "The Man in the White Suit," p.7.
[108] A. Gerber Jr., "The Educational Philosophy of R. Buckminster Fuller," p.13.
[109] Ltr.5/14/57 RBF to L.E. Lloyd in BFI-CR188.
[110] Ibid.
[111] Lorena J. Dean, "'Moon House' Designed for US Astronauts," *St. Louis Post-Dispatch*, 24 June 1963.

This project of modelability to construct the recognizable and nameable wholes from the state of flux was entwined in his narrative of personal visual impairment. This impairment, in the form of extreme undiagnosed near-sightedness, was an opportunity not only to comment on the in-built compensation of other human senses, but also to highlight the danger of over-dependence on the visual senses. The impaired sight episode was meant to be cathartic. The compensation in other ways of knowing was a fail-safe route, one provided by the provenance of Nature. Thus, Fuller's visual handicap became a productive asset. Because of the fuzziness of the world he saw as a child, he argued that he developed a propensity to view patterns rather than details. Hatch reported that Fuller did not take lightly to his description of what he saw as "confusingly nebulous" or his recognition of "only masses of colors with no distinct outlines."[112] Sieden interpreted this visual handicap poetically as "shifting (of) attention inward," requiring Fuller to use "his imagination and intuition, rather than his sight, for guidance." [113]

For Fuller, intuition was free from the shackle of conventions and cultural adulterations which plagued the visual faculty. As he demoted sight as undependable, he concurrently charged the kinetic senses of the touch with a new urgency for the explication of reality. Fuller's often rehearsed episode of tactile experiments with dried peas and toothpick to produce the minimal tetrahedral structure, and Sieden's account of his ability to determine personality through the scent reinforced these personal myths.[114] Further, Fuller claimed that even with his corrected sight, he refused to take all his sense faculties for granted, as he "embarked upon a journey of outward exploration, questioning, and experimental learning."[115] Gerber similarly constructed Fuller's "philosophy of education" based on these homilies:

> Fuller's early experiences regarding his eyesight correlate with a central aspect of his philosophy – a philosophy which emphasizes perception of and progression from the whole, and only then proceeding to details.[116]

For a man steep in his confidence for tools, Fuller's narratives of the positive aspects of his visual impairment seemed anachronistic and contradictory. They were intended, nevertheless,

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[112] A. Hatch, *At Home in the Universe*, p.11.

[113] L. Sieden, *Buckminster Fuller's Universe*, p.8.

[114] See Nathan Aaseng, *More with Less: The Future World of Buckminster Fuller*, Minneapolis: Lerner Publications, 1986, p.15; L. Seiden, *Buckminster Fuller's Universe*, p.5.

[115] Robert Synder, *Buckminster Fuller, Autobiographical Monologue*, p.7.

[116] A. Gerber Jr., "The Educational Philosophy of R. Buckminster Fuller," p.38.

to comfort public anxieties and allay fears regarding an over-dependence on technological instrumentation for visualization and measurement. Still, his own artifactual production, particularly the geoscope, was an obsessive search for a new instrument that would extend man's sensory range.

In the geoscope, man is momentarily enveloped in a continuous, enlarging cosmic pattern. Fuller proposed that man becomes a part of the "999-fold" expanded reality, aware of the whole range of the invisible events of the universe.[117] It is at this pivotal point, Fuller believed, that the expanded awareness would navigate man's destiny and his abode-vehicle, Spaceship Earth, through space and time. The structural, mechanical and information interfaces in the universe provided by the geoscope would be so seamless that it reached a state of perfection that Fuller described in 1948: "so perfect as to be almost completely unaware of their being there -- like human own integral mechanics (e.g. tongue, clothes)."[118] Many years later, Lloyd Kahn, one of many "outlaw builders" of domes described the more expansive experience of dome-building:

> (Y)ou were somehow in touch with the universe in building a dome.[119]

5.3.2. Primitivism - A Return to Edenic Garden in Search of Principles

While Fuller looked to the future industry to affirm and realize his ideas, he excavated the distant past to recover the source of his speculations. His speculative world history, based on technology, was as materialistic and deterministic as it was metaphysical. For example, he took etymology and numerology, one could say almost obsessively. They were not merely disciplines in the past but systems of perennial knowledge disguised from public awareness by power conspiracy of priesthoods and strongmen.[120] Fuller especially considered numerology symbolically and divinely significant. The choice of 1927 as the beginning of all his beginnings, after his "first life" was profusely recorded by his biographers.[121] The significance of the date seems pre-ordained, if one explicate it using Fuller's "indig" (integration of digits), a symbolic

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[117]R. Buckminster Fuller, *Critical Path*, pp.54-55.
[118]R. Buckminster Fuller, "Transcript of Wire-recording to ID, 1948," BFI-MSS 48.11.01, 12/16/48, p.4.
[119]L. Kahn, "The Dome" in *Shelter*, p.119.
[120]See R.B. Fuller's "The Phantom Captain" in *Nine Chains*, pp.27-33 and *Tetrascroll, Goldilocks and the Three Bears*, p.52; "Domes - Their Long History and Recent Development" in J. Meller 's ed., *The Buckminster Fuller Reader*, p.148.
[121]See also Ltr.12/10/76 RBF to T.H. Gibbins; "Letter to Doxiadis" in *Main Currents*, March-April 1969, p.90.

numeration system with a counting base of nine. Hence, 1927 = (10)+(9) = (1)+(9) = (10) = 1, the beginning.[122]

Fuller's sympathy for Jung's psychological studies of the primitive peoples of Africa is another illustration. Among these primitive peoples, Fuller speculated that "their simple experience memory system" was an "internal" system which bear direct fidelity to the external, even if the latter is an "illusion extension."[123] This fascination with the primitive would be reconstituted later in his interests in children. Like the state of the primitives, Fuller believed that childhood, as a pristine stage of life, was neither tainted nor adulterated by culture. In this sense, Fuller shared Veblen's construction of the primitive as an "instinct producer for the material well-being of the group" who was corrupted only by feudalistic culture of "invidious distinctions" based on wealth, ownership and private property.[124]

Fuller's interest in primitivism took a liberal spin with respect to the status of race. His fascination for "race-mixing" turns against the ideological of pure races. Treating the process of race-mixing like alchemy, Fuller implied that the narrow cultural prerogatives of pure races would be dissipated as the genius of various races are coalesced into a common, original collective intelligence. Fuller credited "tribal intrusions" and "Pan-European interbreeding" with advancing the Greek Babylonian period of intellectual output:

> Greeks were a mixed race... History provides many instances of a successful new civilization emerging from an admixture of invading conquerors with a more primitive native race; as when tin is mixed with copper, something new results which is better than either ingredient.[125]

His attitude affirmed the liberal intellectual tenor of his generation which sought a way to redeem American culture against the doctrine of Anglo-Saxon superiority.[126] His race ideology exceeded mere tolerance and positive preference for whatever was most alien or primitive.

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[122]For details of the "indig system," see Entry #1220.00 in *Synergetics*, pp.756ff.

[123]R. Buckminster Fuller, *Nine Chains*, p.26.

[124]See William E. Akin, *Technocracy and the American Dream, The Technocrat Movement, 1900-1941*, especially Ch.1 "The Progressive Formulation: Progressives, Engineers and Thorstein Veblen," pp.1-26, highlighting Veblen's anthropological project as outlined in his *Theory of the Leisure Class* (1899).

[125]Fuller's marginalia in his copy of Sir James Jeans' *The Growth of Physical Science* (1948), p,160.
Marginalia in this book and another, James Conant's *Understanding Science, An Historical Approach* (1947) should be considered together. The marginalia in Jeans' book were variously dated, but mainly between 4/24/48 (p.269, 274) and 4/6/48 (p.194).

[126]Henry E. May, *The End of Innocence*, Chicago: Quadgrangles, 1964, p.350.

Rather, he saw pure race as an exemplar of human and cultural regression; it was a form of de-evolution with pedigrees in-breeding into self-extinction. Pure races, Fuller contended, developed into hegemonic static groups and became monolithic, predatory and conspiratory by developing "feudalist" cultures. In opposition to the perfunctory culture of the former, the culture of mixed races was egalitarian and emancipatory. Privately, Fuller was attracted to mixed progenies in of Isamu Noguchi and Jean Toomer, associating their respective creativity to their mixed racial lineages. Ironically, in the thirties, Fuller admitted that it was race-mixing which produced the virile mid-Westerners who had successfully usurped his enterprises.

5.4. Constructing a New Subject

Fuller's artifacts and speculative world history were more than technical contraptions or resistances against pervasive cultural conventions. Fuller carefully cultivated and rendered them as personable objects and personal ideas. In the same way, Fuller was able to personalize the impending social transformations by using his rhetorical craft to speak about his vision rather than himself. For instance, by placing the nation's experience of technology in the unfolding saga of his family and his life, Fuller effectively forged a personable and human dimension to technology.[127] There was no longer any foreboding anxiety. By his careful placement of his own genealogy and the continuity of five generations of the Fuller family into a technological history of America, technology is eased seamlessly into the fates and lives of real people. The narrative effectively naturalized the trajectory of the American middle-class experience.[128]

5.4.1. The Performer Fuller and his Audience

> If you weren't familiar with Buckminster Fuller before this, what do you think about him after seeing this web piece or the film "Thinking Out Loud"? Genius, visionary, crackpot, saint, or just an ordinary guy?[129]

Over three decades, from the fifties to the eighties, young liberal white-middle class Americans in Fuller's college lecture circuits set the context for his discourses which were

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[127]See example of this in Appendix II (Chronological Inventory of Prominent Scientific, Technological, Economic and Political World Events: 1895 to Date) in *Critical Path* (pp.378-409).

[128]See R. Buckminster Fuller, "Self-disciplines of Buckminster Fuller," *Critical Path*, p.129ff

subsequently transcribed and entered the circuit of popular consumption. For example, Fuller deeply appreciated the layers of audience through which his esoteric *EG* would eventually filter:

> It was inevitable the impact (of *EG*) would be electrifying as it impinged upon first, the student consciousness, second upon the technical world, and third upon the layman world.[130]

Fuller's public performances and records supplanted the various editions of "documentary" type résumé which Fuller had painstakingly compiled and selectively circulated at the close of the Wichita-House episode. Moreover, as public "confessions," these performances added palpability to the man and his work. What partly fueled his popularity on these lecture circuits were his legendary discourses. Contemporary accounts termed them "experiences." The public lectures were customized to the demands of his audience groups, and the overall impression of Fuller the "lecture artist" was unanimously "rippling" and "empowering." Public relation officers, in general, readily grasped the strategy for publicizing Fuller's projects alongside the man. One of them observed:

> Radio is pretty much out because Fuller is more visual than audio ... Fuller is especially good on TV ... keep it (the facts) simple![131]

Similarly, while Atkins, the publisher of *Progressive Architecture*, was bouncing around his idea for a book format on Fuller, he advised Fuller's co-author Richard Hamilton that the book project should not be biographical. Rather it "should be as nearly like Fuller's lectures in its stimulative(sic) aspects as (he could) make it."[132]

Fuller's optimistic rendition of technology was particularly reassuring to those who had experienced the war and witnessed the devastation of the nuclear explosion. The titles of Fuller's lecture topics were carefully crafted: "Building Tomorrow" (Jan. 21 '57, National Association of Home Builders, NAHB Convention-Expo, Chicago); "New Frontiers in Architecture" (Mar. 25-26 '57, Dept. of Architecture, Univ. of Illinois-Urbana); "Anticipatory Science of Design" (Mar. 7 '57, RAIC) and "Architecture of the Space Age" (Oct. 5-8' 58, 9th Annual Conference Gulf

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129 Question posed by Ann Willmott Andersson (WNET-New York) in conjunction with the national airing of "American Masters series: Buckminster Fuller - Thinking out Loud," 9 April 1996 [Source: http://www.pbs.org/wnet/oucky.cgi.].

130 Ltr.10/19/55 RBF to L. Holloway in BFI-CR179.

131 Ltr.3/20/54 M. Lemle to R.M. Horowitz in BFI E-Series.

132 Ltr.8/2/51 W. Atkins to R. Hamilton in BFI-HEv11.

States Region-AIA). Besides revealing the fecundity of Fuller's mind, these discourses exhibited the inter-relatedness of his ideas with emerging social issues. His world-around experiences in the Navy were unfurled in his de-militarized World Games and his transcendental heritage and non-conformity fueled the enthusiasm of both counter culture and counter-counter culture [Fig.5.08a & 5.08b].

5.4.2. *Chronofile* as an Artifact of Life

Overall, the extant biographies not only proposed Fuller's life as an experiment, but also a transparent one requiring no further decoding. Sieden, in particular, ambitiously echoed Fuller's own claim that his life could be critically scrutinized, just as "any experiment should be examined."[133] Fuller's mammoth and ambitious project of self-documentation, the *Chronofile*, was offered for this purpose. The name *Chronofile* first surfaced in 1929 as "4D CHRONOFILE" in *4D Timelock*.[134] Then described as a "business novelty" and a "tactical organ" of 4D administration, its antecedent was the "composite of the various navy logs." It was initially offered as "organization information." Like a company report, it served as an "exposition of the panoramic form of the organization." Fuller had envisioned the *Chronofile* to fulfill several tasks. As a dynamic, open system of information, it was to allay the secrecy of the method of business. Further, it was to be a self-less form, based on the edict that "not to record is to erase the moment of genius away."

The meaning of *Chronofile* was revamped in 1939, after his first book, *Nine Chains to the Moon*. It became a full-fledged self-documentation. While he characterized himself as "a demonstration of the potentials of the decent average-intelligenced(sic) young New Englander," his *Chronofile* was:

> (an) involuntary diary and progressive documentation of an American from 1895-1939 plus good and bad, all included.
> (And Chronofile) serves as continuous perspective builder, makes self glaringly objective and therefore controllable. Gives proportion. Events which seemed all important at date of occurrence as suddenly small and part of far larger pattern continuously evolving.[135]

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[133] L. Sieden, *Buckminster Fuller's Universe*, p.xiii.
[134] In *4D Timelock* (1972 edn.), see pp.38-40.
[135] Ltr.7/1/39 RBF to Joe Byrant in BFI-CR46.

Upon public success in the sixties, *Chronofile* was variously offered as evidence of "a total and unified philosophy (that was) pertinent to the unfolding historical reality"; as a support for Fuller's "world redesigning stratagems," and his tenets: "Reform the environment, don't try to reform man." Fuller offered this comment on its objective distancing:

> Because the data constitutes a faithfully comprehensive record, I am now able to comment objectively upon my subjectively disclosed self, approximately as critically *as though the subject were another man*[136] (Itl., my emphasis).

Sieden assessed the *Chronofile* on two levels: it helped Fuller to "determine and understand large-scale patterns operating throughout the Universe and to recall his feelings about the rapid changes occurring around him"; and it "provide(d) a personal and encompassing view of human development to future generations who might someday discover and explore it."[137] Similarly, Kuromiya characterized the *Chronofile* as a heroic testament to "the individual as uniquely capable of gathering information and solving problems for all future generations."[138] Drake was even more expansive in his characterization of *Chronofile*, calling it a "metaphysical universe."[139]

A substantial portion of Fuller's financial resources was allocated to maintain the *Chronofile*, and the collection exhibited a compulsiveness to "document" his existence as if nothing was considered insignificant for omission. Beyond forging, in a cogent manner, the purpose and meaning in the life of its protagonist; as a diary, autobiography or a journal would; Fuller's repository of his experiences was a data file. Its objectivity is supposedly in the transparency of things and experiences; and open-endedness to "good and bad." Conrad, more critical of Fuller's self-history, called the *Chronofile* an expression of "self-contrived egotism." He was equally skeptical of Fuller's project to "purify" or "resurrect the quality of American civilization."[140]

Indeed, *Chronofile* was a project of paradox -- the individual self was positioned to speak for all, the resources of an elite was destined as fuel for popular imagination. *Chronofile*, thus,

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[136] "Buckminster Fuller Chronofile" in *The Buckminster Fuller Reader*, pp.19-20.
[137] L. Sieden, *Buckminster Fuller's Universe*, p.70.
[138] Kiyoshi Kuromiya, "R. Buckminster Fuller" in *Encyclopedia of Architecture Design, Engineering & Construction*, p.526.
[139] H. Drake, "Alfred Korzybski and Buckminster Fuller," p.83.
[140] K.M. Conrad, "Technocratic Persuasion," p.5.

was more ambitious than a mere recount of his life. Fuller used it to validate how his life had merged historical tendencies in a seamless connection in a "chronological juxtaposition of men and man" and as a tool of divination. Fuller proposed that *Chronofile* allowed him to view himself as a "link in the chain" of human knowledge and continuity.[141] By this second role, one biographer argued, the *Chronofile* allowed not only Fuller but future generations to step outside the bounds of historical moments and conditions to relate with the universe through "generalized principles."

In 1952, Fuller publicly qualified his life as a scientific endeavor, as an act of "set(ting) in order the facts of experience." Fuller even justified his job-hopping as "provid(ing) broad hindsight and perspective and, therefore, very large patterns of experience."[142] However, it was his self-characterizations as "Guinea-pig B"[143] and later as "trim tab" which remain vivid and endearing in public imagination [Fig.5.03]. Among Fuller's predominantly middle-class audiences, this self-label was well placed and redemptive. Rather than suggesting that one should be resigned to fate as an object of an experiment, Fuller's self-characterization was about sacrifice. In treating himself as an object of technology in a metaphysical experiment, Fuller was, in his words, preparing the human race for the "final exam."[144] His self-experiment tested the legitimacy of self-discipline as a substitute for academic and other specialized disciplines. That self-discipline was validated by the imperial position of self-experience to stand in for all experiments:

> (T)his exaggerated relationship of the minute individual in respect to the whole is nonetheless the only possible common direct experience of each and every human being. All else is hearsay.[145]

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[141] R.B. Fuller, *Inventions*, p.xv.

[142] "The Next Two Billion Customers," Speech at the 27th Luncheon Meeting of Export Advertisers Association-New York, in February 1952 (Copy of Transcript in BFI-HEv15).

[143] R.W. Marks, "The Dymaxion World of Buckminster Fuller," ca. 1952 (notes) in BFI-Hev20. Marks first recorded Fuller's characterization of himself as a human guinea pig. Fuller elaborated this motif, labeling his life as "Guinea-pig B":

> This was to be a fifty-year experiment to prove that man, like nature, was not a failure but a success; to rethink everything I knew. It was an experiment in which I myself was the guinea pig. I had to begin from the beginning. I had to find out what man has and see how it can be used for the advantage of others. I became convinced that we're here for each other (*Buckminster Fuller: An Autobiographical Monologue/Scenario* (p.39).

[144] Along the line of spiritual sacrifice, a recent observer of Fuller's life-work characterized this loneliness and isolation of the sacrifice as the act of *"bodhisatvahood"* (R. Carratu [Roan@interramp.com], "American Masters series: Buckminster Fuller-Thinking out Loud," http://www.pbs.org/wnet/bucky.cgi, 13 Apr. 1996).

[145] R. Buckminster Fuller, *The Buckminster Fuller Reader*, p.25.

Fuller clarified the connection between experience and experiment in this way:

> Experiment is part of experience. It is a deliberate experience Many experiences are inadvertent and subjective.[146]

In taking a heroic view of science and in treating himself as an object of science, Fuller subliminally exploited the legendary experiment of Benjamin Franklin, who had used his body as a conduit for a lightning experiment. Besides the persuasive power of self-humility, the presentation of one's life as an experiment reinforces the myth of the deselfed individual. Under a social milieu increasingly shaped by corporation and industry, Fuller's confidence in the "objective" self to stand in for the values of all humans allayed fears about the impotence and helplessness of individual action. Further, with "Guinea pig-B" exhibiting a prolific life of actions, the potential shock and impersonality of Fuller's future of "world man" on "Spaceship Earth" was muted.

5.4.3. Self-discipline in Body and Speech

Fuller's self-presentation as an experiment extended to his entire body culture -- in speech and in action. So attuned was Fuller to this role that he began to animate and personify in the conduct of his speech and body movements what he had perceived as secrets and patterns of the Universe. Both his body and his artifactual geodesics were vivid physical conduits and manifestations of universal forces [Fig.5.06a & 5.06b]. In the forties, Russell Davenport, Fuller's associate and an editor at *Fortune* reported Fuller's interests in way:

> His field, as he himself described it is the architecture of things in motion. 'Buckie's'(sic) structures, or concepts, are built of motion - the motion of life, of wheels, and other waves, of the Gulf Stream, of the Earth, of electrons and civilizations, of starts and students.[147]

Peter Blake similarly recounted his impressionable first encounter with Fuller at ID-Chicago through his dance that linked bebop to his "new mathematical shorthand."[148] Peter Drucker observed that as a geometer, Fuller "experiences the order and rhythm of space."[149] Finally Sam Rosenberg accorded Fuller's walking, stance and movement to his engineering

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[146] R. Buckminster Fuller, "Transcript of "Westinghouse Marketing Seminar," ca. 1966, BFI-MSS 66.10.02.

[147] R. Davenport, "Buckie Fuller Notes," MSS in BFI-CL19.

[148] P. Blake, *No Place Like Utopia* , p.94.

[149] P. Drucker, *Adventures of a Bystander*, p.248.

principles, just as he developed a "system" for resting and sleeping, eating and drinking, conversation and silence.[150]

When Fuller spoke, he was "thinking out loud," in a form of seance unmediated by the conventions of words. In this visible presentation of his life as a process, encapsulated in "I seem to be a Verb,"[151] he assured his audiences that, even as a prophet of technology enmeshed in the inanimate world, he remained deeply humane. One writer observed how Fuller's activity with the semantic groups grew out of his interest in and demands for more effective communication. Yet he observed the irony of the method:

> (Fuller)has an endless flow of ideas coupled with limitless curiosity. Typically, he bubbles over with a mixture of engineering jargon, his own shorthand expressions, and sesquipedalian words.[152]

The impetus for new words in thinking and writing, and the desire for their precision, were to augment the spontaneity of his mind. Words as tools, or "word tools," Fuller believed, constantly evolved to produce new visions, while their precision ensured control. Fuller was not alone in advancing this ambition. Stuart Chase likewise advanced, in *The Tyranny of Words* (1938), a similar discipline of language using the "pure empiricism" of science as a model. A new language to describe reality, he proposed, needed to accompany new physical instrumentations and experiments. Almost thirty years later, at an architectural convention, Cedric Price, one of Fuller's British adherent, similarly argued that "invented" words allowed one "a clean slate upon which (to)... place any new meaning (one) wants."[153]

Fuller's interests in the precision of words came from three known sources. First, Fuller recounted that as a communication officer & personal aide for secret information to Admiral Gleaves (Commander, Atlantic transport operation of the U.S. Cruiser and Transport force at the close of WW I) he valued the power and value of precision of commands in the war efforts.[154] Second, there was Ogden-Richards' BASIC English project (British, American, Scientific, International Language) to transform English from a native to a basic language. Its leanness, in the consolidation of 850 words to do the work of 20,000 was enthusiastically embraced by Fuller

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[150]S. Rosenberg, "The Man in the White Suit," p.4.
[151]R. Buckminster Fuller, *I Seem to Be a Verb* , N.Y.; Bantam Books, 1970
[152]_. "Fuller's Domes Catch On at Last," *Business Week*, 10 May 1958, p.114.
[153]_, "Semantic Drunkenness" in *AD* March 1969, p.124.

in his search for economy of communication for the emerging world-man.[155] Finally, he shared Alfred Korzybski's faith in the language of science of mathematics and science. Both men believed that the instruments of humanity could directly reform man -- Korzybski's semantics was panacea for human ills while Fuller's environmentalism was the source of new a social form.[156]

Alfred Korzybski's (1879-1950) language project was an attempt to establish "the relationship between semantics and man's nervous system." Incensed by World War I, he tried to reestablish a creditable role for man in history in *Manhood of Humanity* (1921). His better known work, *Science and Sanity: An Introduction to Non-Aristotelian Systems and General Semantics* (1933) introduced the discipline of "neuro-linguistics" and inaugurated the General Semantics Movement.[157] The project was an effort to establish correspondence between language and thought concepts. However, Geoffrey Leech, a critic of semantics, argued it was more than a mere interest in "conversational paradise." Rather its utopian possibilities were posed as "a potential cure-all for all the ills of modern society."[158]

However, with the publication of *Synergetics*, Fuller finally disavowed all external influences:

> There appears to be an increasing convergence of scientific explorations in general, and of epistemology and semantics in particular with my own evolutionary development.[159]

Fuller was not deterred by the fundamental contradiction between the demands of "spontaneity" of the mind and the precision of words or between the fleetness of occasion and the contemplated speech moment; apparently, neither were his audiences. Blake conceded that though Fuller's considered words were "barely literate," they were "on a level of sophistication

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[154] R. Buckminster Fuller, "Designing a New Industry," p.9.

[155] *SHELTER*, November 1932, p.100.

[156] For an extended discussion of the connection between Korzybski and Fuller, see Harold Drake's "Alfred Korzybski and Buckminster Fuller: A Study in Environmental Theories," Ph.D. Thesis [Speech], SIU-Carbondale, Graduate School 1972.

[157] Fuller owned a signed copy (1 March 1935) of Alfred Korzybski's *Science & Sanity* (1933). However, it is devoid of marking or marginalia, suggesting that he neither had read it nor was thoroughly acquainted with Korzybski's ideas.

[158] G. Leech, *Semantics*, p.2.

[159] R.B. Fuller, *Synergetics*, p.71.

and conviction that spoke for itself."[160] Robertson echoed the oracular significance of the contradictions:

> Fuller has needed, used and successfully communicated ideas with self-contrived semantics which often convey his expanding meanings by a process which the student himself may not able to analyze. He knows only that he understands, not how.[161]

Biographies on Fuller are replete with examples of his body discipline. One was the development of a new sleep routine, billed as "Dymaxion sleep." This self-discipline consisted of half-hour snatches of nap four times daily in order to produce an almost full day (twenty hours) of productive work.[162] The sleep narrative piece was a carefully crafted public relations feature to steer the public's long fascination with the cult of inventors. Fuller's "Dymaxion sleep" directly paraphrased the particularly noteworthy Thomas Alva Edison catnaps in his laboratory at Menlo Park. It enhanced the myth of the inventor, who Thomas Hughes described, was "indifferent to the regular sleep needed by mere mortal men."[163] To Fuller, the fundamental meaning of the sleep episode was the importance of balance as a principle. In 1928, he noted:

> Everything must balance. Death & sleep are identical - only relative duration. Sleep is the balancing unit between physical & mental. When properly balanced... we need no sleep. Balance (is the) ... only way to handle landing of planes, etc. from air is by gas hydraulics of greater power in earth letting the plane down slowly in the air which supports it.[164]

The apparent asceticism that Fuller maintained in his physical and mental disciplines, though using the machine as an implicit analogy was not mechanistic; rather, it was quasi-theological. The discourse on sleep was about cultivating a body discipline and tuning the body towards the precision and higher productivity of the machine, albeit in a scientistic way. It was about the direct harvesting of the latent motive and productive power of the human body. Realizing that this could be extended by the aid of externally-wrought tools, the internal yogic discipline, Fuller argued, was delusive "Dymaxion sleep" was thus quite unlike the sleep discourse among mystics. In the Gurdjieffean system for instance, the uninitiated man is in

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[160] P. Blake, *No Place Like Utopia*, p.215.

[161] D. Robertson, *The Mind's Eye*, p.16.

[162] See R. Buckminster Fuller, "Notes to Joe Byrant," p.10; Arthur D. Little, "Buckminster Fuller's Sleep Experiment" in *Industrial Bulletin Time*, Sept. 1943; "Dymaxion Sleep" in *American Weekly-Hearst Sunday Syndicate*, 14 Nov. 1943; "Fuller's Sleep Experiments" in *Ripley "Believe it or Not,"* Nov. 1943; "Fuller's Sleep Experiment" in *Jerry Klutz's Radio Program* and "Sleeping on Installment Plan" in *Magazine Digest*, Feb. 1944.

[163] T. Hughes, *American Genesis*, p.33.

[164] R. Buckminster Fuller, "4D File Manuscript MSS 28.01.01, Folder VII" (Loose notes), ca. 1928 in BFI-CR64.

perpetual sleep and not living his full spiritual potential. Thus, the end of the mystic discipline is towards spiritual awareness rather than productive ends.

Paradoxically, in the contemporary settings and demands, body discipline was a luxury that modern man could no longer afford. For this reason, "Universal Architecture" was offered as "fatigue and repression proofing" artifactual environment to reduce the internal destructive forces of "human robotism(sic)" and drudgery.[165] Particularly with the geodesic artifacts, the narrative for the development of precision in the mind as necessary steps to sublimate its bestial impulses of the body reached new limits.

5.4.4. Fuller's Biograpby- A Chosen Marginality

Fuller's artifacts and his persona were simultaneously created in the margin. Fuller's marginality and role as an outsider were adopted by choice and forged by circumstances [Fig.5.07b]. These choices were, his biographers offered, affected by changes in his family fortunes, and augmented by the standing pedigree tradition of non-conformity. Upon the loss of material comfort when his father fell sick, Gerber explained that Fuller felt the longing for that long family-line tradition of "intellectual and rebels." The impasse of his own business ventures exacerbated this earlier state of forlorn.[166] Tomkins suggested in his psychohistory that in Fuller's childhood, his relationship with his father were particularly "unhappy (and difficult)." Orphaned in the teens, Fuller had to assume the role of "man of the family, and had to prove himself."[167] Presumably, unable to fulfill that role fully, Fuller opted to remain outside conventions.

However, the variety of non-conformity, promulgated by his grandaunt Margaret Fuller, was more attractive and influential. Her self-didacticism and transcendentalist sway resisted conventions and compromises. Fuller was cognizant of and openly prided Margaret Fuller's ideas during the writing of his *4D Timelock*.[168] In the early thirties, Fuller reported that even his private audiences found a "high similarity" between his *4D* philosophy and Margaret Fuller's

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[165]R. Buckminster Fuller, "Universal Architecture Essay No.1," p.67.

[166]A. Gerber Jr., "The Educational Philosophy of R. Buckminster Fuller," p.38.

[167]K. Simon & K. Goodman, Transcript of Interview with Calvin Tomkins (for a PBS Documentary "Thinking Out loud"), ca. 1995, New York, p.11.

[168]See "References" (Notes assembled for preparation of 4D Timelock), ca. April 1928 in BFI-CR35.

ideas.[169] It is likely that the "time lock" dial-motif that Fuller had used for his aphoristic essay, mimicked *DIAL* (1839-1843), a literary journal founded by Margaret Fuller and Ralph Waldo Emerson. In the forties, a journalist dramatized the connection of the two Fullers:

> He seems to have inherited not the solidity of his father, but the demonic force and energy of his great aunt, 'the high priestess of transcendentalism', Margaret Fuller.[170]

Rather than a "demonic force," Margaret's aura softened Fuller's image as a philosopher of technology. Many biographers suggested that his "comprehensivist" approach followed in the wake of her transcendentalist legacy. To establish an identity between the views and thought structures of Fuller and his grandaunt, Kathleen Guerin, for instance, ahistoricized Margaret Fuller's "universal" project to search for immutable patterns. She wrote:

> (They) consciously transcended their cultural background to become transformist rather than reformist, democratic rather than exclusive, and holistic rather than segregationist.
> ... (And they) deliberately and consciously sought a context of life that would permit them to comprehend the universe and to direct it teleologically for the betterment of civilization.
> (T)heir views, their thought-structures and their conclusions are identical.[171]

A recent example of a similar conflation of the two Fullers was offered by Kirby Urner. He cast Fuller's entire project based on her nature-based philosophy so as to represent the divine orderliness of the universe:

> Fuller himself was a New England Transcendentalist, in the mold of Emerson and his great aunt, Margaret Fuller. He was a mystic. In Fuller's universe, technology is synonymous with the physical. Nature is the supreme architect and technophile, her creatures being far and away more sophisticated than anything humans have themselves consciously invented. For Fuller, the technology vs nature dichotomy did not exist and he was dismayed that the counter-culture might throw out the technology baby with the evil-uses-of-same bath water.[172]

To adopt the sociologist, David Riesman's distinctions on marginality, Fuller's marginality, at a personal level, was a "secret" form to resist the identity expected of him.[173] His marginality was not economical, psychological nor political; rather, it was ideological. Fuller

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[169]Ltr.5/27/31 RBF to E. Schwartz in BFI-CR39.

[170]Leigh White, "Bucky and the Dymaxion World" Saturday *Evening Post*, 15 October 1944, p.23.

[171]K. Guerin, "The Fuller Mind and the Cosmic Vision," ca. 1982, MSS in BFI, pp.1-2.

[172]Christopher J. Fearnley (cjf@netaxs.com), "The R. Buckminster Fuller FAQ," v.1.0, 12 July 1994.

[173]David Riesman, "Some Observations Concerning Marginality," *Individualism Reconsidered*, Glencoe, Ill., Free Press, 1954, pp.153-165.

privately attributed his non-conformity to his own quiet rebellion. He blamed the surrounding as he sought to recover the harmonious inner self he claimed he had lost while growing up. Writing in second person, Fuller confessed:

> The writer in his stumblings around in life was imbued with a most uncontrolable(sic) sense of harmony, which ... was diverted from its useful channel when young...and yet persisted in all his relationships with the world .... *The emphasis of harmony was entirely hereditary mark of the good traits of his forebears, for degrees of harmony are the essences of the lives before which god carries from life to life*[174] (It., my emphasis).

While the constructed marginality in his character and projects were productive, they were also often contradictory. This was demonstrated in the efforts to advance his geodesic enterprises, and his role vis-a-vis their operations. Despite his "secret" marginality, he obsessively sought official recognition to establish legitimacy of his work. While professing a life devoted to the production of de-selfed artifacts, he obsessively documented his life to forge proprietary rights for his ideas. Likewise, while eschewing publicity, he openly prototyped his artifacts in the public eye and sought public approval. In attempting to direct his artifactual production towards some form of assimilation in society, he simultaneously rallied and renounced corporate and state patronage.

5.4.4.1. Ideological Underpinning of Everyman and "Averageness"

Publicly, Fuller was adamant in projecting his "averageness" and refused to be categorized. The intent was to create an exemplary identity for his imagined "world man," a new Everyman. This, however, did not mean that he denied his individual identity; rather, it was an affirmation of the individuated person. Rosen, for example, recounted Fuller's experimentation with the ways he inscribed his name -- as "Richard B. Fuller," "Richard (Bucky) Fuller," "R. B. Fuller," and finally, as "Bucky."[175] For this reason, Fuller's purported averageness was paradoxically unique, resembling a kind of marginal differentiation of personality. However, some of his biographers were quick to resist the implied non-discreteness in averageness by installing distinctions in Fuller's averageness. Thus, while Fuller only openly professed his vocation was that of "machinist,"[176] he had been variously called a "20th-Century Leonardo da

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[174]R. Buckminster Fuller, "Lightful Houses," p.61.

[175]S. Rosen, *Wizard of the Dome*, Boston: Little, Brown & Co., 1969, p.9.

[176]Fuller joined the IAM Local 733 in Wichita-Kansas, 1945 at the time of the Beech Aircraft project, probably upon the recommendation of Harvey Brown (President, International Machinist) who was elected to the Board of DDM Inc. in 1944 (See *The Machinist*, Vol. XXV, No.8, 23 Apr. 1970, p.1).

Vinci" and "high priest-philosopher of the technological age."[177] The corollary of this average man is an Everyman who is non-classifiable.

Fuller's own character marginalization and his subject construction of the Everyman was neither about an anonymous man operating in an open, defined institutionalized marginality nor was it about a classless man in America. The ideological basis of his Everyman was its accordance with the dictates of Nature. Nature in the broadest sense, Fuller argued, had no departments; and the corollary Everyman was a type of ground-zero man, a revamped man with no boundaries. This was to be distinguished from the compromised identity of the institutionalized, corporatized or class man in post-industrial America. Pitched ideologically against the notion of the classless man, the Fuller's Everyman, by contrast, was sensitive and comradely. Everyman was made in every class, yet, belonging to none.

In public presentation, Fuller was careful to sketch himself as someone who had experienced a wide spectrum of America's economic classes, making "contacts of all sorts down to Capone and up to heaven."[178] In the late fifties, while speaking to the inmates at San Quentin, Fuller expanded on the meaning of his encounters with Everyman from every class:

> I had met J.P. Morgan, partners, etc. I knew them all enough that I had been to dinner with them and I knew Al Capone; I knew people all across the board. I know them pretty damn well, and I was pretty convinced that people on either side of the track in many situations really didn't understand one another and yet somehow or another I did seem to know them both and did seem to understand them both. And they seemed to understand me. One *thing I could say was that I did seem to be a person of a broad pattern of experience and that there could be some value in that*[179](Id., my emphasis).

Fuller's affinity for this class of the labor union was selective. Under the factory conditions, the machinists' roles were more than remnant islands of craft and creativity. Especially as machine-toolers, machinists were carry-over positions of privilege from the craft shops. Konrad Wachsmann had characterized the machinists as "thoroughly universal craftsman." Henry Ford also recognized that the machinists' role in industry was amplified and extended because their control of machine tools were fundamentally the control over methods of the application of power. Thus the machinists were the "aristocratic" class of labor, and historically it was conservative in its organizational and political outlook. They were vehemently against the open shop arrangements of the factory. Nevertheless, the public use of the role "machinist" to describe Fuller was to affirm the humility of Fuller, the working man. He was a man identified by his work. This is evident in J. Baldwin's account:

> University presidents introduced him as Dr. Fuller ... He claimed he was no more intelligent than anybody else. And if pushed he'd say I'm just a humble machinist, and he'd whip out his machinist's card (K. Simon & K. Goodman, Transcript of Interview with Jay Baldwin, http://www.pbs.org/wnet/bucky.cgi, 8/6/96).

[177]"Personality," *Times*, 19 Jan. 1953, p.39.

[178]See Ltr.ca. Nov. 1932 RBF to W. Delano in BFI-CR42.

[179]"San Quentin Speech," 31 Jan. 1959 (Transcript of Fuller's Speech), BFI-MSS, p.8.

Fuller's Everyman acknowledged the existence and inescapable reality of class in America. In conjunction with the perennial abundance of the mythical frontier made possible by the genius of tools, Everyman would partake in what Max Lerner termed, "the democratic class struggle."[180] Not surprisingly, the phrase "democratic class struggle" was attributed to Russell Davenport, Fuller's long time associate at *Fortune*. It proposed as a type of "social partnership" in opposition to the revolutionary sort. Here the struggle supposedly occurred within the framework of social mobility and hope. The equal access to opportunities meant that the task of an individual was to escape his class through self-energy and intelligence. Thus, the Everyman ideology recognized the existence of classes and provided a way to transcend the bounds of class culture.

In relation to this ideology of the Everyman, Fuller's background seemed contradictory. As a member of the New England elite, Fuller was a beneficiary of the best education and careful breeding. This privilege of birth, at least, had successfully accounted for his initiations into the various privileged networks closed to most. However, Fuller was careful to steer the public towards a reading of his life as self-made. This was to give greater regard to his character development over his talent as a genius. Fuller was cognizant of the public abhorrence for the excesses of rugged individualism that characterized the old self-made man. His discourse, thus, of the new self-made man was about the cultivation of self-discipline to exceed the given limitations of nature. Richard Hofstadler, examining the intellectual climate of American society, described the new self-made man in this way:

> The average man, by intensifying his qualities, by applying common sense to a high degree could have the equivalent of genius or something much better.[181]

Fuller effectively used self-help and self-didacticism as primitive propaganda to gain popular identification with his work and to assign to him the due credits despite the inherited privileges of his class position. Through Fuller, the mythic self-made man as a folk hero was renewed. There were progressive and reactionary dimensions to this new role. The role was a psychological assurance of self-empowerment to overcome the social strictures and functional demands of the emerging corporate-industrial society. Yet, in denying the effective limit of that

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180 Max Lerner, *America as Civilization*, New York: Simon and Schuster, 1957, p.539.
181 Richard Hofstadler, "Self-help and Spiritual Technology" in *Anti-Intellectualism in American Life*, N.Y.: Random House, 1963, p.254.

self-empowerment, the role also disguised the oppressive effect of actual power sources in the emerging economic formation.

Unlike the old self-made man who depended on the external disciplines of poverty, frugality and "school of hard knocks" to form faith and character, Fuller's self-made man was accomplished through his self-disciplines, forged in the vaguely fused realms of self, world and spirit. In Fuller's narrative, he recovered part of these qualities from the sensitivities of his childhood, from his apprenticeships among the toilers in the mills and the workshops, and finally, in the non-conformity and transcendentalism of his family history. In this way, Fuller's self-made man straddled the predominant type of new self-made men arising from the industrial disciplines and related professions. However, their formal initiations, he believed, were detached from and wanting of wholeness and general integrity.

Hofstadler identified, in his examination of the new spiritual self-help in America, an overt compartmentalization of the relationships between God, service and self:

> Whereas business had been an instrument in religious discipline, one of the various means of serving God; *religious discipline now became an instrument in business, a way of using God to a world end.* And whereas men had once been able to take heart from business success as a sign that they have been saved, they now took salvation as a thing to be achieved in this life by an effort of will, as something that bring it success in the pursuit of worldly goals.[182]

Calling this transformation a "secularization of the American middle-class mind," Hofstadler proposed that the "mental self-manipulation" produced a new self-made man. His new-found capacity was focused on self-manipulation for accessing wealth in the broadest ramifications. Thus, when Fuller announced that he had discovered the "cosmic valve" as a perennial way to "plug into" the universe," the claim resounded an earlier, less respectful and coarser version: "God is a twenty-four hour station. All you need to do is to plug in."[183] Thus, despite a biographer's caution against viewing Fuller as a motivational speaker,[184] Fuller's discourses, nevertheless, fitted into the general billing of a secular "inspirational cult." In the middle-ground of the self-help, self-made man, Fuller did not completely break down the basis of the old spiritual self-help that contained an organic relationship between the world of human affairs and the world of religious contemplation. Thus, Fuller's role as a conduit of and surrogate

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[182] Ibid., p.265.
[183] Ibid., p.267.

for universal power is illustrative of a "strain" that Niebuhr, a historian of Christianity, observed in American religion. Americans, he said:

> tend to define religion in terms of adjustment to divine reality for the sake of gaining power rather than in terms of revelation which subjects the recipient to the criticism of that which is revealed.[185]

Fuller's new self-made man, produced by the new spiritual self-help, was a man centered with God, who acted as aide rather than judge and redeemer. Similarly, his self-created science, *Synergetics*, remained essentially anthropocentric. However, both the subject role and the science that Fuller created eliminated much of the doctrine and the bulk of religious rituals of the 19th and 20th centuries that could be called Christian. Further, the new Everyman that Fuller tried to construct possessed qualities which, Riesman criticized, stemmed from confusion over the subject's position in the social system. This in turn nurtured "other-direction" as a psychological trait and caused these predicaments in his role. Thus:

> in order to do this they must be sensitive enough to themselves and with other to know how they appear to others, and to be aware concerning the degree to which they are different from others without being too different.[186]

5.4.4.2. Everyman Redeems the Genteel Class

Biographies of Fuller and his own consummate self-presentations were not merely accounts of a down-and-out subject making good. Neither were they offered as a total disavowal of his New England middle-class gentility and elitism. Except for what he perceived as stasis of nine-generations of Harvard education, Fuller did not indicate any kind of class adversities in his passionate twenty-two page contribution, "Class of 1917," written for his class reunion in June 1942. Rather, it bellied his quiet pride in Harvard.

In the early fifties, Fuller selectively distanced himself from the social elitism of Harvard and his social progeny. His biographers began to treat his Harvard experience as proof of his non-conformity and as a rebellion against the elitism and social distinction of his class. In breaking the tradition set by his forbears, he also proved that he could realize his personal potential independent of class affiliation. By the early sixties, the incompleteness of his formal

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[184] Cynthia L. Kersteins, "Dome Magazine Talks to Amy Edmundson," *Dome Magazine*, Fall 1988, pp.50-76.
[185] Quoted in Richard Hofstadler's "Self-help and Spiritual Technology," p.266.

education, rather than a stigma, assumed a status of virtue. It effectively augmented his cultivation of a personal history of anti-establishment.

Fuller's "reluctant" years at Harvard and his unfinished education had been narrated as expulsion, the consequence of incomplete course-work or rebellion; but overall, the implication of failure was avoided.[187] In all these narratives, both Fuller and his biographers remained silent on how the setting of Harvard and its elite network had provided him countless opportunities to advance and publicize his works. For example, under the auspices of the Harvard Society for Contemporary Art, especially through the support of Kirstein (d.1996, founder the New York City Ballet) and John Walker III (later Director of the National Gallery), Fuller mounted his first major exhibit for the Dymaxion House on the East-coast in May 1929. From Sept. 1961-May 1962, George Bundy appointed Fuller as C.E. Norton Professor of Poetry. Finally, Gerard Piel (publisher of the new *Scientific American*) was probably instrumental in establishing Fuller's connection to the industrialist, Henry Kaiser. John Locke provided him the first opportunity to build a large span industrial dome for Union Tank Car Company.

Fuller demonstrated how it was possible for his genteel class to recuperate its special status in post-industrial America. While the rest of America was either subsumed in the vagaries of changes or had insulated itself from these changes, Fuller's new found self-identity and the one he imagined for his class was in the vocation of selfless and detached engagement. In this way, one biographer noted, Fuller was the culmination of several generations of New England non-conformity.[188] Offering a skeptical reading of this redemptive role, Conrad proposed:

> The Civil War ended the intellectual and cultural hegemony of the old centers of American authority, and in the future American culture would no longer be equated with that of Massachusetts. *The impact of mechanical power was overwhelming the older forces of spiritual and moral energy*[189] (Itl., my emphasis).

Despite the fact that Fuller primarily addressed the managerial and professional elites, the new middle-class, Fuller's self-history as "average man" was representative of all like-minded Everyman from other class strata. Fuller's discourses on the possibility of Everyman to escape

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186D. Riesman, *Individualism Reconsidered*, p.156.

187See L. Sieden, *Buckminster Fuller's Universe*, p.20; A. Hatch, *At Home in the Universe*, p.30; Dick Compton, "The Dymaxion Dreams of R. Buckminster Fuller," *The Minnesota Daily*, 15 Nov. 1954, p.8; R.W. Marks, MSS. Notes for "The Dymaxion World of Buckminster Fuller," p.6; "Transcript of "San Quentin Speech," BFI-MSS.

188L. Sieden, Buckminster Fuller's Universe, p.1.

the bounds of class culture fed on tangible evidence of social hope ensuing from the war and consumer economies. Expanding college attendance after the Second World War for the working class had created a new sense of social mobility. The movement to the suburbs had removed fears of entrenchment in the city. Growth and social acceptance of collective bargaining had reduced the imminent violent class conflicts. Finally, the media had reduced the sense of class isolation by providing alternative vistas of experiences.[190] In this sense, social circumstances assisted Fuller's implicit "folk belief" of social possibility and upward mobility. The geodesic enterprises, in the various ramifications, vividly articulated these desires.

5.4.4.3. The Protean Everyman

If one accepts the proposition that the identity of the speaker is located in his audience, then the wide range of Fuller's audiences from middle-class college students, corporate executives of Wall Street, the street gangs of New York, to the Droppers of Drop City, reinforces the protean and expansive nature of his Everyman. In their respective eyes, his Everyman was an uncompromising individualist unfettered by shackles of conventions or a "technology-saint" cruising through the pessimistic landscape of modern industrial culture, or a modern-day pioneer empowered by self-knowledge and discovery. In the context of everyday life under corporation, these readings were very pertinent.

The phenomenon of corporation in American myth, Robertson noted, was simultaneously about collectivity and self-realization. As a collectivity, the corporation was seen as a way to eliminate the wastefulness of individual work. Moreover, as a new social arrangement, it was a source of opportunities for the realization of self-potentials; a frontier of abundance; and a field of equality in opportunities:

> The larger the corporation, the more certain is the office boy to ultimately reach a foremost place if he is made of the right stuff, if he keeps everlastingly at it, and if he determined to become master of each position he occupies ... Everything is giving way and must give way to the one supreme and of fitness.[191]

Thus, Fuller's Everyman is a perpetual outsider with the ability to cross all social strata, yet able to transcend their respective myopias. In Fuller's public discourses in the fifties,

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[189]K.M. Conrad, "Technocratic Persuasion," p.35.
[190]M. Lerner, *America as Civilization*, p.540.

Everyman is a subject construction to challenge the institutionalization and corporatization of society which he felt had stymied his enterprises. This was in contrast to his more positive social views of industry and corporation during the late-twenties. Then, the corporation represented more than a new economic entity; it was a new social collectivity.

5.4.4.4. Everyman as an Individuated Man in Corporate America

In his construction of Everyman, Fuller tried to contain the historical anxiety experienced by individuals living under the effects of corporation and its culture. In particular, the anxiety, now a basic cliché, pertains to the powerless individual in the face of huge corporations of the post-industrial state. While previously, the corporation as society in the collective vision had promised some latitude of optimism, the real corporate world proved otherwise for most. By always viewing the concept of corporation positively since his aphoristic 4D-essays, Fuller's recourse to the issue of agency was to advance the significance of self-initiatives.

Fuller proposed that Everyman in the new corporate-industrial society was "not as a 'worker' but a 'regenerative consumer,' (a) discoverer, (a) selector, (a) interpolator of its processes, (a) formulator of its order."[192] Eventually, however, the Everyman as a secular agent gave way to spiritual one formed by "wisdom over conditioned reflexes." Despite his increasing ambivalence towards the idea of corporation, he believed that its excesses could be readily reformed. In 1969, for example, upon his engagement as a consultant to Bangor Punta Corporation to design its line of mobile vacation homes, Fuller worded a one page demand as a precondition of his contract. He demanded that the Bangor Punta gradually divest its profitable Wesson-Smith Division that produced a variety of crowd control devices, the foremost of which, its famous firearms. Bangor Punta did not divest these interests, but Fuller continued with his appointment.

Fuller's publicly rendered philosophy from the mid-fifties was an attempt to salvage his Everyman from the effects of vicious competition among corporations. The individualism Fuller prescribed was ideological, not economic. In this sense, he echoed the old-fashioned individualism of the Jeffersonian variety, which was characterized by the traditional myths of

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[191] J. Robertson, *American Myth, American Reality*, p.179.

[192] R. Buckminster Fuller, *Education Automation*, Garden City, N.Y.: Doubleday & Co. Inc., 1963, p.44, 46; see also Entry #537.51-537.54, *Synergetics 2*, pp.137-138.

farming or pioneering. Fuller's notion of industrial democracy was a type of organized cooperation around a "commonwealth" of industrial activities that required incorporated individualism. For this reason, Conrad located Fuller's character formation at the point of bifurcation in American culture, between the "highbrow...pale, bloodless gentility" and the "lowbrow...coarseness of the business civilization-the natural descendent of a utilitarianism fathered by the necessities of the frontier."[193]

A critic noted that while personalities like Fuller left behind institutions to become one in their own right, the process of the transformation was paradoxically enabled by the colossal scale of media society.[194] Fuller forged his legacy ideologically by proposing that his Everyman, though individuated, is a universal man. The self-sufficient Emersonian man, as an exemplar of the individualistic man, was limited to merely perpetuating his own potential. In contrast to the individualistic man, Fuller's universal man was endowed with teleological powers through his experiences to affect the human race as a whole. Thus, Fuller's Everyman answered the challenge of how to augment an organized pursuit of abundance without redundancy, waste and destructive competition, and loss of self-identity. By accomplishing, increasingly, more with less through his artifacts, Fuller believed that he could circumvent the social-political question of resource apportionment. By constructing the myth of the Everyman, he believed he could address the loss of self-identity.

In practice, Fuller as an Everyman, however, bellies numerous paradoxes. As a selfless man, he was, by all accounts; fanatically individualistic. One of his biographers apologetically located Fuller's ego around the social conditioning of his upbringing:

> Even though on an altruistic level he felt that everyone's opinions were equally valid and that each person had something to offer, the practical side of Fuller often prevailed and brushed aside the feelings of some individuals in his attempt to be supportive of as many people as possible.[195]

As an average man, however, Fuller preferred to act alone rather than labor in the company of others. As an enthusiast of future society, his broad pattern of experiences was directed effectively in a rear-guard position against specialization. As an empiricist, his

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[193] K.M. Conrad, "Technocratic Persuasion," p.83.
[194] William Irwin Thompson, *Passages about Earth*, N.Y.: Harper & Row, 1973, p.31.
[195] L. Sieden, *Buckminster Fuller's Universe*, p.67.

disposition for the frontier created a prodigious contempt for theory. Nevertheless, it is only by seeing Fuller's construction of Everyman as an outsider, rather than as an iconoclast or as "subversive," that one could advance a critical account of his work.[196] Fuller was keenly aware of the dilemma posed by his chosen position. He implied this in the following encryption:

> Whenever I draw a circle, I immediately want to step out of it.[197]

Fuller's Everyman, initially standing for the new subject of an American technological utopia, would eventually represent all humanity when the broad phenomenon of industrialization envelops the rest of the world. Fuller offered this triumphalist end to his speculative world history:

> (T)he U.S. is the greatest democratic melting pot of all races and thereby constitutes the frontier force of industrializing man.[198]

In the same way, Guerin, in assessing Fuller's Everyman, echoed a similar Euro-centric view:

> (Fuller's) 'everyman' incarnates democracy as a citizen of the 'world community' that was chartered in 1492 and contracted for in 1781.[199]

Fuller advanced this optimism in spiritual terms when he claimed that his ego enjoined the design of the Great Intellect. With his passing, the sustenance and reproduction of Everyman would be perpetuated by Fuller's carefully appointed and timed artifacts.

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[196]From Notes transcribed by the Author of a video-tape Interview of Ed Applewhite by Duschany [uncirculated], ca.1992 (copy in BFI).

[197]R. Buckminster Fuller, *I Seem to Be a Verb*, p.5. This predicament of an outsider is curiously echoed in Margaret Fuller's confession regarding the difficulty to formulate the "whole":

> I often flattered myself that I was arriving at the center of things from which I could trace the general plan but ... I was forced back again upon parts. I was compelled to feel that by no process could I expand my mind to the needful UNIVERSALITY (*Ossoli, Ms. Works III*, quoted in Guerin's "The Fuller Mind and the Cosmic Vision," MSS in BFI, p.16).

[198]"'Life' of R. Buckminster Fuller," Dec.1941-Jan 1942, MSS in BFI-HEv18, p.10.

[199]K. Guerin "The New American Metaphysical Poetry: R.B. Fuller's 'How Little I know'," ca. 1982 MSS in BFI, p.3.

5.5. Appraisal

None of Fuller's artifacts was ever an anonymous object; rather, each was carefully cultivated in the public's imagination and intimately related to the inventor's life-history. In this way, the "biography" of the geodesic dome was intricately entwined with Fuller's life. Both were characterized by the sublimation of material and the resistance to tradition.

Throughout his life, Fuller viewed the effects of world industrialization, world corporations and a one-world community optimistically. Thus, the tenor of Fuller's overall project was concerned with the organic way to link their effects to individual lives. While his ambivalent actions and patronages on many occasions provoked skepticism and deep anxieties about the true intent of his projections, he nevertheless believed that his artifactual productions would become useful navigatory tools under an increasing trend of ephemeral reality.

Fuller was unremittingly convinced of the emergence of a new phase in American manifest destiny. This entailed America becoming a world society to spearhead a new world commonwealth; and the American as exemplar of "world man." These myths were aided no less by the mounting influence of America in world affairs, as well as by his own speculative history and anthropological construction. The latter was based on a set of environmental and technological determinants. However, under the aegis of the post-war American military build-up and the politics of the Cold War, Fuller's geodesic projects became inextricably entangled with them; a situation unfortunately caused by his opportunism and circumstances. Fuller became a beleaguered liberal caught simultaneously between fighting against and joining the Cold War. Despite his political ambivalence, Fuller continued to skillfully orchestrate and feed American public imaginations in the potentialities of his geodesic artifacts to transcend the excesses of political systems. This crusade was dramatized further by his own presentations and those by the public of his life as an exemplary "world man." His artifacts and his life, as artifacts collectively, became his persona. When the hyped pragmatism of geodesic structuring receded into the background, both Fuller the man and his life project regained the pristine innocence of their earlier missions.

The 4D-Dymaxion projects merged the ethos of the industrial-corporate landscape into the domestic space and directed it along the consumptive imperatives of mass-production and the aesthetic of lightness. The geodesic projects were destined to be ecumenical tools for any purpose, scale and locale. The skybreak-geoscope, particularly, marked the new symbolic envelop of his Everyman. The shelter-structure coalesced with energized networks of information and ever-transforming trends. The tool ensured, if not realistically, then ideologically access to information for individual control. In this sense, the utopic intent of the geoscope, like all previous artifacts, was to give a momentary repose in the dynamic world of human affairs and the uncertainties of fluid geography. That repose, afforded by visuality of amassed information, was a window towards a moment of control, albeit an illusory one. The first skybreak of 1948 consisting of his Dymaxion map and the great-circle dome was to enable "see(ing) one's geography correctly" so that one could make reasoned decisions independently of institutions. The updated geoscope expanded to include the mapping of planetary, institutional, and individual destinies. In collapsing all these categories of information, Fuller started from the confident level of the secularized Christian space of the self. He treated it as the veritable and final source.

Fuller's geodesic artifacts confidently suggested that one could create an alternative and a total living environment outside the structure of society. The omni-symmetry of Fuller's spherical geodesic structure, appearing half-mechanistic and half-organic, was by itself, self-referential. Besides the neutrality in geometry, it appeared complete and self-contained. The semantic basis for communicating its meaning was sited in the natural laws of energy and geometry. It was not dependent on the conventional devices of facades and decorations to communicate its intent. Fuller's projects, the geodesic artifacts included was intended to be neutral and a rarefied realm towards which all future desires would be predicated [Fig.5.07a].

Fuller's underlying assumption for imagining his artifacts was that in the post-industrial society, not only was the autonomous environment possible, it was inescapable. In Fuller's geodesic dome, there was no segmentation of realities - that is, no inside and outside. Set against a natural map of cosmic efficiency of the universe, and supplied with a mix-and-match "autonomous dwelling package," Fuller's final Garden of Eden epitomized the fruits of American industrial democracy. Through a two-way television, the geoscope as the final living room plebiscite would issue constant communal referendum. His artifacts, starting with the 4D-Dymaxion House and culminating in the geoscope, were efforts to reconcile the individualistic and isolated domestic sphere with the new and expanding demands of universal interests.

Against the invisible world forces that are shaping local destinies everywhere, Fuller's collection of artifacts was a panacea for the collective fear and anxiety of losing touch and control. More than a representation of the invisible and the previously imperceptible, Fuller's geodesic project was instructive of a way to dwell seamlessly in the universe and in the flux of human affairs.

The Geodesic Works of Richard Buckminster Fuller, 1948-68
(The Universe as a Home of Man)

Volume Two of Two

by

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1978

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Washington University-St. Louis
1981

SUBMITTED TO THE DEPARTMENT OF ARCHITECTURE
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY
IN THE FIELD OF
HISTORY AND THEORY OF ARCHITECTURE
AT THE
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
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Submitted to the Department of Architecture
on 30 April 1999 in Partial Fulfillment of the
Requirements for the Degree of Doctor of Philosophy in
The History and Theory of Architecture

ABSTRACT

The thesis investigates the geodesic structure and dome phase in the corpus of Richard Buckminster Fuller's artifactual production and writings. It offers a history of the meteoric rise of the geodesic structure, its production, deployment, reception and subsequent marginalization. The geodesic work, as a pinnacle of Fuller's life work, forms a multi-layered symbolic project with significance that extends beyond architecture. While the geodesic dome is an aspect of Fuller's many artifactual productions, it is studied here as a culmination of a set of ideas that Fuller developed and refined over a course of forty years, beginning with the 4D-Dymaxion House. These ideas represent a set of poignant observations and critique of design and design practices in particular, and of contemporary American culture in general.

At a cursory level, Fuller's invention of the geodesic dome in the late forties appears to be a historical aberration, given the traditional, deeply symbolic significance of the dome and the fairly entrenched modern aesthetic sensibility based on planes and asymmetry. Yet, over a period of twenty years, the geodesic invention reinvigorated a traditional archetypal form besides charging up new interests in all types of space-frame structures. The invention of the geodesic structure invention enjoyed professional attention and rallied public enthusiasm. However, with its swan-song at the Montreal Expo '67, it was quickly eclipsed and marginalized.

The thesis shows that Fuller's geodesic work is an attempt to create a seamless continuity between nature and society, following on the heels of his first attempt (in the 4D-Dymaxion House phase) to create a similar continuity between society and industry and between production and consumption. To understand any one of these aspects, one must posit the invention in the context of its inventor and the relationship of the desires he brought to bear on American society and culture in his time.

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Appendix I

An Annotation of a List of Drawings on Geodesic Structuring in J. Ward's The Artifacts of R. Buckminster Fuller. (Vol.1-IV) New York: Garland Publishing Inc., 1985.

General remarks

The third volume of the James Ward's compilation, The Artifacts of R. Buckminster Fuller, contains a cluster of drawings dealing primarily with the genesis of the geodesic invention, and its developmental prototypes. Overall, it is a poorly executed compilation that also lacks careful examination of the works.[1] The accompanying notes are inaccurate and the drawings are frequently mixed or chronologically listed in the wrong order. Among some of the outstanding example are:

1 The 31-GC(great circle) hub-and-strut construction on (p.20) was placed alongside the drawings of the venetian blind mock-up dome (pp.21-22) and a layout for an officer's quarter based on the Pentagon dome necklace-dome (p.23).

2 The actual 31-GC hub-and-strut construction (pp.28-30) were placed under the pan-type construction. Given that many of the extant drawings were blueprints rather than actual drawings; the bad reproduction makes closer inspection all the more difficult. Ward thus seriously erred where he suggested that there were "eight distinct types" of hub-details when there were only six in these GC-geodesics. (He probably referred to III:30.1, confusing two plans with the hub details)

3 D. Stuart's "vortexial vertexes" was designed as part of Skybreak Carolina, but was wrongly labeled Fuller Houses Inc. (p.87).

4 The Aspen Dome (p.77) was a 64-frequency breakdown, not a sixty-four foot dome as listed.

5 "Great Circle Mapping Device Booklet" (pp.11-19) contained l[illegible] material from the great-circle geodesic period (pp.17-19); likewise "Miscellaneous Geodesic Structures. 1950"(pp.37-68) contains preparatory drawings (pp.51-52; cf. pp.237-238) from the Paperboard Domes of the mid-fifties

6 There are substantial redundancies in drawings. See pp.41-42.

I have attempted to arrange the drawing chronologically as accurate as I could using evidence on the drawings, and through cross-referencing these drawings with extant notes and letters elsewhere in the BFI-archives. My own notes, made during the examination of the drawings, are indicated as "Note/s " "Notations," on the other hand, refer to notes,

[1]Bonnie Goldstein, then a volunteer at the Buckminster Fuller Institute in Los Angeles (BFI), recalled that Fuller assembled most of the extant drawings and documentations for the publisher, who in turn published the work in haste. This was confirmed by Prof. A. Tzonis, who edited the earlier series on Le Corbusier and Louis Kahn.

inscriptions, etc, left by either Fuller or his collaborators. In annotating the key geodesic drawings in Ward's compilation, I devised the following numbering convention:

e.g. **III:30.1 (BFI 15-53)** indicates that the drawing is drawn from Ward's Volume III, pg. 30, Dwg #1; information in brackets correlate with actual drawings in the BFI-Flat-file #15, Dwg. 53. Where two drawings appear in a portrait-format on a page in the Ward's compilation, I have them (for cross-reference purpose) numbered them from top to bottom; when there are three or more drawings, the numbers start from the top left and in a "Z"-route to the last in the right bottom. The title of each drawing is indicated next to the Dwg. # in italics.

1947

January – June. The following are the some of the drawings that Fuller worked on at Forest Hill-New York. [See explanation in R. B. Fuller, "Architecture Out of the Laboratory," *Student Publication* (University of Michigan, College of Architecture and Design), Vol.1 No.1, 1955, p.16ff.]

III:5.0 (not in BFI) *The icosahedron's 31 Great Circles (All Triangular areas. All right-spherical Triangles)*

Notes:

1 Notation: "Copyrighted 1947. (Signed by Fuller)"
2 Its earliest possible execution date is probably in the Fall '47.
3 The drawing is probably an inked (upside-down) version of **III:6.3.**

1948

May

III:6.3 (not in BFI) *Spherical icosahedron with 31 Great Circles All Triangle Grid*

Notes:

1 Notation: "(Signed). 5/1/1948", with breakdown of 10, 6 & 15 great circle groupings
2. Again, its early execution date is highly unlikely; probably wrongly backdated by RBF.

July. Fuller conducted the first summer session at BMC.

III:21.1 (BFI 15-37) *1949 FRF Dymaxion Geodesic Structure Twenty-five Great Circles*

Notes:

1 Spherical trigonometry using Napier Rules.
2 Six groups/lines of with standard positions of the great circle intersections

III:21.2 (BFI 15-35) *Dymaxion Geodesic Structure Thirty-one Great Circles*

Notes:

1 Drawn at full scale.
2 Six groups of assemblage line; each group has a combination of chords A-B-C-D-E of F; each with an angle descriptor, arc an chord length.

III:21.3 (BFI 15-38) *Dymaxion Geodesic Structure Thirty-one Great Circles. L-frame, left and right basic triangles and five typical joints Dwg.1*

Notes:

1 Full-scale, radius of 30"

III:21.4 (BFI 15-36) *Dymaxion Geodesic Structure Thirty-one Great Circles. L-Frame Dwg.2*

Notes:

1 Full scale.

III:22.1 (BFI 15-41) *Dymaxion Geodesic Structure Thirty-one Great Circles. L-Frame Templates Dwg.3*

III:22.2 (BFI 15-39) *Dymaxion Geodesic Structure Thirty-one Great Circles. U-Frame, Left & Right Basic Triangles, and five typical joints. Dwg.4*

Notes:

1 Full scale, 5 sets of joint details.

III:22.3 (BFI 15-40) *Dymaxion Geodesic Structure Thirty-one Great Circles. U-Frame Templates and Left Basic Triangle Dwg.5*

Notes:

1 Full scale.
2 End of each piece variously chamfered sides.
3 Also refer to Photo #O-4 (R.W. Marks, The Dymaxion World of Buckminster Fuller, p.179).
4 Though dated 1949, these drawings were probably completed at ID-Chicago in the Fall'48. The listed credits included the following:

Drawn by: Brock Arms, George Welch
Structure: Louis Caviani, Walter Ferris & Arthur Molnar

5 Marginalia, undated (by RBF) on the back of Dwg. BFI 15-40:
"Fuller Res. Foundation Chi-Inst. Des. Geodesic Structures By Fuller's class at ID. Lic(ensed) under his patent applied for."

6 Though patent rights were not applied for until 1951, the claims made on the drawings were used as deterrent for potential infringement (cf. use of the stamp "OBSOLETE" to disguise up-dated and corrected details)
7 The diagrammatic line assembly reinforces notion of "nature's energy continuum", re-configured in an energy lattice.
8 These drawings probably represent the 48'-D BMC supine-dome made of 2-inch Venetian slats

1949 Work accomplished October through December at ID-Chicago ca. January, completion.

III:30.1 (BFI 15-53), undated and untitled (but probably an earlier version of BFI-15-50, 15-51 and 15-52)

Notes:

1 Hub Details, Six types (A, B, C, D, E & F).

2 The lips on the hub suggests that it was to be cast; with ball centering studs of 17/64 inch.
3 Each tube slot on the hub, uniquely angled -- thus each hub is asymmetrical in profile.
4 Each hub has a standard cap-piece hides this asymmetry; the cap is to screwed onto the hub.
5 Tubes are presumably held in place at each if the six hubs by friction.

III:28.2 (BFI 15-50) *Tube-Hub Construction. 31GC*
Four Hub-details (#1 through #4) [162 required]

Notes:

1 Hub #1 has twelve tube-locations; thirty required at identical diamonds completing sphere.
2 Hub #2 has four tube-locations; sixty required.
3 Hub #3 has nine tube-locations; twelve required.
4 Hub #4 has six tube-locations; sixty required.

III:29.1 (BFI 15-51) *Tube-Hub Construction. 31GC*
Four Hub-details (#5 through #6) [80 required]; each location with tension pins (740 required)

Notes:

1 Hub #5 has four tube-locations; sixty required (fifty whole; ten half).
2 Hub #6 has nine tube-locations; twenty required.
3 Also **six** tube lengths required: the chord length is a (function of chord factor x radius of structure) minus diameter of the hub.
For example, Component #22, 60 required: Chord Factor = (0.3845 x radius of structure) - diameter of the hub.

III:29.2 (BFI 15-52) *Tube-Hub Construction. 31GC Section Assembly*

Notes:

1 Shows five lines of assembly, according to the great circle tracks.
2 Undated, but probably drawings made for the 14' D, 31GC **Pentagon Necklace Dome**.
3 The fundamental design change simplifies the assemblage via the **tension pin**, connected to the end of tubes (screwed?).
4 There are also six hub-sleeve details connected to be fitted into each hub. Each sleeve has holes, numbers and positions coordinated and positioned like its corresponding hub; hence the six varieties indicated. They are fitted from above, with holes revealing past the hub-line.
5 Wire/cables are to be woven through these holes; as the notes suggests "tension applied to structure from inside." If executed, this dome would have been the first tensegrity dome. This is a fundamental design transformation; one that Lindsay would develop with greater sophistication, with his rod/spike construction.
6 Though considerably simplified without screw details; it is clear from the detail-parts are elaborate, requiring high tolerance and skillful machining.

1949 <u>ca. January</u>, ID-Chicago

III:25.3 (BFI 15-45) *Geodesic Structure, 40" Diameter, Pan Type* (Also see Photo, III:24.1)

<u>Notes:</u>

1 Four component triangles; Drawn (designed by J. Lindsay).
2 Notation: "Plastic sheet 0.20" thick, hooks 3/16"-dia centered ribs 1" from edge-slot 60-degree. Assembly by elastic band staples 3/16" locator Rivnuts Ribs 3/4" wide."
3 Metal molds were used to fabricate the panels
4 Ltr. 8/2/49 John & Jano Walley to Daisy Igel & Polita in BFI-CR134, described the structure as a "curved space geodesic structure."

III:26-1 (BFI 15-46) *Geodesic Ring Assembly. Representing 1/5 section hemisphere. 31 Great Circle Structure.*
III:26-2 (BFI 15-46A) *Geodesic Ring Assembly. Representing 1/5 section hemisphere. 31 Great Circle Structure.*

<u>Notes:</u>

1 These two drawings are identical; interestingly the first attributed to FRF-Canada, and dated January 1949; the second signed as JL (probably J. Lindsay).
2 Both are position maps for six rings of the four pan-type triangles listed in **III:25.3 (BFI 15-45).**
3 They represent two halves of the right and left basic triangles of the GC subdivisions.
4 Compare **III:26-2 (BFI 15-46A)** with a drawing dated 25/9/49 by J. Lindsay in BFI (unnumbered) titled "31 Great Circle Geodesic Structure. Vertical expression Chart."

1949 <u>after February 1949</u> -- ID-Chicago

III:23.1(BFI 15-42) untitled
III:23.2(BFI 15-43) untitled

<u>Notes:</u>

1 Undated, but plans for a geodesic structure with free-standing partitions (labeled Lower and Upper levels).
2 20-sided geodesic structure at base-line.
3 Lower level with cooking, dining and living; Upper level with three bedrooms, bath and dressing.
Probably done after **Pentagon Necklace Dome**, to show how the dome could be used as Navy-Air Corp barracks.
4 Correlate this to the development of the autonomous package unit (TBI) at Chicago

<u>Summer at BMC</u>, second session

III:25.1 (BFI 15-46) *Aluminum Pan Construction. 31 Great Circle*
III:25.2 (BFI 15-44) *Dome. Aluminum Slat and Pneumatic Bag*

<u>Notes:</u>

1 Four pan types to be cut out of a 48"x30" sheet
2 Notation:

Material-aluminum blind slat stock, 30# required of each.

3 Slat differentiated by central angle, chord factors, R(ight) or L(eft) triangle, joint, internal/external.
4 The slats were meant to be folded into U-shape; the slats with Rivnut-holes to be connected to the strut (?) and filled in between with "inflated plastic sac filler", and clipped in place.
5 The slats appear to be modified from those of the serpentine-dome.

Notes:

1 Pan types here were probably considered as a way to cover the hub and strut dome.
2 Compare with J. Lindsay's own work on 48" plexiglass sheets.

December

III:37.1 (BFI 15-75) *31 Great Circle Geodesic Structure No.1 Type* -- 15 Great Circles sphere
III:38.1 (BFI 15-76) *31 Great Circle Geodesic Structure No.2 Type* -- 10 Great circles sphere
III:38.2 (BFI 15-77) *31 Great Circle Geodesic Structure No.3 Type* 6 Great circles sphere

Notes:

1 This group of drawings are to be treated as a set.
2 Dated and drawn by J. Lindsay; attributed to FRF-Canada.
3 This is a mapping of the positions of the great circle group in relation to one another. Each mapping is taken at the equator.
4 (A-F) segments suggest six hub types.

1950

March 9
III:60.1 (BFI 15-134) *Data Sheet*
III:60.2 (BFI 15-135) *Basic Triangle of 15 Great Circle Sphere (Chord factors and arc angles)*
III:61.1 (BFI 15-137) *Basic Triangle of 15 Great Circle Sphere (Interior angles)*

Notes

1 The drawings identify 16 triangle types, 15 vertices, 12 exterior edges, 18 interior edges.
2 **III:61.1** is probably a part of the set.
3 The vertical components of the right triangles are redundant, eventually replaced by **III:61.2**; even in this drawing, chord DE is redundant.
4 This series was executed at MIT, probably by Fuller & Don Richter (DR, elsewhere as DLR).

ca. March 1950
III:62.1 (BFI 15-138) *15 Great Circle Vault Facet Structure*
III:63.1 (BFI 15-139) *15 Great Circle Vault Facet. Nomenclature*

Notes:

1 Both drawings by J. Lindsay (JL), attributed to FRF-Canada

2 Probably a latter version, compared to **III:60.1-2 & III:61.1** , the triangular breakdown now is based on the bisectors of the three interior angles of the basic triangle.
3 Central hub of the basic triangle has six-struts; the vertices with twelve, eight and twenty struts respectively; the three hubs on the triangle edges with four struts each. It is obvious from this allocation of struts to the hub that one of the vertex has a disproportionate number of hubs, almost an impossibility to coordinate and construct, given the tooling tolerance level.
4 Worked out a range of dome sizes from 15'-D to 60'-D; with corresponding lengths, circumferences, dome seam length, dome area and dome volume.
5 More detail on the chord factors.

ca. March 1950
III:61.2 (BFI 15-136) *Typical Triangle Left Side. 15 Great Circle Unit Module (3-Way Grid)*
Notes:
1 Probably a later version of **III:60.1-2, III:62.1 & III:63.1**

May 10
III:65.1 (BFI 15-141) *Sphere involute 31'-Radius*
Notes:
1 Drawing done by Don Richter (DLR)
2 A six-frequency dome, **but not listed as such**; represents the most advanced sub-division to date.
3 Specification of base-line of the sphere.
4 Probably linked to III:67-1; also to NGS-1 "31'-R Plan of Sphere Involute."

ca. early-May 1950
III:53.1 (BFI 15-115) *Table of Central Angle (ARC) Cord and Cord Segment (Truss or Truncated Central Angle isosceles triangle) of Three-way Grid, Uniform Module-Edge Spherical Equilateral Triangle of 8 spaces (on Icosahedral)*
Notes:
1 Four strips with markings of Chordal factors.

III:53.2 (BFI 15-116) *Data Sequence of 4 Unique Structural Component of 3-Way Grid of 8 Interval Icosahedron*
Notes:
1 with Euler's Law: V+F-2=E (Vertex, Faces & Edges)
2 2360 pieces of strips per sphere (60 yellow, 60 brown, 120 green, and 30 red)
3 The nomenclature of "interval" rather than "frequency" was used. Probably an earlier version than May10-version.

May13
III:67-1 (BFI 15-147A) *Sphere Involute 21'-Radius*
Notes:
1 Probably linked to III:67-1; also to NGS-1 "31'-R Plan of Sphere Involute."

2 Listed as Dwg. #F1.

<u>May 19</u>
III:67-2 (BFI 15-145) *Sub-divided 15 Great Circle*
<u>Notes:</u>
1 Appears to be three types of sub-divisions of triangles, listed from left to right as Division 4, 3 & 2.
2 Drawing done by L. Caviani

<u>May 29</u>
III:68.1 (BFI 15-146) *Sphere Involute 20'-R*
<u>Notes:</u>
1 Hub Design, vertex hub & joint types -- depending on what joint, different hub
2 Listed as Dwg. #F7

<u>May29</u>
III:66.1 (none) untitled
III:66.2 (BFI 15-143) *Unit 20/F Vent*
<u>Notes:</u>
1 Construction assumed a pent-hex panel construction
2 Probably related to **III:66.2** [not listed in BFI], which shows hexagonal panel.
3 Listed as Dwg. #F5, cross-section of the pentagonal panel with vent; scale of 1inch: 1 ft.

<u>June 16</u>
III:71.1 (BFI 15-151) *Cast Aluminum Hub and tube terminal for 8, 16 and 32 (frequency) 3-Way Geodesic Dome (Both Single Shell and Hex-pent Involute)*
III:71.2 (BFI 15-152) *Cast Aluminum Hub and tube terminal (Axonometric)*
<u>Notes:</u>
1 Both items are full size drawing, by Don Richter.
2 Tube fits over "insert stub" with different types of fastening -- from "spot weld, brazing, rivets or adhesives."
3 The hub contains two parts held in place by an eye-bolt, nut and coil-spring; the eye-bolt for holding up tent.
4 This is the "sliding joint" that Fuller referred to in his 1951 patent application. The fundamental innovation in this joint is that it not a dedicated joint, rather it acts as a general one -- to allows for adjustments at different angles; final position of the struts were "locked by gravity compression."
5 The angle of lower hub piece is fixed at 20-degree; but with adequate clearance for larger angle tolerance. RBF would later propose this feature suitable even for his involute domes.

<u>July 9</u>
III:50.1 (BFI 15-109) *8-Piece Basic Assembly Unit (Assemblies 30 per sphere)*
<u>Notes:</u>
1 Dated and signed by R. B. Fuller.

2 Notation:

with uniform boundary scale, 15 Great Circle Unit, as Diagonal 5-star to 5-start diamond removed and short great circle inner grid terminals. Cross spliced to form equivalent (triangles) along basic edge - two boundary scale is invisible. EGG CRATE SCHEMETICA. For 3 way-grid of Great circles based on uniform boundary scale of basic spherical-equiangular equilateral (triangles) in this case 8-fold edge subdivision, in uniform module, of spherical **icosahedron** triangles.

3 Contains "five prototype production components" -- with grooves cut in proportions of 1/4, 1/2, 3/4 or 1/3 and 2/3 with respect to unit thickness of the slat

4 Despite the thickness of the slat, the egg crate remained a fundamentally 2D triangulated network (not a 3D truss)

5 See also Ltr. 7/25/50 J. Lindsay to Don Richter (Chicago) in BFI-CR133, mentions of drawings for the egg-crate grid. Both J. Lindsay & D. Richter worked on this dome variety in New York City, and mentioned difficulties with it, namely "unit 1" and "unit 3" crosses itself three times.

<u>July 9</u>

III:49.2 (BFI 15-108) untitled

<u>Notes:</u>

1 Notation:

This basic assembly bandages across common edge of adjacent spherical equi-angle side triangles and by progressive overlay of extended ends beyond basic diamonds of 4 Basic (1/6) Equilateral triangles crosses itself to create 3-Way Great Circle Grid.

2 Uncrossed assemblies may be bundled.

3 Resembles **III:50.1**; but a whole system entirely with three types of joints characterized by the number of intersections -- three, four and five-way (with the five-way acting in compression, that is the closing pentagon).

<u>August 7</u>

III:44.1 (BFI 15-98) *3-Way Grid Uniform Boundary Module. Great Circle Data*

<u>Notes:</u>

1 Related to the Drawings **III:39.1-4, III:40.1-4 & III:41.1(BFI 15-78 through 88)**: the drawing identifies 9-hub types

2 Also related to the two data charts **III:41.2 & III:41.3 (BFI 15-89) and III:41.4 & III:42.1 (BFI 15-87)**

3 Also related to **III:55.2 (BFI 15-127) III:56 1-4 & III:571-4 (BFI 125-132), III:58.1-4 & III:59.1**

4 Triangles A-J (10-types) with six combinations of diamonds, hence the name "6-Diamond Structure"

5 [III:44.2 is a variation], signed by R.B. Fuller

<u>*August 15</u>

III42.2 *3-Way Geodesic Grid 4 Module Stress Flow Balance and Single Zigzag Component Completing sphere and self-weave locking*

<u>Notes:</u>

1 Not in BFI Drawing File; but see version in Figure 8, BFI MSS "Noah's Ark" 50.06.02.

2 Notation:

> This pattern shows 2-Way synchronization and 3-way yield and basic 6 function satisfaction with singling out at external edge for complementation by adjacent triangles.

*August 15

III:45.1 (BFI 15-99)

III:45.2 (BFI 15-100) [See version in BFI MSS "Noah's Ark" 50.06.02, p.20] *High Speed Expanding, Skinned & Trussed 3-Way Geodesic Structure*

Notes:

1 See versions of both in BFI MSS "Noah's Ark" 50.06.02, p.20]

ca. August 1950

III:48.1 (BFI 15-105) *Truss Dimension Stretchout of Basic Triangles Grouped by Diamonds*

Notes:

1 Related to **III:44.1 (BFI 15-98)** and **III:41.2 (BFI 15-89)** because of color reference and coordination of the chord factor.

2 Also contains a summary of triangular truss dimensions for the whole sphere; overall truss length of 10 Basic Triangles.

ca. August 1950

III:39.1 (BFI 15-80) *Hub #1(c)*
III:39.2 (BFI 15-78) *Hub #2*
III:39.3 (BFI 15-81) *Hub #3*
III:39.4 (BFI 15-79) *Hub #4*
III:40.1 (BFI 15-84) *Hub #5*
III:40.2 (BFI 15-82) *Hub #6*
III:40.3 (BFI 15-85) *Hub #7*
III:40.4 (BFI 15-83) *Hub #8*
III:41.1 (BFI 15-88) *Hub #9(a)*

Notes:

1 These are a group of nine-drawings, indicating simultaneously the position of the slat and the angles they fit at the hub and in relation to adjacent slats.

2 possibly for the creation of templates to cut slats.

3 But why nine hub types, when six would have sufficed for a low frequency 31GC?

4 Drawings were attributed to FRF-Canada.

5 **III:41.1 (BFI 15-88)** shows the closing hub of five struts (pentagon).

August 10 1950

III: 54.1 (BFI 15-118) *The Self-Gripping of Structural Parts*

Notes:

1 Dwg. Is a variation of **III:54.2**.

1 Notation:

> Here is disclosed the sublimely simple system by which domes and spheres may be deep truss structured without fastenings other than the self-gripping of structural parts zig-zag..."

By "deep truss,"Fuller probably referred to the advantage offered by truss-flange ratio of 10:1, see thumb-nail sketch in **III:49.1**.
2 A & B strips suggest that the "zig-zags" referred to previously in **III:41.2 & III:41.3, III:48.2 & III:49.1.**
3 RBF's marginalia:

> Invented August 10 1950 as a consummation of a series of inventions and discoveries over the past two years all stemming from my 3-way great circle uniform boundary (patented) projection.

4 Significant production process outlined, which Fuller would returnto in the Paper-board dome (1956):

> each zig-zag is interwrapped with the other *by the method of patterning the strip* as a continuous rolled strip onto which all the cutting and folding lines are roto printed."

<u>ca.August 1950</u>
III:41.2 & III:41.3 (BFI 15-89) *Data for Zig-Zag Truss for 3-way Grid of Uniform Boundary Module Geodesic Structures of FRF*
<u>Notations:</u>

> (T)o be covered with nylon and polyethylene skin pre-sewn and attached. Truss is however 'final' and not improvised - may be skinned opaquely, etc."

<u>ca. August 1950</u>
III:48.2 (BFI 15-106) *'B' Zig-Zag Strip*
III:49.1 (BFI 15-107) *Production Strip Patterns of 'A' and 'B' Zig-Zag which Interact to Comprise A Complete 3-Way Grid Trussed All Triangle Sphere. Requiring No Other Fastenings*
<u>Notes:</u>
1 Shows fold lines and alternating cut lines; portions proportioned according to chord factors.
2 Probably related to **III:41.2 & III:41.3 (BFI 15-89)** "Data for Zig-Zag Truss for 3-way."
3 DrawingS illustrate the folding into U-shaped zig-zags.

<u>ca. August 1950</u>
III:41.4 & III:42.1 (BFI 15-87) *Data for 6-Diamond Structure*

<u>ca. August 1950</u>
III: 42.3 (BFI 15-93) [similar to III:42.2] *Typical Dymaxion Projection. 3-Way Grid Great Circles interaction between uniform boundary scale sub-divisioned triangle from 60-degree to (angles) up to 180-degree (angles)*

<u>ca. August 1950</u>
III:55.2 (BFI 15-127) [similar to III57.3, expanded version] *Uniform Boundary Divisions Generated by Three-way Grid Geodesic Structures.*
Notes:
1 480 assemblies per sphere (8 types of diamonds of which two are handed; 60 pieces for each of the 8 types, making a total of 480)
III:56.1 (BFI 15-125) *No.1 Red Diamond (A-A)*

III:56.2 (BFI 15-130) *No.2 Orange Diamond (C-B)*
III:56.3 (BFI 15-128) *No.3 Orange Diamond (D-E)*
III:56.4 (BFI 15-131) *No.4 Orange Diamond (F-G)*
III:57.1 (BFI 15-129) *No.5 Orange Diamond (H-H)*
III:57.2 (BFI 15-132) *No.6 Orange Diamond (I-J)*
III:57.3 [Expanded version of III:55.2]
III:57.4 [Variation of III:56.1]
III:58.1 [Variation of III:56.2]
III:58.2 [Variation of III:56.3]
III:58.3 [Variation of III:56.4]
III:58.4 [Variation of III:57.1]
III:59.1 [Variation of III:57.2]

ca. August 1950
III: 46.2 (BFI 15-102) *High Speed Expanding, Skinned & Trussed 3-Way Geodesic Structure*

Notes:

1 cf. Original Sketch **III:45.2 (BFI 15-100)**, signed and dated 8/6/50.
1 Basically a collapsible trussed-structure, with compression rods and tension members between hubs of two types, one slack (fixed tension) and the other unfastenable (hook cable tension). The hook cable tension completes the two tetrahedron truss grid.
2 Proposes two ways to make the dome skin for a tube-ball-cable "necklace structure":

> a. four strips of nylon sewn in a diamond, with zippers along the edges
> b."pillowcase" which are presewn nylon envelop per unit diamond

ca.1950
III:55.1 (BFI 15-110) *Production Stretchout of Structural 'Diamond' Two Spherical Tetrahedrae, trussed between radius of 2 magnitudes*

Notes:

1 Intended for a 22.5-foot (outside) radius dome; 22-foot inside.
2 Sheet size of 16ft x-ft.
3 Notation:

> I learned that in folding map, truncated tetrahedron of spherical assemblies are independently rigid trussings. Therefor (diamond) assembly of tetra with elongated sets of 4 edges as truncated sections of central -chordal triangles successfully truss the structure by 3 trapezoidals related by 2 (triangles) or 5 trapezoidal by 4 (triangles).

4 Correlate the sheet size with arguments for making a 8-frequency dome (in "Noah's Ark #2" p13), that is keeping down size to reduce waste and keeping down weight to facilitate "handability."
5 Six different types of triangles were envisaged.

ca.1950
III:59.2 (BFI 15-133) *LOGISTICAL i.e. (Strategic Complex of types - parts -weights - energy-time- input-output) inventory of 3 way grid 8 unit edge structures.*

ca. 1950

III: 47.2 (BFI 15-104) *Assembly component and Routine for Plastic Fabric Covered Zig-Zag truss Units (of metals, plastics or fibrous boards) of 3-way grid. Uniform Edge (disappearing) module Geodesic Structure formed or spherical Icosahedron*

Notes:

1 Possibly to complement, the collapsible trussed 3-way Geodesic Structure, the tube-ball-cable "necklace structure" with hook-cable tension, in **III: 46.2 (BFI 15-102)**

2 Also contain a sketch of an omnibus "foldable roll-around see-saw ladder...that pivots to any position in the dome."

3 III:47.1 is a preparatory version.

1951

III:70.1 (BFI-15-149) *8-Frequency Geodesphere*

III:70.2 (BFI-15-150) *8-Frequency Geodesphere*

Notes:

1 Executed as part of FRF-NC and drawn by Duncan Stuart (DS); to be constructed in wood

2 Rather than geodesic dome, D. Stuart appropriately termed it a sphere

3 One is a plan rendition of the hemisphere; the other shows subdivisions as dodecacap, icosacap and hemisphere.

III:69.1 (BFI 15-148) *Zig-Zag Assembly. 3-Way Grid. 10 Frequency*

Notes:

1 Drawn by W. Reid

III.79.1 (BFI 15-156) Strip Schedule. 16 Frequency Skybreak

Notes:

1 Designed by Duncan Stuart, FRF-Raleigh, N.C.

2 There are six categories of strips, with nine variables:

a profile of the ends of the strip-chamfered or straight (6 variables)

b spacing of notches, on one or both sides (3 variables)

3 Development from **III:50.1 (BFI 15-109)**.

4 Grouping structural information by material, section, weight per linear foot, number of pieces required of each strip.

III:77.1 (BFI 15-153) *Proposed 64(frequency) Geodesic 'Skybreak' For Aspen Colorado*

Note:

1 Designed by Duncan Stuart ,Skybreak Carolina.

The following drawings in BFI were bond together and numbered in red pencil from 1 through 24; probably executed at the time when Fuller was assembling the drawings for Ward's Compendium:

1 BFI 15-93	2 BFI 15-136	3 BFI 15-115	4 BFI 15-116
5 BFI 15-98	6 BFI 15-87	7 BFI 15-89	8 BFI 15-105
9 BFI 15-108			
10 BFI 15-109	11 BFI 15-127	12 BFI 15-125	

13 BFI 15-130

14 BFI 15-128 15 BFI 15-131 16 BFI 15-129
17 BFI 15-132 18 BFI 15-110 19 BFI 15-135

20 BFI 15-102 21 BFI 15-104 22 BFI 15-118
23 BFI 15-106 24 BFI 15-107

These drawings lodged in BFI was not featured in the in Garland Series Drawings:

1949

August 15
NGS 3.1-3.5 *A Series of 5 Drawings Hyperbolic FRF Geodesic 1949*
(RBF's notation on verso Dwg. B5)
NGS3.1 *Dwg. B1. Rib 'R' Curved Space Geodesic*
NGS3.2 *Dwg. B2. Ribs 'T & N'*
NGS3.3 *Dwg. B3. Ribs 'O & P'*
NGS3.4 *Dwg. B4. Ribs 'S & J'*
NGS3.5 *Dwg. B5. Ribs 'Q & M'*
Notes:
1 Full Scale Drawing by Harold Young

August 9- 18
NGS 4.1-4.3 are a series of three drawings.
NGS 4.1 *Dwg. A3 Curved Space Geodesic Triangles and Details*
-- Drawn by D. Richter; scale (3" to 1'); dated 8/9/49
NGS 4.2 *Dwg. A2 Isometric of Key Triangles. Curved Space Geodesic*
-- drawn by D. Richter; dated 8/11/49
NGS 4.3 *Dwg. A1 Key Triangles*
-- Drawing was dated 8/14/49; drawn by Y. Martinez, with no scale, showing a total of 24 triangles.

September 25
NGS-2 *31 Great Circle Geodesic Structure. Vertical Expansion Chart.*

1950

May 13
NGS-1 *31'-R Plan of Division of Sphere Involute*
Notes:
1 Drawn by Don Richter (DR)

Appendix II

A Chronology of Geodesic Dome projects

The list offered here is not exhaustive. Rather, it is primarily based on the extant of projects and actual domes described in this dissertation. The dates are based on the project start date rather than completion; the latter, where pertinent is indicated in []. Materials for the chronology are drawn from various sources, the most useful one (up to 1953) being two editions of Fuller's privately published Dymaxion Index (Edn.1: 1927-47; Edn.2: 1927-53, indicated as Edn.1 & Edn.2 respectively).

1942

May R.B. Fuller showed Elsa Maxwell his **map of "squares and triangles."** [Source: Elsa Maxwell, "Elsa Maxwell's Party Line. Designs for Living," *New York Post* 10/22/42, p.12.].

1944

Fuller, as the Head Mechanical Engineer, Chief of Mechanical Engineering Section-Office of Economic Warfare (FEA) claimed that he:

> Discovered and developed **Energetic Geometry** as a basis for complete revision of the Comprehensive System of mensuration, which is the means of technology integration of advanced science into industrialization." [Source: Item #4, Entry in Fuller's Memorandum of Activities, p.5].

Jan. **26 January. U.S. Patent #2,393,676** issued to Fuller for his cartographical method based on a spherical cube-octahedron. Patent claims were filed on February 1944.

Development of Energetic Geometry at Forest Hills (N.Y.) [Source: Dymaxion Index 1927-1953, second edn., p.52]; Beginning of lecture circuit

Fall Fuller recorded that he "assembled a four-foot diameter 3-way grid geodesic structure at (his) Forest Hills New York apartment, and that winter and spring (he) made two more four footers" [Source: R.B. Fuller, "Architecture Out of the Laboratory," p.17].

1948

Among the projects cited as "underway" was Energetic Geometry, exploration of a new comprehensive system. [Source: "Index of Survey of Fuller Research Foundation.5/1/46 to 3/8/48," ca.1948, BFI MSS 46.08.01]

Jan.-Jun. **Undertook self-study on Energetic Geometry at Forest Hill-N.Y.** [Source: "Loose Notes," variously dated form 1/1/48 through 5/27/48 in BFI-EJA Blue]

May Fuller's first version of the 31-GC (icosahedral) geodesic, imagined in the form of diamond modules [Source: BFI-EJA Blue Trunk, reproduced in this dissertation as Fig.2.07]

1 May. Dwg. of 31-GC gridding [Source: J. Ward, The Artifacts of R. Buckminster Fuller, Vol.3, p.5].

May 15. Fuller's earliest sketch on "private sky" in which he proposed that one's "sky" within the dome "maybe surfaced(sic)...with sections of global map with corresponding zenith corresponding with zenith of 'sky' and oriented accurately to the north. **Thus the inhabitant may see his geography correctly**." Fuller explained that the inhabitant "can follow constellations and start paths and tell date and hour by location -- sun clock in day, star clock at night."

June Fuller conceived of the great-circle geodesic as a "private sky" dwelling [Source: R. Buckminster Fuller, Loose Notes, 6/15/48 in BFI-EJA Blue.]

Summer

June-Sept. Summer Session at BMC Fuller arrived at BMC in June with his "magical world of his mathematical models" [Source: M. E. Harris. "Art As Experiment: From The Arts At Black Mountain College," *The American Poetry Review*, May/June 1987:7-17].

BMC 36-hours of Dymaxion Architecture. "Geodesic Structures and Philosophy"

Sept. Public demonstration of his 48-footer 31-GC "supine dome" made from aluminum Venetian blinds. After "testing" the dome structure "looked like a pile of limp pastel spaghetti" [Source: M. E. Harris. "Art As Experiment: From The Arts At Black Mountain College," *The American Poetry Review*, May/June 1987:7-17].

Fuller called this dome the "first generalized prototype model" [Source: R.B. Fuller, "Architecture Out of the Laboratory," *Student Publication* (University of Michigan, College of Architecture and Design), Vol.1 No.1, 1955, p.17].

Sept "Geodesic Structures" & "Energetic Geometry" at ID-Chicago (100 hours on 'Wire-recordings")

December Completion of the 14-foot diameter, hub-and-strut, 31-GC dome at ID-Chicago, also known as the "**necklace geodesic**." at 6 Kinzie St., Chicago [Source: R.B. Fuller, "Architecture Out of the Laboratory," *Student Publication* (University of Michigan, College of Architecture and Design), Vol.1 No.1, 1955, p.17].

Fall — Fuller experimented on 31-GC structures of prefabricate triangles, pentagons and hexagons, using struts, hubs, and cables for pan, separate skin and strut components" [Source: R.W. Marks, The Dymaxion World of Richard Buckminster Fuller, p.178].
Fuller mentioned 14-foot aluminum pans, with "an equator to equator tension strap to hold the pans in place" [Source: R.B. Fuller, "Architecture Out of the Laboratory," *Student Publication* (University of Michigan, College of Architecture and Design), Vol.1 No.1, 1955, p.16.].

"Garden of Eden" project, ID-Chicago.

1949

Feb.-June — ID-Chicago, Spring session

1950

February — Fuller recorded that "at the request of the Air Force" his necklace geodesic was assembled in the Pentagon Building garden at Washington, D.C. This was a 31-great circles (GC), triangular necklace geodesic dome [R.B. Fuller, "Architecture Out of the Laboratory," *Student Publication* (University of Michigan, College of Architecture and Design), Vol.1 No.1, 1955, p.17].

Summer — Assembled a journal of his geodesic dome experiments as **Noah's Ark II**. "Written between Jan. to July/September 1950; "distributed" in final form in August 1950. From this (works) ... his first geodesic structure, December 1950" [Source: Ward's Artifacts-Volume III, p.35]
In BFI-MSS Noah's Ark 50.06.02 ("Discovering New Man (sic) Advantage"), Fuller noted on one of the illustrations, Fig.8:

> "This phenomenal discovered extrapolation into structural invention. (signed: R. Buckminster Fuller) throughout spring and summer of 1950."

Jan.-July — Fuller's choice of the icosahedron as the root polyhedron for his geodesic structure [Source: "Project - Noah's Ark #2," ca. Sept.1952].

October — FRF earliest domestic dome: 46-footer **Brewer Dome House.**

December — Fuller filed of claims for geodesic structure.

FRF-Canada "Weatherbreak", geodesic dome planned as a shelter in either Arctic or tropic regions, and easily transportable to remote areas, Montreal, Canada

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1951

Feb. — **FRF-NC Division was organized.**

Cardboard Dome, Yale University

June — Lawrence, New York, 3/4 sphere, Experimental wire structure

July	FRF-Canada's 'Weatherbreak," designed for the Arctic Institute of North America, Montreal-Canada.
Sept.	US Navy Bureau of Aeronautics (BUAer) expressed interests in the dome.
Sept.	MIT-Cambridge [?] Model designed for BUAer, as a student problem at MIT; A geodesic double-dome hangar with alternate quadrant 'open' and 'closed' registration.
Sept.	MIT-Cambridge [?] Model designed for U.S. Navy Bureau of Aeronautics (BuAer), as a student problem.
Oct.	FRF-Canada constructed for use as a ski lodge and weekend house Laurentian Mountains-Canada
	R.B. Fuller, "Deployment Problem" and "90% Automatic Factory", NCSC Design School (student publication), Vol2, #1October 1951. North Carolina State College 90% Automatic Cotton Factory: Model of 8-floor structure; the design was intended to show the possibilities of a vertical factory as opposed to the modern horizontal design which spreads out over many acres [Feb.'52].
	G. Nelson-Fuller's Bubble House ['52]
Dec.	12/12/51 **Claims for Geodesic patent filed.**

1952

Jan.	North Carolina State College (NCSC) 30-foot wood-slat experimental shelter, but two years later [in Jan.'54] was further developed, as a "cocoon dome" for use by Marine Corps as a mobile shelter. A 5/6 scale model of the shelter was lifted by a helicopter and successfully towed over a course of about one mile.
Feb.	The formation of Skybreak Carolina:
June	Duncan Stuart (FRF-N. Carolina) developed the geodesic "**Triacon**" for a four-frequency dome.
Nov.	Yale University, Paperboard structure. Erected by students on the roof of one of the University buildings to demonstrate the possibilities of low-cost shelter, easily transported, erected and dismantled, and providing a living space of 700 square feet. 276 triangular box sections of Kraft paper board; units glued together with a resin-based self-seal compound coated on the flanges.
	MIT student project: Living Accommodation for a Ford Ranch Wagon.
Dec	**Ford Rotunda Dome**, Dearborn Michigan. 93-foot clear span, 1/2 sphere First commercial application of Fuller's geodesic principles. Dome constructed to provide a weatherbreak for exhibition work in the inner

circular court of the Rotunda Building, erected for the 50th anniversary display of the Ford Motor Company [May '53].

1953

Feb.	Lincoln Lab-MIT. Test section on 18-foot dome.
April	Announcement in *FORD TIMES* that Fuller's geodesic structure would cover Ford Rotunda
May	**Woods Hole Dome**-Mass. Gunnar Peterson/Fuller 54-ft.dia., 1/2 sphere, used as a restaurant. Hyperbolic parabolic diamond sections constructed of Douglas Fir plywood [Oct. 1953]. North Carolina State College Dept. of Architecture, in collaboration with the Agricultural and Engineering Depts. 1/2 Sphere, experimental structure, 1"x 21/2" pine strips Polyethylene cover suspended on the inside of the dome frame University of Minnesota Senior project of architectural students who had attended RBF's lecture course at the University. Proposed as a thesis problem the development and completion of a tricontahedronal third-sphere and the development of a structural system which would be used for temporary housing of civil defense and post-disaster personnel. University of Oregon, Experimental Dome. Three materials were used in construction: Mylar "D" plastic covering, Goodyear Pliobond adhesive No.20, used to bond the plastic skin o the wood frame; Polyken No. 361, a weather-resistant tape used to seal exposed joints.
Oct.	Marines express interests in Fuller's dome projects.
Nov.	Princeton University-N.J. Sphere built by 15 graduate students as a practical exercise in discontinuous compression. Weight is transferred through tension from interlocking point to point, thereby distributing it so generally that the entire structure can support applied at any one point.
Dec.	University of Minnesota 2/3 sphere, Experimental discontinuous compression sphere constructed by architectural students.

1954

Jan.	Choice of paperboard dome for Milan Triennale identified [July '55] **Radomes on the Distant Early Warning System** (DEW-line), 3000 mile strip of radar installations in the northern rim of Alaska and Canada; mostly 55-footers [1954-58].

Feb.	Tulane University 1/2 Sphere; 1/6 scale model, Prototype geodesic constructed by architectural students, designed for use as Marine aircraft hangar; illustrated the use of a large size dome as a rotating hangar.
ca. Feb	Col. H.C. Lane's "*Informal Report of a study of requirements and design of shelters for Marine Aviation advanced bases*"
March	University of Michigan 3/4 Sphere; to be used as a six-man personnel shelter. Diamond shaped sheets of corrugated paperboard reinforced with polyester resin, with special overlaps for joining and reinforcement; and fastened together with common staples.
April	North Carolina State College 1/2 Sphere; design utilized an improved version of Tulane basic triangular section.
May	Virginia Polytechnic Institute 3/4 sphere; demonstrated the geodesic dome truss type of construction to be used in large structures over 100ft in diameter.
June	Special BUAER (Navy Bureau of Aeronautics) Dome 1/2 sphere, Full scale model. Built of materials purchased by the Navy BUAer.
July	Quantico-Virginia (Fuller Paperboard Dome) 1/2 Sphere. The duplicate was exhibited in the Tenth International Exposition of Art and Architecture in Milan (the Milan Triennale).
Aug.	MIT-Cambridge/Marine Corps Schools-Quantico BuAeR Mark-III, 1/2 Sphere; 50'-diameter magnesium dome, for aircraft hangar, vehicular garage, field hospital, storage shelter, maintenance shop, parachute loft.
Ca. Sept.	Airlift of Mark-III, 50-ft magnesium dome at Quantico-Va.
Sept.-Dec.	Princeton, Washington University dome prototyping for the Marines. Washington University Mark-II Flying Seed Pod for the Swedish Fair Hälsingborg (H55 Fair)
	U.S. Patent #2,682,235 granted for Fuller's geodesic structure.

1955

	Minni-Earth Project Univ. of Minnesota 50-ft dia, 12-frequency geoscope project.
Aug.	Full-test of Geodesic Inc. (Cambridge) rigid geodesic radome at Huntington, R.I>

ca. Aug Col. H.C. Lane, "Final Report: A Study of Shelter Logistics For Marine Corps Aviation," USMC, 1955

O'Malley-Fuller Dome for the Brooklyn Dodgers (New York), 30-stuorey, 750-ft. aluminum geodesic trussed dome.

1956

June **The Kabul Dome**, Jeshyn International Trade Fair, Afghanistan [Aug'56].

Sept. Trade Fair Zagreb-Yugoslavia

Univ. Minnesota's **Minni Earth** project for the Blakewell Ledge in NY for UN.

Better Homes and Gardens (BHG) Plydome ['57]

1957

Jan. **Union Tank Car Dome**, Baton Rouge-Louisiana (UTLx) [March '58]

Nov. Kaiser's **Hawaiian Dome**

1959

Pease Dome [1964]

Graver Tank's **UTCC Mark-II** Dome, Wood River-Ill. ['61]

The Climatron, Missouri Botanical Garden (MBG), St. Louis, planned for Oct. '59 [Oct.'60].

1959

Jan. **Frobisher Bay Project**, 2,300-foot diameter "town-enclosure."

ca. March 250-ft dia **American Society of Metals** (ASM) Dome in Metals Park-Ohio,

May-Nov. **Three Structures** Exhibition at MoMA.

April **Moscow Dome** in Sokolniki Park, Moscow (Built by Kaiser Aluminum).

1960

Sept. **Visionary Architecture** Exhibition at MoMA, with Fuller's **Dome over Manhattan** project

1961

	Yomiuri Golf Club Star-dome ['64]
July	Fuller's World Design Science Decade – A ten-year "world retooling" design program launched.

1964

	Synergetics Inc. project for a 200-300ft. geoscope project for the New York Fair.
	U.S. Pavilion at Montreal Expo'67 [April'67]

1965

April	Harlem urban "revitalization" project
	Geodesia community, "**Drop City**" in Trinidad-Colorado ['67].

1966

Dec.	Tetrahedronal Floating cities, etc., also known as "Cloud Nine," "Sky Island." – among projects proposed to M. Shoriki.

1967

May	Idea for "Comprehensive Umbrella" for the city of East St. Louis proposed.
	X-MC (Univ. Minnesota)
	Triton City
1968	
Aug.	J.W. Fitzgibbon's "Full City Cover" for Kuwait City

1970

Nov.	**OMR City** project for East St. Louis-Mo.
	Charas Project in New York City [till '73]

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2 The location of material in the BFI-Archives which the author was not able to locate is indicated by BFI-[?].

3 Letters are sorted in alphabetical order according to the author's name.

Abbreviations used in this Bibliography

BFI	Buckminster Fuller Institute, Santa Barbara, Calif.
CL	Clipping Collection
CR	Chronofile
EJA Green or EJA Blue	Edward. J. Applewhite compilations, stored in the Green and Blue metal storage trunks at BFI.
HE	Hamilton Extracts (identified by volume), eg. HEv1 for Vol. 1, etc.
MBG-ARC	Missouri Botanical Gardens Archives (St. Louis, Mo.)
MSS	Manuscripts
RBF	Richard Buckminster Fuller
n.d.	undated

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1946

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1949

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1950

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1951

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Gardner, Maj.-Gen. Grandison (Dir., Air Installations, USAF-Washington D.C.). Ltr. 10/22/51 to RBF in BFI-CR134.

Haskell, Douglas.(Editor, *A Forum*) Ltr. 4/12/51 to RBF in BFI-CR137.

Koch, Carl. Ltr. 3/27/51 to RBF in BFI-CR137.

Lawler, J.T. (Commander, USN-Head, Aircraft Maintenance Branch, Bureau of Aeronautics, Department of Navy). Ltr. 9/27/51 to RBF in BFI- CR134.

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Marson, F.M. (Chief, Technical intelligence Branch, Engineer Research Development Laboratories, Fort Belvoir, Va.). Ltr. 10/12/51 in BFI-CR134.

Musgrove Jr., Col. A. M. (Chief- Installations Engr. Staff School, USAF Institute of Technology, Wright Field, Dayton, Ohio). Ltr. 2/1/51 to Carl Koch in BFI-CR137.

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1952

Alexander, S. O. (*International Markets*). Ltr. 3/21/52 to RBF in BFI-CR138.

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Fitzgibbon, J.W. Ltr. 4/3/52 to RBF in BFI-CR139.

Fitzgibbon, J.W. Ltr. 4/3/52 to RBF in BFI-CR139.

Fitzgibbon, J.W. Ltr. 5/8/52 to RBF in BFI-CR139.

Fitzgibbon, J.W. Ltr. 6/17/52 to RBF in BFI-CR139.

Fitzgibbon, J.W. Ltr. 6/7/52 to RBF in BFI-CR139.

Fitzgibbon, J.W. Ltr. 6/9/52 to RBF in BFI-CR139.

Fitzgibbon, J.W. Ltr. 11/20/52 to RBF in BFI-CR139.

Fuller, Richard Buckminster. Ltr. 1/23/52 to J.T. Lawler (USN-Head, Aircraft Maintenance Branch, Bureau of Aeronautics- Department of Navy) in BFI-CR134.

Fuller, Richard Buckminster. Ltr. 4/23/52 to Dir. of Hydrographic Office, US Navy in BFI-CR138.

Fuller, Richard Buckminster. Ltr. 4/23/52 to H. Fischer (Ames, Iowa) in BFI-CR138.

Fuller, Richard Buckminster. Ltr. 4/28/52 to J. Lindsay in BFI-CR139.

Fuller, Richard Buckminster. Ltr. 4/30/52 to R. Hamilton in BFI-HEv10.

Fuller, Richard Buckminster. Ltr. 5/23/52 to J.W. Fitzgibbon in BFI-CR139.

Howe, George (Chairman, Dept. of Architecture, Yale University). Ltr. 12/15/52 to RBF in BFI-CR146.

Lindsay, Jeffrey (FRF-Canada). Ltr. 5/21/52 to RBF in BFI-CR139.

Lindsay, Jeffrey. Ltr. 2/7/52 to RBF in BFI-CR139.

Lindsay, Jeffrey. Ltr. 4/3/52 to RBF in BFI-CR139.

Lindsay, Jeffrey. Ltr. 5/21/52 to RBF in BFI-CR139.

Lindsay, Jeffrey. Ltr. 5/9/52 to RBF in BFI-CR139.

Lindsay, Jeffrey. Ltr. 6/25/52 to RBF in BFI-CR139.

Lindsay, Jeffrey. Ltr. 6/3/52 to RBF in BFI-CR139.

Mango, Roberto. Ltr. 4/28/52 to RBF in BFI-CR138.

Parkhurst, W.M. Ltr. 5/9/52 to J.W. Fitzgibbon in BFI-CR135.

1953

Ahern, William. Ltr. 1/8/53 to RBF in BFI-E Series.

Ahern, William. Ltr. 2/20/53 to RBF in BFI-E Series.

Ferguson, R. C. (Fuller Study Group, New Haven, Conn.). Ltr. 3/31/53 to RBF in BFI-E Series.

Fitzgibbon, J.W. Ltr. 12/21/53 to RBF in BFI-CR155.

Floyd, Peter. Ltr. 11/17/53 to RBF in BFI-CR155.

Fuller, Richard Buckminster. Ltr. 1/7/53 to George Howe in BFI-CR146.

Fuller, Richard Buckminster. Ltr. 2/7/53 to J.A. Vitale (MIT-Project Lincoln) in BFI-E Series.

Fuller, Richard Buckminster. Ltr. 3/18/53 to W. Ahern in BFI-E Series.

Fuller, Richard Buckminster. Ltr. 3/9/53 to William Groves in BFI-HEv6.

Fuller, Richard Buckminster. Ltr. 4/24/53 to Stuart, Duncan in BFI-CR147.

Fuller, Richard Buckminster. Ltr. 11/24/53 to T. Rodgers in BFI-CR155.

Hamilton, Richard. Ltr. 5/15/53 to RBF in BFI-HEv4.

Perry, Howard (Fuller Study Group, New Haven, Conn.). Ltr. 2/17/53 to RBF in BFI-E Series.

Peterson, E.G. (Falmouth, Mass.) Telegram 4/22/53 to RBF in BFI-E Series.

Richter, Don. L. Ltr. 10/13/53 to RBF in BFI-CR148.

Wainwright, William. Ltr. 10/18/53 to E.G. Peterson in BFI-E Series.

Welch, George A. Ltr. 4/22/53 to J.A. MacAlarney in BFI-CR 162.

Williams, J. Ltr. 2/2/53 to RBF in BFI-E Series.

Woodruff, Maj. W.L. (Division of Aviation, Hdqr. United States Marine Corps, Department of Navy). Ltr. 10/26/53 to RBF in BFI-CR163.

Woodruff, Maj. W.L. Ltr. 12/3/53 to RBF in BFI-CR163.

1954

Ahern, William. Ltr. 4/26/54 to RBF in BFI-CR 256.

Ahern, William. Ltr. 10/28/54 to Bendix Radio in BFI-CR256.

Bayer, Herbert. Ltr. 6/10/54 to RBF in BFI-CR156.

Bendix Radio. Ltr. 10/21/54 to W. Ahern in BFI-CR256.

Dixon, John. Ltr. 1/14/54 to J.L. Rodgers (Bakelite Division-N.Y.) in BFI-CR153.

Dixon, John. Ltr. 2/18/54 to Richard Porter (Board Product Publishing Co., Chicago, Ill.) in BFI-Hev6.

Dixon, John. Ltr. 10/29/54 to R. Hamilton in BFI-HEv1.

Dixon, John. Ltr. 11/14/54 to Ake H. Huldt in BFI-E series.

Dixon, John. Ltr. 11/15/54 to H.T. Hunsworth (Container Corporation of America, Philadelphia, Pa.) in BFI-CR157 (Also in BFI-HEv6).

Dixon, John. Ltr. 12/10/54 to J. Cadwell in BFI-CR157.

Dixon, John. Ltr. 12/13/54 to H.T. Hunsworth (Container Corporation of America) in BFI-CR157.

Fitzgibbon, J.W. Ltr. 3/14/54 to RBF in BFI-CR162.

Fitzgibbon, J.W. Ltr. 7/11/54 to RBF in BFI-CR162.

Fitzgibbon, J.W. Ltr. 11/2/54 to RBF in BFI-CR162

Fuller, Richard Buckminster. Ltr. 2/7/54 to Olga Gueft (Editor, *Interiors*) in BFI-CR156.

Fuller, Richard Buckminster. Ltr. 3/19/54 to Walter Paepcke (Container Corporation of America, Philadelphia, Pa.) in BFI-CR153.

Fuller, Richard Buckminster. Ltr. 3/19/54 to Walter Paepcke (Container Corporation of America, Philadelphia, Pa.) in BFI-CR153.

Fuller, Richard Buckminster. Ltr. 4/29/54 to W. Ahern in BFI-CR256.

Fuller, Richard Buckminster. Ltr. 4/9/54 to Col. H.C. Lane in BFI-CR163.

Fuller, Richard Buckminster. Ltr. 7/26/54 to Ruth H. Shipley (U.S. Department of State, Washington D.C.) in BFI-CR 156.

Fuller, Richard Buckminster. Ltr. 8/12/54 to B. Howsam (Mgr., Denver Bears) in BFI-CR154.

Fuller, Richard Buckminster. Ltr. 10/13/54 to Col. H.C. Lane in BFI-CR163.

Fuller, Richard Buckminster. Ltr. 11/15/54 to Col. H.C. Lane in BFI-CR163.

Fuller, Richard Buckminster. Ltr. 12/6/54 to W. Wainwright in BFI-CR256.

Fuller, Richard Buckminster. Memo. 20/12/54 to W. Wainwright in BFI-CR256.

Gueft, Olga (Editor, *Interiors*). Ltr. 1/26/54 to RBF in BFI-CR156.

Gueft, Olga (Editor, *Interiors*). Ltr. 2/26/54 to Edgar Kaufmann Jr. (MoMA) in BFI-CR156.

Gueft, Olga (Editor, *Interiors*). Ltr. 3/1/54 to RBF in BFI-CR156.

Gueft, Olga (Editor, *Interiors*). Ltr. 4/30/54 to RBF in BFI-CR156.

Gueft, Olga (Editor, *Interiors*). Ltr. 5/24/54 to RBF/John Dixon in BFI-CR156.

Gueft, Olga (Editor, *Interiors*). Ltr. 5/3/54 to Peter Muller-Munk Associates in BFI-CR156.

Gueft, Olga (Editor, *Interiors*). Ltr. 6/20/54 to Roberto Mango, T. Ferraris & M. Zanuso in BFI-CR156.

Huldt, Ake H. (Commissioner General, Hälsingborg 1955) Ltr. 11/13/54 to RBF.

Krogsgard, Russell (School of Architecture, Tulane Univ.). Ltr. 3/11/54 to RBF in BFI-CR163.

Lane, Col. H.C. Ltr. 5/13/54 to RBF in BFI-CR163.

Lane, Col. H.C. Ltr. 5/28/54 to RBF in BFI-CR163

Lane, Col. H.C. Ltr. 8/7/54 to RBF in BFI-CR163.

Lane, Col. H.C. Ltr. ca. Feb '54 to J.S. Kirkpatrick (Brooks & Perkins Inc., Mich.) in BFI-CR163.

Lane, Col. H.C. (U.S. Marine Corps). Ltr. 2/17/54 to RBF in BFI-CR163.

Lemle, M. Ltr. 3/20/54 to R. M. Horowitz in BFI E-Series.

Mango, Roberto. (Studio di architettura, Napoli) Ltr. 7/10/54 to RBF in BFI-CR156.

Mango, Roberto. Ltr. 11/2/54 to RBF in BFI-CR159.

Parkhurst, W.M. Ltr. 11/2/54 to RBF in BFI-CR159.

Robertson, D.W. Ltr. 9/24/54 to RBF in BFI-CR172.

Robertson, D.W. Ltr. 9/8/54 to RBF in BFI-CR172.

Sadao, Shoji. Ltr. 8/12/54 to RBF in BFI-CR156.

Wagner, Martin. Ltr. 11/15/54 to Aviation Division, Marine Corps in BFI-CR163.

Wainwright, William. Ltr. 1/1/54 to J.A. Vitale (Project Lincoln) in BFI-CR256.

Wainwright, William. Ltr. 4/20/54 to RBF in BFI-CR256.

Wainwright, William. Ltr. 6/1/54 to Signal Corp (Fort Monmouth, N.J.) in BFI-G17.2.

Wainwright, William. Ltr. 11/21/54 to RBF in BFI-CR256.

Yost, Zane & Roberto Mango (Studio di architettura, Napoli). Ltr. 2/19/54 to RBF in BFI-CR156.

Yost, Zane. Ltr. 6/6/54 to RBF in BFI-CR156.

Yost, Zane. Ltr. 7/27/54 to RBF in BFI-CR156.

1955

Dixon, John. Ltr. 1/13/55 to Ake H. Huldt in BFI-HEv6.

Dixon, John. Ltr. 1/13/55 to RBF in BFI-HEv6.

Dixon, John. Ltr. 2/13/55 to M. Kendig (Institute of General Semantics) in BFI-CR164

Dixon, John. Ltr. 2/18/55 to Col. H.C. Lane in BFI-CR163.

Dixon, John. Ltr. 2/29/55 to 2/15/55 in BFI-CR164.

Dixon, John. Ltr. 3/1/55 to Bennett Shapiro in BFI-E Series.

Dixon, John. Ltr. 4/18/55 to B.L. Pickens (Dean, School of Arch., Washington Univ.) in BFI-E Series

Dixon, John. Ltr. 5/26/55 to D.D. Canfield (Field Office-U.S. Dept. of Commerce) in BFI-E Series.

Dixon, John. Ltr. 6/4/55 to D.D. Canfield (Field Office-U.S. Dept. of Commerce) in BFI-CR165.

Dixon, John. Ltr. 7/9/55 to Lt. Col. William Woodruff (USMC) in BFI-CR164.

Dixon, John. Ltr. 8/3/55 to Brig. Gen. Harold E. Watson in BFI-CR165.

Fitzgibbon, J.W. Ltr. 2/5/55 to Roberto Mango in BFI-CR164

Fitzgibbon, J.W. Ltr. 4/3/55 to Brig. Gen. Harold E. Watson (USAF, Wright-Patterson Air Force Base) in BFI-CR256.

Fitzgibbon, J.W. Ltr. 4/8/55 to Brig. Gen. Harold E. Watson (USAF, Wright-Patterson Air Force Base) in BFI-CR256.

Fitzgibbon, J.W. Ltr. 8/8/55 to Lt. Colonel T.K. Pexton (Hdqr.-QM, Nattick Mass.) in BFI-CR166.

Fitzgibbon, J.W. Ltr. 11/25/55 to RBF in BFI-CR168.

Fitzgibbon, J.W. Ltr. 12/12/55 to RBF in BFI-CR171.

Fuller, Richard Buckminster. Ltr. 2/11/55 to T. Miake in BFI-CR164.

Fuller, Richard Buckminster. Ltr. 2/17/55 to Clare Booth Luce in BFI-CR165.

Fuller, Richard Buckminster. Ltr. 2/17/55 to John Vitale (MIT-Lincoln Lab) in BFI-CR164.

Fuller, Richard Buckminster. Ltr. 2/21/55 to Mango, Roberto in BFI-CR164.

Fuller, Richard Buckminster. Ltr. 4/11/55 to Brig-Gen. Harold Watson(Commander Air Technical Intelligence Center, USAF, Wright Patterson Air Force Base, Ohio) in BFI-Hev6. (Copy in BFI-CR256.)

Fuller, Richard Buckminster. Ltr. 4/19/55 to Brig. Gen. Harold E. Watson (Commander, Technical Intelligence Center, Wright-Patterson Air Force Base, Ohio) in BFI-HEv1.

Fuller, Richard Buckminster. Ltr. 5/27/55 to Procurement Office, R & D Command (Rome Air Development Center, Griffiss Air Force Base, Rome, N.Y.) in BFI-CR165.

Fuller, Richard Buckminster. Ltr. 6/9/55 to Dwane Wallace (Chairman, Cessna Aircraft, Wichita, Kans.) in BFI-CR165.

Fuller, Richard Buckminster. Ltr. 8/31/55 to Col. Charles B. Hazeltine (Hdqr. Continental Army Command, Fort Monroes, Va.) in BFI-CR166.

Fuller, Richard Buckminster. Ltr. 8/31/55 to J.W. Fitzgibbon in BFI-CR166.

Fuller, Richard Buckminster. Ltr. 9/26/55 to Maj. George J. King (Division of Public Information, Hqrs. U.S. Marine Corps., Washington D.C.) in BFI-CR167.

Fuller, Richard Buckminster. Ltr. 10/19/55 to L. Holloway in BFI-CR179.

Fuller, Richard Buckminster. Ltr. 12/1/55 to W.F. O'Malley in BFI-CR171.

Fuller, Richard Buckminster. Ltr. 12/9/55 to Don Robertson in BFI-HEv2.

Fuller, Richard Buckminster. Ltr.(Draft) 4/27/55 to Col. H.C. Lane in BFI-CR165.

Fuller, Richard Buckminster. Ltr.9/1/55 to Dean Henry Kamphoefner in BFI-CR167.

Fuller, Richard Buckminster. Ltr.9/1/55 to W. Hall in BFI-CR167.

Fuller, Robert (Textile Fibers Dept.-Du Pont). Ltr. 4/14/55 to RBF in BFI-E Series.

Geodesics Inc. (Cambridge, Mass.) Ltr. 10/13/55 to RBF in BFI-CR167.

Geodesics Inc. (Cambridge, Mass.) Ltr. 1/17/55 to Western Electric in BFI-G17.2.

Harnden, Peter G. (Director, European Trade Fair Program) Ltr. 2/7/55 to RBF in BFI-CR164.

Hazeltine, Col. Charles B. (Hdqr. Continental Army Command, Fort Monroes, Va) Ltr. 8/24/55 to RBF in BFI-CR166.

Lindsay, Jeffrey. Ltr. 3/7/55 to RBF in BFI-CR164.

Mango, Roberto. Ltr. 1/26/55 to RBF in BFI-CR165.

Messr. Bigelow Reinforced Plastics. Ltr. 11/21/55 to W. Wainwright in BFI-G17.2.

Miller, Alvin (Asst. Ed., *Better Homes and Garden*). Ltr. 12/6/55 to RBF in BFI-CR171.

O'Malley, Walter F. (Dodgers Inc.). Ltr. 5/26/55 to RBF in BFI-CR165.

O'Malley, Walter F. (Dodgers Inc.). Ltr. 12/9/55 to RBF in BFI-CR171.

Parkhurst, W.M. Ltr. 4/27/55 to RBF in BFI-CR165.

Parkhurst, W.M. Ltr. 7/7/55 to RBF in BFI-CR 174.

Parkhurst, W.M. Ltr. 11/15/55 to RBF in BFI-CR168.

Pickens, B.L. Ltr. 4/13/55 to RBF in BFI-E Series.

Pickens, B.L. Ltr. 4/27/55 to RBF/J. Dixon in BFI-CR 165.

Pickens, B.L. Ltr. 6/7/55 to RBF in BFI-E Series.

Pickens, B.L. (Dean, School of Arch., Washington Univ.) Ltr. 3/16/55 to RBF in BFI-E Series.

Robertson, D.W. Ltr. 5/11/55 to Chief, Bureau of Aeronautics in BFI-CR 172.

Robertson, D.W. Ltr. 7/5/55 to W.M. Parkhurst in BFI-CR174.

Robertson, D.W. Ltr. 7/6/55 to RBF in BFI-CR174.

Shapiro, Bennett . Ltr. 7/1/55 to RBF in BFI-E Series.

Wainwright, William. Ltr. 3/2/55 to RBF in BFI-CR256.

Wallace, D. Ltr. 6/7/55 to RBF in BFI-CR161.

Watson, Brig-Gen. Harold E. (Commander Air Technical Intelligence Center, USAF, Wright Patterson Air Force Base, Ohio). Ltr. 3/26/55 to RBF in BFI-CR256.

1956

Baldanza, Masey & Miller. Telegram (copy) 7/23/56 to Dept. of Commerce, et.al. in BFI-CR179.

Dixon, John. Ltr. 5/11/56 to John Owen (Middleton, Ohio) in BFI-CR175.

Dixon, John. Ltr. 5/20/56 to Claude Rubenstein (McGill University, Montreal) in BFI-CR174.

Dixon, John. Ltr. 7/26/56 to RBF in BFI-CR178.

Dixon, John. Ltr. 8/8/56 to RBF in BFI-CR178.

Dixon, John. Ltr. 9/7/56 to RBF in BFI-CR179.

Fitzgibbon, J.W. Ltr. 3/26/56 to RBF in BFI-CR173.

Fitzgibbon, J.W. Ltr. 3/27/56 to RBF in BFI-CR173.

Fitzgibbon, J.W. Ltr. 3/27/56 to William H. Wainwright in BFI-CR173.

Fitzgibbon, J.W. Ltr. 5/8/56 to RBF in BFI-CR173.

Fitzgibbon, J.W. Ltr. 12/13/56 to B. Damiani (Union Tank Car Co) in BFI-CR181.

Fitzgibbon, J.W. Ltr. 12/29/56 to RBF in BFI-CR184.

Fitzgibbon, J.W. Ltr.10/9/56 D.L. Richter (Kaiser Aluminum & Chemical Sales Inc.) in BFI-CR180.

Fitzgibbon, J.W. Ltr.9/21/56 to Ralph Knight (VP, R&D Kaiser Aluminum) in BFI-CR179.

Fuller, Richard Buckminster. Ltr. 6/1/56 to John Talbot (St. Louis, Mo.) in BFI-CR175.

Fuller, Richard Buckminster. Ltr. 6/30/56 to Major George J. King (Division of Public Information, Hdqrs., US Marine Corps., Washington D.C.) in BFI-CR178.

Fuller, Richard Buckminster. Ltr. 7/1/56 to James Harr (Actg. Chief, Chart Research Division, Aeronautical Chart & Information Center, Washington D.C.) in BFI-CR178.

Fuller, Richard Buckminster. Ltr. 7/19/56 to Walter F. O'Malley in BFI-CR178.

Fuller, Richard Buckminster. Ltr. 7/19/56 to Walter. F. O'Malley in BFI-CR178.

Fuller, Richard Buckminster. Ltr. 7/31/56 to A. Miller in BFI-CR178.

Fuller, Richard Buckminster. Ltr. 10/11/56 to Signals Corps. Procurement Office (Washington D.C.) in BFI-CR180.

Graves, D.C. & R. A. Lehr. Ltr. 12/11/56 to RBF in BFI-CR191.

Graves, D.C. & R.A. Lehr. Ltr. 12/4/56 to RBF in BFI-CR191.

Mackey, Eugene . Ltr. 12/11/56 to RBF in BFI-CR190.

McKittrick, S. Ltr. 8/22/56 to RBF in BFI-CR179.

McKittrick, S. Ltr. 12/5/56 to W.M. Parkhurst in BFI-CR181.

Parkhurst, W.M. Ltr. 4/26/56 to RBF in BFI-CR177.

Richter, Don L. Ltr. 8/20/56 to RBF in BFI-CR179.

Wainwright, William. Ltr. 7/10/56 to H. Fitzpatrick (Lincoln Lab) in BFI-CR177.

1957

Anderson, L. Ltr. 8/22/57 to Ken Olson in BFI-CR189.

Blosser, Dale A. Ltr. 7/3/57 to W.M. Parkhurst in BFI-CR187.

Blosser, Dale. Ltr. 11/29/57 to Geodesic Inc. in BFI-CR191.

Botts, Lloyd G. (Battey-Childs, Baton Rouge). In-house Memoranda [RE#595 A-1] 11/30/57 to J. H. Wilson (Battey-Childs, Chicago) in BFI-CR191.

Botts, Lloyd G. (Battey-Childs, Baton Rouge). In-house Memoranda [RE#595-4] 12/9/57 to J.H. Wilson (Battey-Childs, Chicago) in BFI-CR190.

Fitzgibbon, J.W. Ltr. 2/26/57 to George W. Parmalee (Curator-Garfield Botanic Garden, Mich.) in BFI-CR183.

Fitzgibbon, J.W. Ltr. 2/27/57 to R.A. Lehr (Union Tank Car Co.) in BFI-CR185.

Fitzgibbon, J.W. Ltr. 2/27/57 to RBF in BFI-CR185.

Fitzgibbon, J.W. Ltr. 2/28/57 to D. Robertson in BFI-CR185.

Fitzgibbon, J.W. Ltr. 6/14/57 to R.A. Lehr (Union Tank Car Co.) in BFI-CR185.

Fitzgibbon, J.W. Ltr. 7/11/57 to D.C. Graves (Union Tank Car Co.) in BFI-CR188.

Fitzgibbon, J.W. Ltr. 7/9/57 to R.A. Lehr (Union Tank Car Co.) in BFI-CR188.

Fitzgibbon, J.W. Ltr. 8/2/57 to R.A. Lehr in BFI-CR188.

Fitzgibbon, J.W. Ltr. 8/5/57 to R.A. Lehr in BFI-CR188.

Floyd, Peter. Ltr. 7/19/57 to RBF in BFI-CR188.

Floyd, Peter. Ltr. 8/22/57 to C. Stodder in BFI-CR189.

Floyd, Peter. Ltr. 12/6/57 to C.J. Mauro (U.S. Department of State) in BFI-CR191.

Fuller, Anne. Ltr. 2/27/57 to P. Reps in BFI-CR183.

Fuller, Anne. Ltr. 9/26/57 to P. Floyd in BFI-CR189.

Fuller, Richard Buckminster. Ltr. 3/9/57 to Roberto Mango in BFI-CR192.

Fuller, Richard Buckminster. Ltr. 5/10/57 to L. Anderson (Alpha Rho Chi-U. Minn.) in BFI-CR189.

Fuller, Richard Buckminster. Ltr. 5/14/57 to L.E. Lloyd in BFI-CR188.

Fuller, Richard Buckminster. Ltr. 5/16/57 to J. Lindsay in BFI-CR186

Fuller, Richard Buckminster. Ltr. 8/17/57 to Frank Laucomer in BFI-CR188.

Fuller, Richard Buckminster. Ltr. 10/17/57 to R. Lewontin in BFI-CR189.

Godffrey, M.J. Ltr. 9/9/57 to Ken Olson in BFI-CR189.

Grae, H.D. Ltr. 8/10/57 to RBF in BFI-CR188.

Hughes Aircraft. Ltr. 2/28/57 to W.M. Parkhurst in BFI-CR185.

Locke Jr., Edwin A. (President, Union Tank Car Co) Ltr. 7/10/57 to RBF in BFI-CR188 (Copy in BFI-G-76 Shoji Geodesic Inc.).

Miller, Alvin & Ken Olson (*Better Homes & Gardens*). Ltr. 2/14/57 to RBF in BFI-CR183.

Miller, Alvin and Ken Olson. (*Better Homes & Gardens*) Ltr. 1/7/57 to RBF in BFI-CR184.

Olson, Ken. Ltr. 5/7/57 to D. Mortellito in BFI-CR186.

Olson, Ken. Ltr. 6/24/57 to J. Pease in BFI-CR187.

Olson, Ken. Ltr. 6/24/57 to Jim Solosky (Dow Chemical Co.) in BFI-CR187.

Olson, Ken. Ltr. 6/26/57 to RBF in BFI-CR187.

Olson, Ken. Ltr. 7/15/57 to H.D. Grae in BFI-CR188.

Olson, Ken. Ltr. 7/2/57 to The Rev. R.J. Welsh in BFI-CR187.

Olson, Ken. Ltr. 7/29/57 to RBF in BFI-CR188.

Olson, Ken. Ltr. 7/30/57 to E. Godffrey in BFI-CR188.

Olson, Ken. Ltr. 8/27/57 to RBF in BFI-CR189.

Olson, Ken. Ltr. 9/16/57 to J.B. Cleary in BFI-CR189.

Olson, Ken. Ltr. 9/17/57 to Schneider Built Homes Inc. in BFI-CR189.

Olson, Ken. Ltr. 9/24/57 to J.J. King in BFI-CR189.

Olson, Ken. Ltr. 10/18/57 to Rev. Colm Murphy in BFI-CR191.

Olson, Ken. Ltr. 11/1/57 to M.J. Godffrey in BFI-CR191.

Parkhurst, W.M. Ltr. 1/23/57 to Zenith Plastics in BFI-CR184.

Parkhurst, W.M. Ltr. 3/15/57 to M.P.M. in BFI-CR185.

Parkhurst, W.M. Ltr. 11/4/57 to RBF in BFI-CR190

Passoneau, J Ltr. 2/24/57 to RBF in BFI-CR184.

Plydomes Inc. Ltr. 5/16/57 to R.W. Marks in BFI-CR186.

Plydomes Inc.. Ltr. 5/10/57 to T. Pope in BFI-CR186.

Pope, Ted. Ltr. 1/17/57 to RBF in BFI-CR187.

Robertson, D.W. Ltr. 2/21/57 to James E. Toomey (Counselor-Patent/Kaiser Aluminum Washington D.C.) in BFI-CR183.

Robertson, D.W. Ltr. 7/25/57 to W.M. Parkhurst in BFI-CR188.

Sides, C. David (Synergetics Inc.). Ltr. 7/3/57 to R. A. Lehr (Union Tank Car Co.) in BFI-CR187.

Talbot, Winchell. Ltr.1/15/57 to RBF in BFI-CR184.

Wainwright, William. Ltr. 6/6/57 to RBF in BFI-CR187.

Washburn, A.N. Ltr. 12/4/57 to RBF in BFI-CR191.

1958

Craighead, P.B. . Ltr. 10/23/58 to RBF in BFI-CR197

Fitzgibbon, J.W. Ltr. (draft) 7/29/58 to Edwin A. Locke Jr. (Union Tank Car Co.) in BFI-CR195.

Fitzgibbon, J.W. Ltr. 5/13/58 to W.M. Parkhurst in BFI-CR195.

Fitzgibbon, J.W. Ltr. 6/6/58 to Clark Roote (Graver Tank & Manufacturing Co.) in BFI-CR195.

Fitzgibbon, J.W. Ltr. 8/18/58 to D.W. Robertson in BFI-CR193.

Fuller, Richard Buckminster. Ltr. 1/24/58 to Brattinga in BFI-CR190.

Fuller, Richard Buckminster. Ltr. 2/12/58 to Prof. E.W. McMillan in BFI-CR194.

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Fuller, Richard Buckminster. Ltr. 12/22/58 to Stuart Campbell (Univ. of Birmingham) in BFI-CR196.

Landers, David (Amsterdam Development Corpn.). Ltr. 1/7/58 to RBF in BFI-CR193.

Locke, E.A. Ltr. 10/6/58 to RBF in BFI-CR197.

Parkhurst, W.M. Ltr. 1/17/58 to M. Miller in BFI-CR190.

Parkhurst, W.M. Ltr. 1/20/58 to A.J. Piot in BFI-CR190.

Parkhurst, W.M. Ltr. 7/7/58 to RBF in BFI-CR195.

Root, Clark.(Graver Tank & Mfg. Co. Inc.) Ltr. 10/8/58 to J.W. Fitzgibbon (Synergetics Inc.) in BFI-CR197.

Stryker, C.E. Ltr. 3/6/58 to W.M. Parkhurst in BFI-CR192.

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Zenith Plastics Co. (Gardena, Calif.) Ltr. 2/12/58 to W. Parkhurst in BFI-CR192.

1959

Allen, George (Director, USIA). Ltr. 4/20/59 to RBF in BFI-CR201.

Banham, P.R. Ltr. 5/28/59 to RBF in BFI-CR201.

Dixon, John. Ltr. 2/22/59 to The New York Times in BFI-CR198.

Fitzgibbon, J.W. Ltr. 1/19/59 to N.M. Graham (NAA, Ohio) in BFI-CR196.

Fitzgibbon, J.W. Ltr. 1/5/59 to J. Lindsay in BFI-CR196.

Fitzgibbon, J.W. Ltr. 1/5/59 to M.A. Haymore in BFI-CR196.

Fitzgibbon, J.W. Ltr. 1/8/59 to W.M. Parkhurst in BFI-CR196.

Fitzgibbon, J.W. Ltr. 2/12/59 to RBF in BFI-CR206.

Fitzgibbon, J.W. Ltr. 2/9/59 to RBF in BFI-CR206 (Also known as Baton Rouge Wood River Dome Memorandum).

Fitzgibbon, J.W. Ltr. 8/4/59 to RBF in BFI-CR203.

Fuller, R. Buckminster. Ltr. 4/1/59 to Z.S. Makowski (Ed.,*Tchnika i Nauka*, The Journal & Institution of Polish Engineer) in BFI-CR199.

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Fuller, R. Buckminster. Ltr. 9/12/59 to D. Robertson in BFI-CR256.

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Fuller, Richard Buckminster. Ltr. 10/19/59 to J. Montgomery in BFI-CR204.

Fuller, Richard Buckminster. Ltr. 10/6/59 to R. Beverly in BFI-CR204.

Fuller, Richard Buckminster. Ltr. 11/23/59 to K. Fulmer in BFI-CR208.

Fuller, Richard Buckminster. Ltr. 12/28/59 to J.W. Fitzgibbon in BFI-CR206.

Graves, D.C. (Union Tank Car Co.) Ltr. 6/4/59 to RBF in BFI-CR201.

Lindsay, Jeffrey. Ltr.(n.d.) ca. Jan. 1959 to J.W. Fitzgibbon in BFI-CR196.

Makowski, Z.S. Ltr. 1/26/59 to RBF in BFI-CR199.

Strub, H.E. Ltr. 12/29/59 to RBF in BFI-CR206.

1960

Fitzgibbon, J.W. Ltr. 1/14/60 to RBF in BFI-CR206.

Fuller, Anne. Ltr. 3/5/60 to R.E. Philips in BFI-CR208.

Fuller, Richard Buckminster. Ltr. 1/2/60 to H.E. Strub in BFI-CR206.

Fuller, Richard Buckminster. Ltr. 2/11/60 to H.E. Strub in BFI-CR208.

Fuller, Richard Buckminster. Ltr. 5/16/60 to J. Pease in BFI-CR211.

Fuller, Richard Buckminster. Ltr. 5/31/60 to Henri Pradier (Seine-et-osie, France) in BFI-CR211.

Fuller, Richard Buckminster. Ltr. 9/20/60 to F. Upchurch in BFI-CR213.

Fuller, Richard Buckminster. Ltr. 11/25/60 to J.T. Kelly in BFI-CR216.

Moore, Don. Ltr. 9/16/60 to W. L. Le Page (Franklin Institute) in BFI-G85.

O'Malley, W.F. Ltr. 7/13/60 to RBF in BFI-EJA Green.

Philips, R.E. Ltr. 3/5/60 to RBF in BFI-CR208.

Russell, I. Ltr. 11/12/60 to RBF in BFI-CR215.

1961

Fuller, Richard Buckminster. Ltr. 4/20/61 to R.W. McLaughlin in BFI-CR219.

Fuller, Richard Buckminster. Ltr. 10/26/61 to Mary Jean Alexander (NYC-N.Y.) in BFI-CR224.

Fuller, Richard Buckminster. Ltr. 11/20/61 to J.W. Fitzgibbon in BFI-CR225.

Fuller, Richard Buckminster. Ltr. 12/11/61 to Mrs. Peter Brattinga (NY-N.Y.) in BFI-CR225.

Lindsay, Jeffrey. Ltr. 3/24/61 to W.M. Parkhurst in BFI-CR218.

McClue, H. (Dean, SOA-Clemson College). Ltr. 6/8/61 to RBF in BFI-CR221.

Parkhurst, W.M. Ltr. 7/21/61 to RBF in BFI-CR222.

Robertson, D.W. Ltr. 6/2/61 to W.M. Parkhurst in BFI-CR221.

1962

Bundy, McGeorge. Ltr. 12/20/62 to RBF in BFI-CR226.

Franco, R.M. Ltr. 10/29/62 to RBF in BFI-CR236.

Fuller, R Buckminster. Ltr. 8/3/62 to D.M. Allen (Kings College, Durham University, Newcastle-upon-Tyne) in BFI-CR236.

Fuller, Richard Buckminster. Ltr. 1/17/62 to H. Shibata in BFI-CR227.

Fuller, Richard Buckminster. Ltr. 6/29/62 to W.M. Parkhurst in BFI-CR233.

Fuller, Richard Buckminster. Ltr. 7/28/62 to J.K. Delson (Energy Resources Panel, National Academy of Science) in BFI-CR234.

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Fuller, Richard Buckminster. Ltr. 8/10/62 to H. Shibata in BFI-CR240.

Fuller, Richard Buckminster. Ltr. 11/27/62 to Delyte W. Morris (President, SIU) in BFI-CR236.

Fuller, Richard Buckminster. Ltr. 11/30/62 to McGeorge Bundy (Asst. for National Security, White House Executive Offices, Washington, D.C.) in BFI-CR236.

Lindsay, Jeffrey. Ltr. 2/25/62 to RBF in BFI-CR228.

Lindsay, Jeffrey. Ltr. 3/17/62 to E. Locke in BFI-CR228.

Lindsay, Jeffrey. Ltr. 3/6/62 to A. Fuller in BFI-CR229.

Parrish Const. Co. Ltr. 3/15/62 to RBF in BFI-CR229.

Pidgeon, Monica (Editor, *Architectural Design*). Ltr. 12/17/62 to RBF in BFI-CR238.

Robertson, D.W. Ltr. 10/9/62 to S.R. Foster in BFI-CR236.

1963

Fuller, Richard Buckminster. Ltr. 1/4/63 to McGeorge Bundy in BFI-CR243.

Fuller, Richard Buckminster. Ltr. 3/30/63 to Gerald Piel (*Scientific American*, N.Y.) in BFI-CR247.

Fuller, Richard Buckminster. Ltr. 4/2/63 to R.M. Franco (Dir., Organizing Committee of the VII UIA-Congress, La Habana, Cuba) in BFI-CR237.

Fuller, Richard Buckminster. Ltr. 5/20/63 to August Heckscher (Special Consultant on Arts, White House) in BFI-CR242.

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Fuller, Richard Buckminster. Ltr. 5/29/63 to Gerald Piel (*Scientific American*, N.Y.) in BFI-CR239.

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Fuller, Richard Buckminster. Ltr. 10/1/63 to Mrs. Sarah Z. Bardin (Wilson, N.C.) in BFI-CR247.

Fuller, Richard Buckminster. Ltr. 11/11/63 to Ernest G. Friesem (Flushing, N.Y.) in BFI-CR249.

Fuller, Richard Buckminster. Ltr. 11/18/63 to W.M. Parkhurst in BFI-CR249.

Fuller, Richard Buckminster. Ltr. 11/22/63 to N.B. Greenleaf (Pompano Beach, Fla.) in BFI-CR249.

Fuller, Richard Buckminster. Ltr. 11/6/63 to W.R. Ewald Jr. in BFI-CR249.

Johnson, Philip. Ltr. 11/6/63 to RBF in BFI-CR248.

Kendig, M. (Institute of General Semantics). Ltr. 10/7/63 to RBF in BFI-CR249.

Pease, John. Ltr. 11/1/63 to RBF in BFI-CR249.

Pidgeon, Monica. Ltr. 1/7/63 to RBF in BFI-CR237.

Richter, D.L. Ltr. 6/26/63 to W.M. Parkhurst in BFI-CR245.

Ritner, P.V. Ltr. 5/20/63 to Macmillan Company, N.Y. in BFI-CR239.

1964

Chermayeff, Peter. Ltr. 12/29/64 to RBF in BFI-CR265.

Cousins, Norman (Editor, *Saturday Review*). Ltr. 6/10/64 to RBF in BFI-CR258.

Dixon, John. Ltr. 12/10/64 to RBF in BFI-CR265.

Fitzgibbon, J.W. Ltr. 9/30/64 to RBF in BFI-CR269

Fuller, Richard Buckminster. Ltr. n.d., (ca. Sept. '64) to Hon. G. Lewis in BFI-CR262.

Masey, Jack. Ltr. 12/16/64 to RBF in BFI-CR265.

Parkhurst, W.M. Ltr. 7/9/64 to W. E. Farragher (Youngstown Sheet & Tube Corporation, Ohio) in BFI-CR260.

1965

Fitzgibbon, J.W. Ltr. 2/24/65 to RBF in BFI-CR280.

Fitzgibbon, J.W. Ltr. 3/10/65 to RBF in BFI-CR268.

Floyd, Peter. Ltr. 1/13/65 to J. Masey in BFI-CR266.

Floyd, Peter. Ltr. 2/26/65 to J. Masey in BFI-CR266.

Floyd, Peter. Ltr. 3/4/65 to J. Masey in BFI-CR268.

Floyd, Peter. Ltr. 5/25/65 to RBF in BFI-CR269.

Fuller, Richard Buckminster. Ltr. 2/14/65 to Jerome B. Wiesner (President's Advisory Committee on Science, The White House) in BFI-CR267.

Fuller, Richard Buckminster. Ltr. 2/24/65 to D.W. Robertson in BFI-CR267.

Fuller, Richard Buckminster. Ltr. 9/21/65 to Prof. Hyman Cumin in BFI-CR271.

Fuller, Richard Buckminster. Ltr. 10/6/65 to Albert Moore (Falls Village, Conn.) in BFI-CR274.

Masey, Jack. Ltr. 1/15/65 to P. Floyd in BFI-CR266.

Parkhurst, W.M. Ltr. 1/13/65 to RBF in BFI-CR267

Robertson, D.W. Ltr. 12/27/65 to R.P. Stevenson (Editor, *Home & Shop*) in BFI-CR282.

<u>1966</u>

Douthit, P.L. Ltr. 10/28/66 to RBF in BFI-CR285.

Fitzgibbon, J.W. Ltr. 8/26/66 to RBF in BFI-CR289.

Fuller, Richard Buckminster. Ltr. 2/23/66 to Dr. J.G. Campbell in BFI-CR280.

Fuller, Richard Buckminster. Ltr. 3/29/66 to The Participants in the Hotel Palais Gare d'Orsay in BFI-CR270.

Fuller, Richard Buckminster. Ltr. 9/22/66 to Claude Stoller in BFI-[?]

Fuller, Richard Buckminster. Ltr. 11/29/66 to Ben Hellman (Publisher, *Contract*) in BFI-CR291.

Fuller, Richard Buckminster. Ltr. 12/29/66 to J. Fudge, J. Clower & B. Wadman (Drop City) in BFI-CR293.

Pease. John. Ltr. 1/27/66 to W.M. Parkhurst in BFI-CR279.

Sadao, Shoji. Ltr. 4/11/66 to RBF in BFI-CR300.

Sadao, Shoji. Ltr. 6/2/66 to RBF in BFI-CR285.

Sadao, Shoji. Ltr. 7/12/66 to Mr Thayer in BFI-CR289.

Shibata, Hidetoshi (NTV Network Corpn.,Tokyo). Ltr. 8/19/66 to RBF in BFI-G91.

Wachsmann, Konrad. Ltr. 8/11/66 to RBF, et.al in BFI-CR288.

<u>1967</u>

Applewhite, E.J. Ltr. 9/8/67 to RBF in BFI-CR308.

Brand, Stewart. Ltr. 11/21/67 to RBF in BFI-CR312.

Chermayeff, Serge. Ltr. 4/27/67 to P. Blake in BFI-CR301.

Dardick, S.I.(Chief Planner, Model City Agency). Ltr. 5/24/67 to RBF in BFI-CR303.

Fuller, Richard Buckminster. Ltr. 1/26/67 to H. Shibata in BFI-CR296.

Fuller, Richard Buckminster. Ltr. 4/4/67 to L.J. Fricker (Department of Architecture, University of Edinburgh) in BFI-CR300.

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Fuller, Richard Buckminster. Ltr. 5/11/67 to W.F. O'Malley in BFI-CR303.

Fuller, Richard Buckminster. Ltr. 6/18/67 to J. Meller in BFI-CR315.

Fuller, Richard Buckminster. Ltr. 6/20/67 to S.I. Dardick in BFI-CR303.

Fuller, Richard Buckminster. Ltr. 6/21/67 to J. McCarthy in BFI-CR300.

Fuller, Richard Buckminster. Ltr. 6/6/67 to H. Shibata in BFI-CR304.

Gocar, Jiri (President of the IXth World Congress of UIA, Prague). Ltr. 1/24/67 to RBF in BFI-CR279.

Javits, J.K. (Senator). Ltr. 9/8/67 to RBF in BFI-CR308.

Lloyd, John (Principal, AA). Ltr. 3/22/67 to J. McHale in BFI-CR301.

Sadao, Shoji. Ltr. 3/17/67 to RBF in BFI-CR299.

Sadao, Shoji. Ltr. 3/4/67 to H. Shibata in BFI-G91.

Welling, H. Ltr. 9/18/67 to RBF in BFI-CR308.

1968

Brand, Stewart. Ltr. 1/3/68 to RBF in BFI-CR296.

Brand, Stewart. Ltr. 4/10/68 to RBF in BFI-CR325.

Fitzgibbon, J.W. Ltr. 7/27/68 to RBF in BFI-CR330.

Fitzgibbon, J.W. Ltr. 8/23/68 to RBF in BFI-G-91 #5. (Known as the JWF Dossier Kuwait project).

Fuller, Richard Buckminster. Ltr. 5/8/68 to Thomas Hoving (National Citizens Committee for Public Television) in BFI-CR323.

Fuller, Richard Buckminster. Ltr. 6/20/68 to A.C. Clarke in BFI-CR327.

Gordon, D. Ltr. 9/18/68 to RBF in BFI-CR332.

Masey, Jack. Ltr. 4/8/68 to RBF in BFI-CR323.

1969

Fuller, Richard Buckminster. Ltr. 2/24/69 to W.M. Parkhurst in BFI-CR339.

Getman, Carl G. (Cadco). Ltr. 6/14/69 to "Sirs" in BFI-EJA Sub.

Getman, Carl G. (Cadco). Ltr. 12/19/69 to D. Klaus in BFI-EJA Sub.

Klaus, Dale. Ltr.12/8/69 to C. Getman (Cadco) in BFI-EJA Sub.

1970

Fitzgibbon, J.W. Ltr. 12/23/70 to RBF in BFI-OMR Folder (Active Files).

Klaus, Dale. Ltr. 12/15/70 to RBF in BFI-OMR Folder (Active Files).

Younge, Wyvetter (Ill. State representative). Ltr. 11/4/70 to RBF in BFI-CR396.

1974

Fuller, Richard Buckminster. Ltr. 11/22/74 to Susan Redd (Virginia Beach, Va.) in BFI-[?]

1976

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Gibbins, Thomas H. (Santa Rosa, Calif.). Ltr. 12/29/76. to RBF.

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1977

Fitzgibbon, J.W. Ltr. 3/10/77 to Rep. W. Younge in BFI-OMR Folder (Active Files).

Gibbins, Thomas H. Ltr. 2/28/77 to RBF.

1979

Snelson, Kenneth. Ltr. 12/31/79 to RBF in BFI-MSS 80.02.02 (known as the "Kenneth Snelson Letter").

1980

Fuller, Richard Buckminster. Ltr. 3/1/80 to K. Snelson (cc. to Arthur Drexler) in BFI-EJA Green.

1995-98

Burnham, Kelly (Prof. Emeritus, Cornell University). Ltr. 10/25/95 to Y.C. Wong (Author's private communication).

Park, David (Prof. Emeritus, Williams College) . Ltr. (e-mail) 6/21/98 to Y.C. Wong (Author's private communication).

n.d. (no date)

Calverley, E. Ltr. to (Anon. Russian) in BFI-CR314.

Fitzgibbon, J.W. Ltr. to Lt. Col. T.K. Pexton in BFI-CR166.

Fuller, R. Buckminster Ltr. to Major George J. King (Division of Public Information, Hdqr.. US Marine Corps., Washington D.C.) in BFI-CR178.

Fuller, Richard Buckminster. Ltr. (draft, ca.1932) to William Adams Delano in BFI-CR42.

Fuller, Richard Buckminster. Ltr. to W.D. Wenzlau in BFI-CR158.

Jones, Cranston (Associate Editor, *TIMES*). Ltr. to Edwin Locke Jr. in BFI-CR196.

Lane, Col. H.C. (USMC). Ltr. to RBF in BFI-CR161.

Messr. Beetle Boat Co. Ltr. to RBF/W. Wainwright in BFI- BFI-G17.2.

Messr. Wilson's American Co. Inc. Ltr. n.d. to B.L. Pickens (Dean, School of Arch., Washington Univ.) in BFI-E Series.

Stuart, Duncan. Ltr. to G. Cox (Dept. of Mathematical Statistics, Univ. of North Carolina) in BFI-EJA Green.

Wainwright, William. Ltr. to RBF in BFI-CR179.

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Director of Aviation. Memorandum (February 24 1954):"Purchase of Geodesic Dome Personnel Shelter for Test," to Assistant Chief of Staff.

Dixon, John. "John Dixon." Resume, ca. March 1968 in BFI-CR232.

Dixon, John. "Notes of RBF Conference with Col. Lane (Sept 15-17)," 15 September 1954 in BFI-CR163.

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Fig.1.00a Portrait of Richard Buckminster Fuller at Woodstock, N.Y., ca. 1951. Source: BFI-Photo #F-3-1.

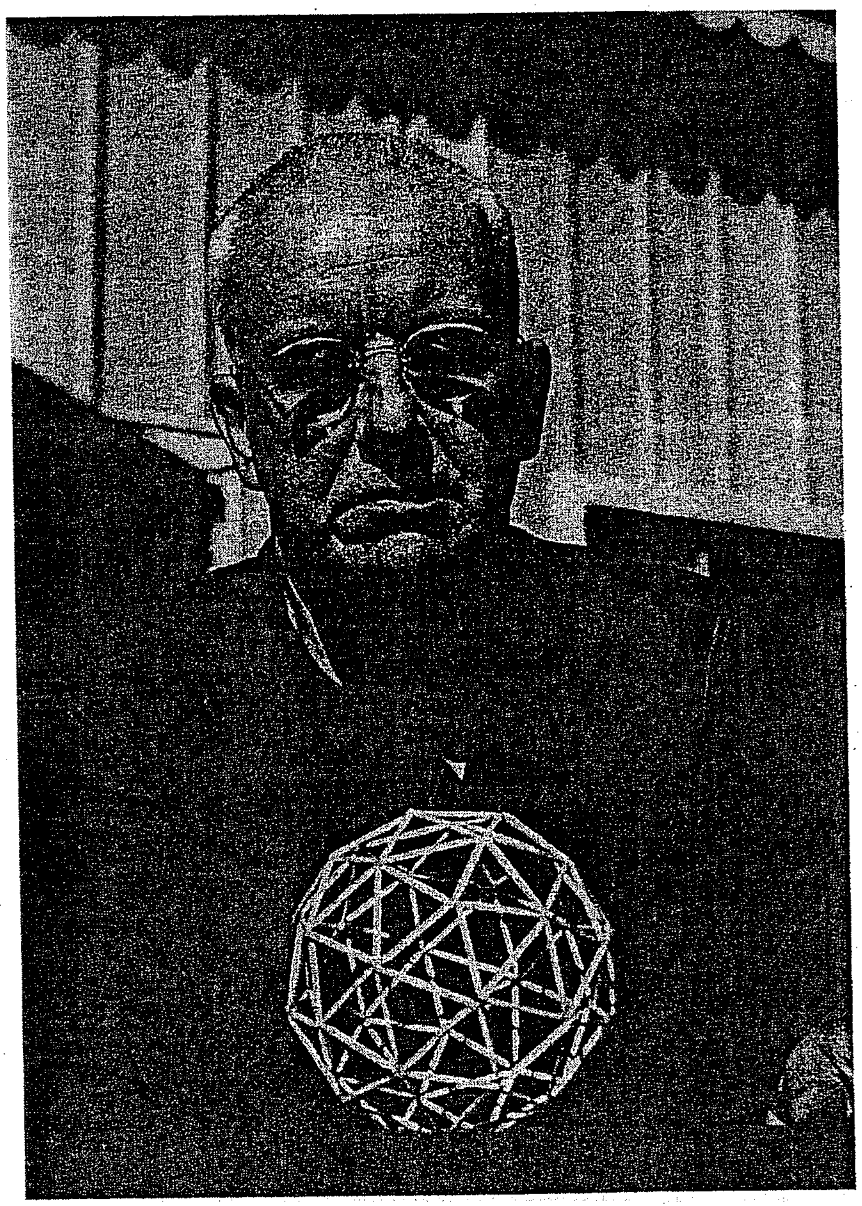
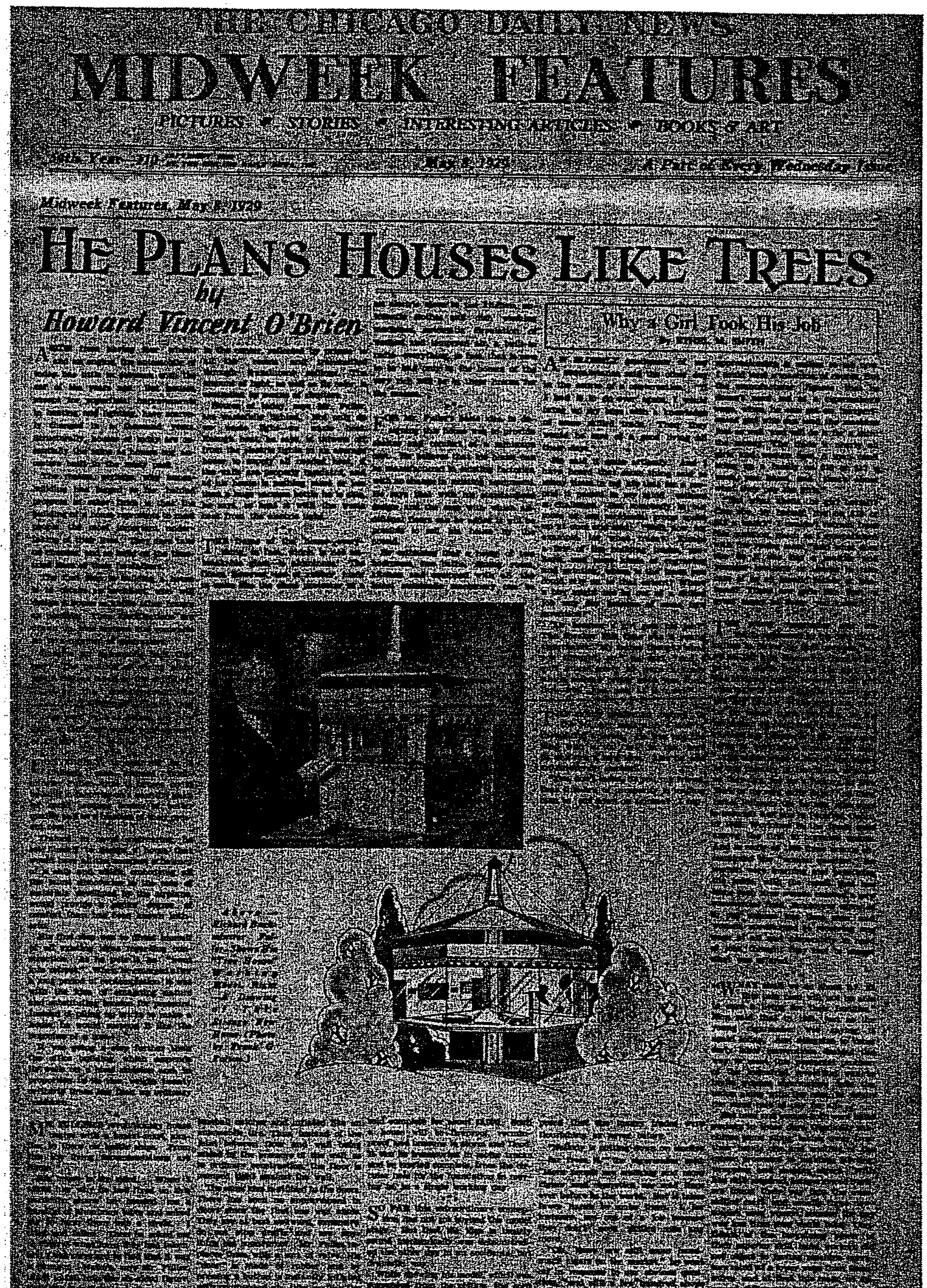


Fig.1.00b 4D-Dymaxion House, 1929. Source: *The Chicago Daily News*, May 1929.


THE CHICAGO DAILY NEWS

MIDWEEK FEATURES

PICTURES • STORIES • INTERESTING ARTICLES • BOOKS & ART

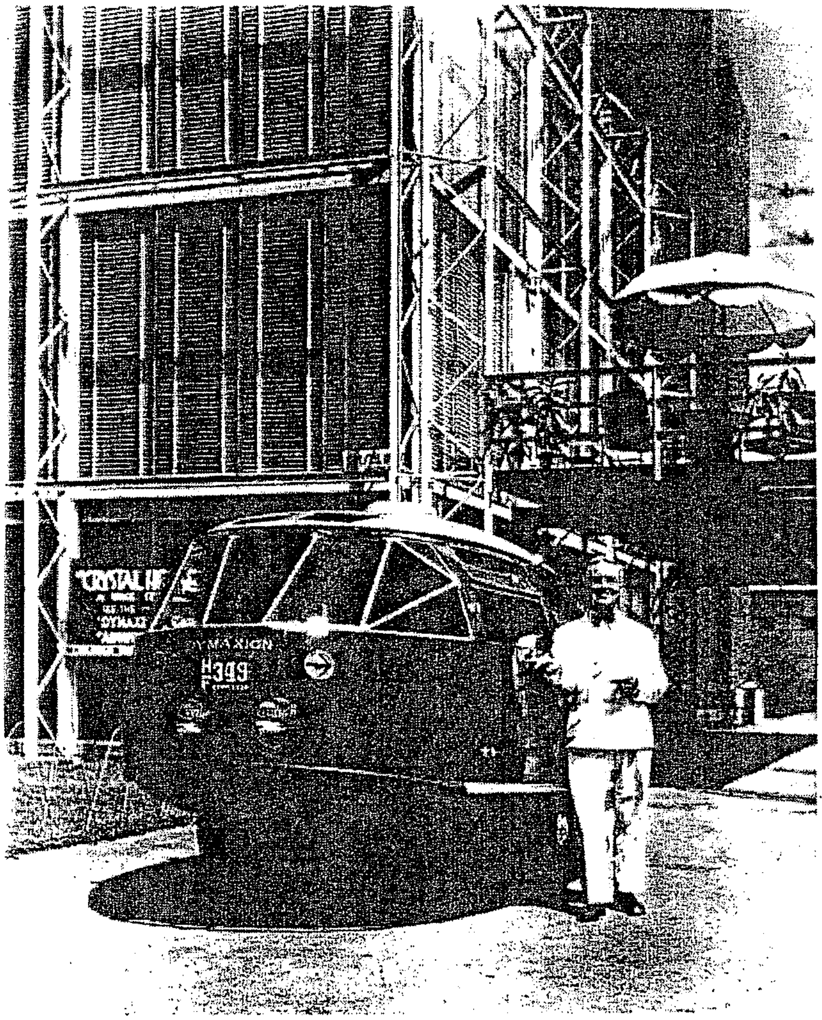
Midweek Features, May 8, 1929

He Plans Houses Like Trees

by *Howard Vincent O'Brien*

Why a Girl Took His Job

Fig.1.00c Fuller and his Dymaxion Transport Unit (DTU), ca.1931. Source: BFI-Photo #D-3-19.



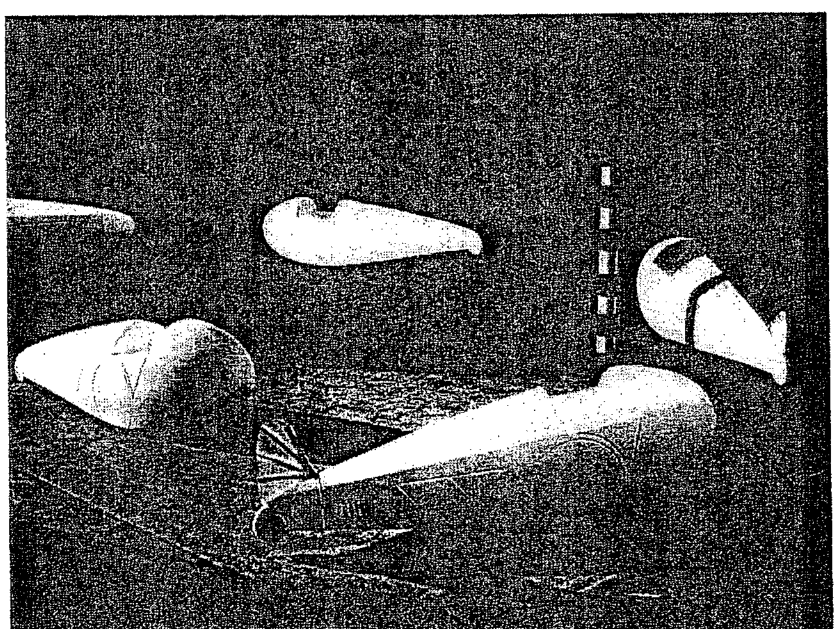


Fig.1.01a Stockade Building System. <u>Source:</u> BFI-HEv14.

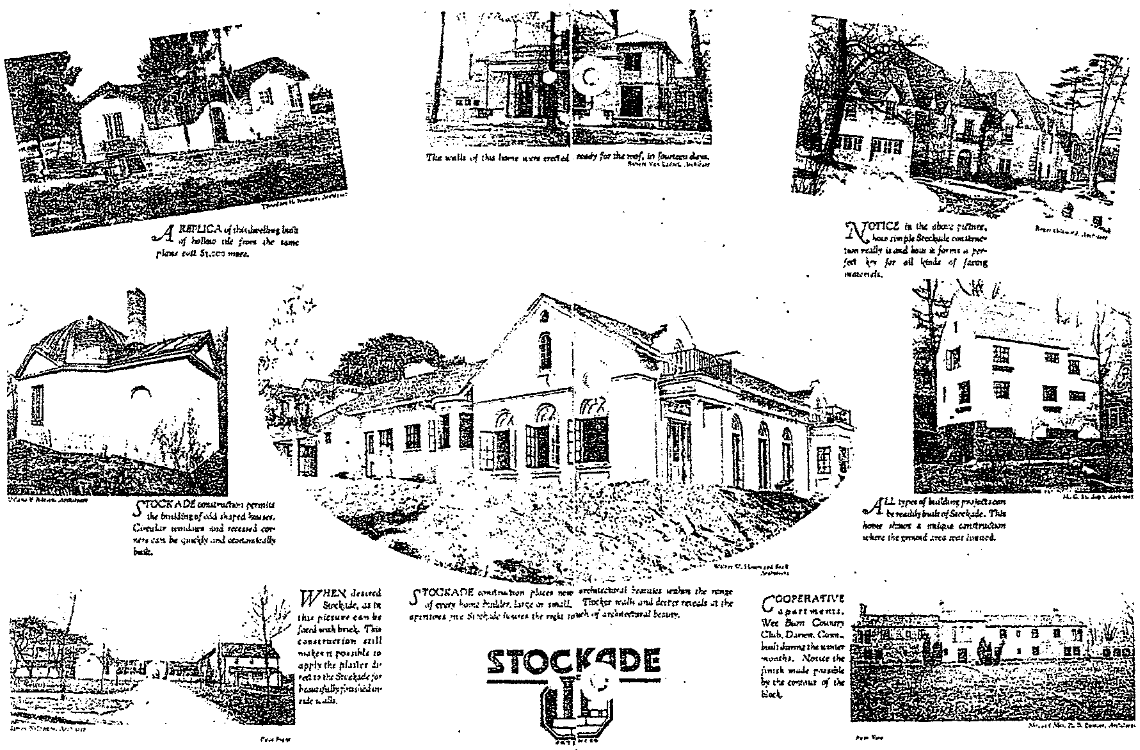


Fig.1.01b U.S. Patent #1,450,723 (3 April 1923) Stockade Building System of J.M. Hewlett. Source: BFI-HEv14.

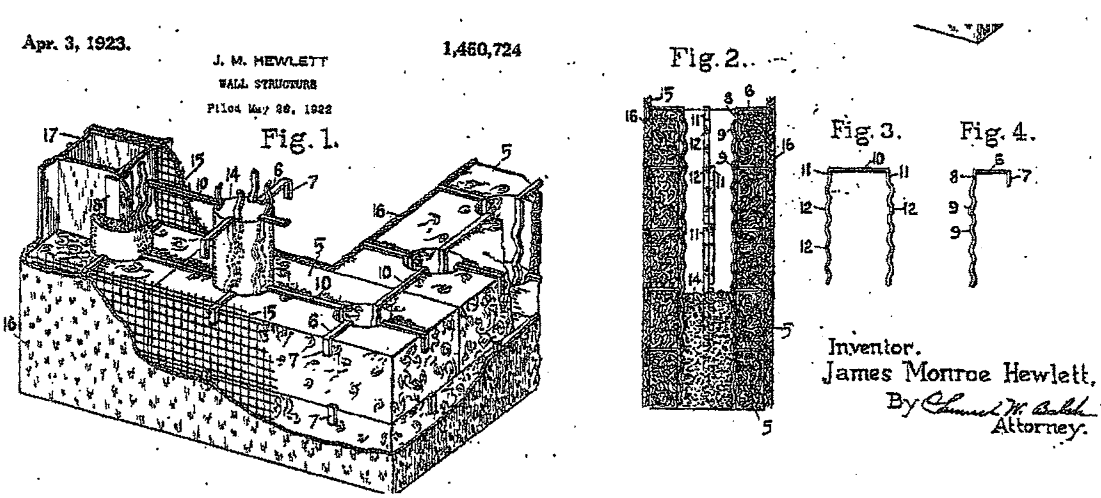


Fig.1.02a Untitled emblematic drawing, possibly to accompany "Lightful Houses." Source: BFI-MSS 28.01.01.

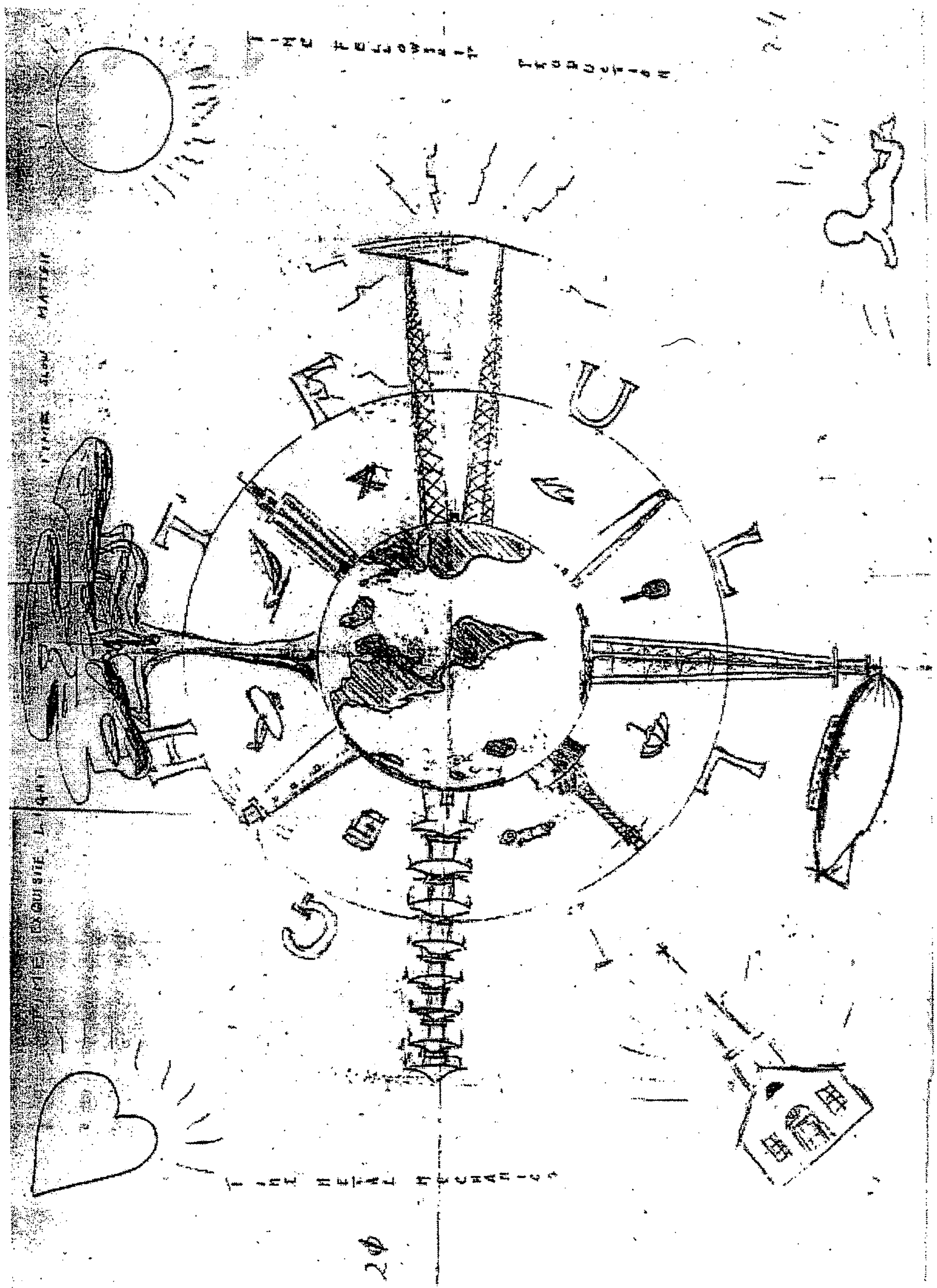


Fig.1.02b Untitled emblematic sketch, possibly to accompany "Lightful Houses." Source: BFI-MSS 28.01.01.

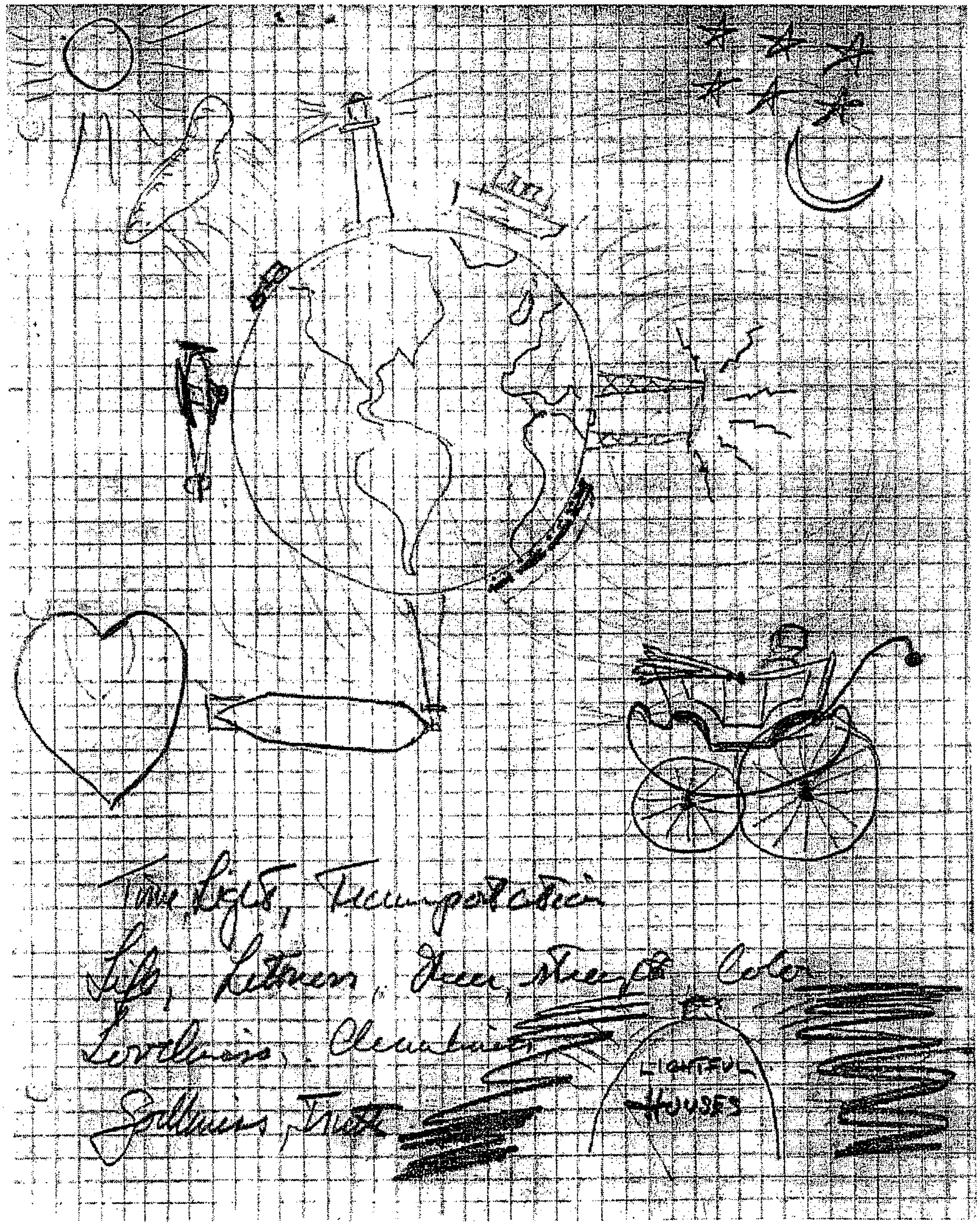
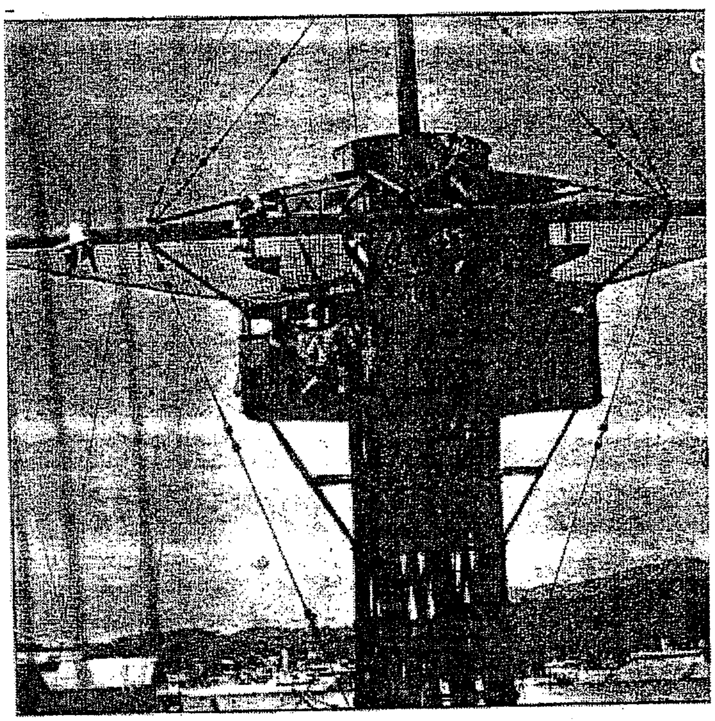
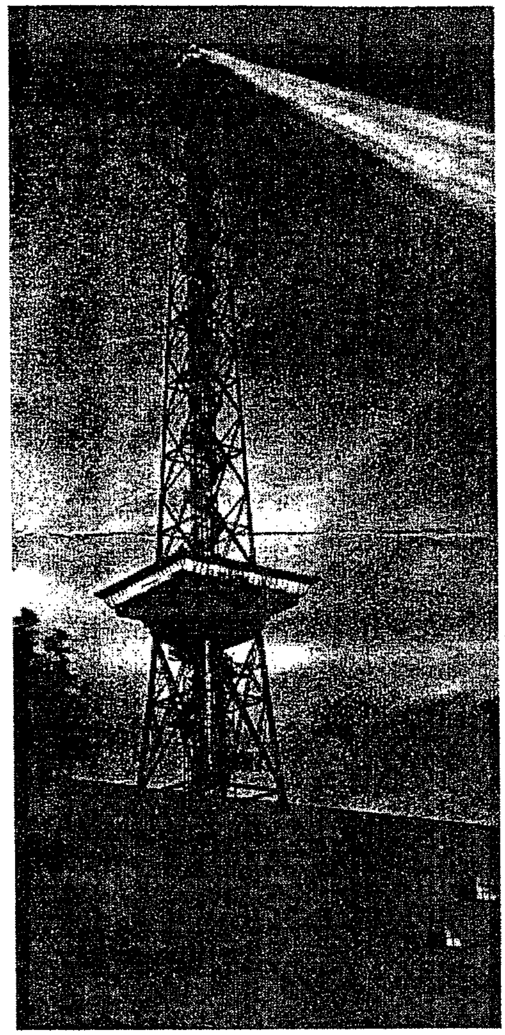


Fig.1.03a A selection of photographic images from newspaper cuttings that Fuller consulted during the development of the 4D House: **1.** A Berlin Radio Tower (undated, The Daily News); **2.** Rigid test on Romar in Berlin, the world's largest airplane (undated); **3.** Dirigible Construction at Glendale & structure of a pentagonal propeller (undated, New *York Herald Tribune*) Source: All images in BFI-CR33; **4.** Mast of U.S.S. California (undated, *New York Herald Tribune*) e Trade catalog samples, *Revolvo* Display stands (undated) Source: All images in BFI-CR36.





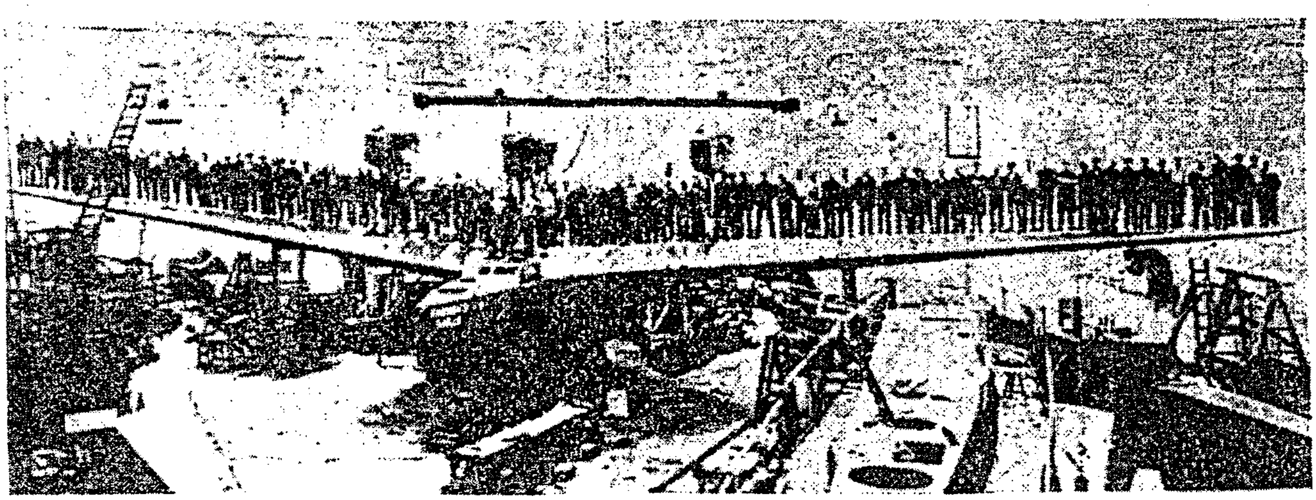
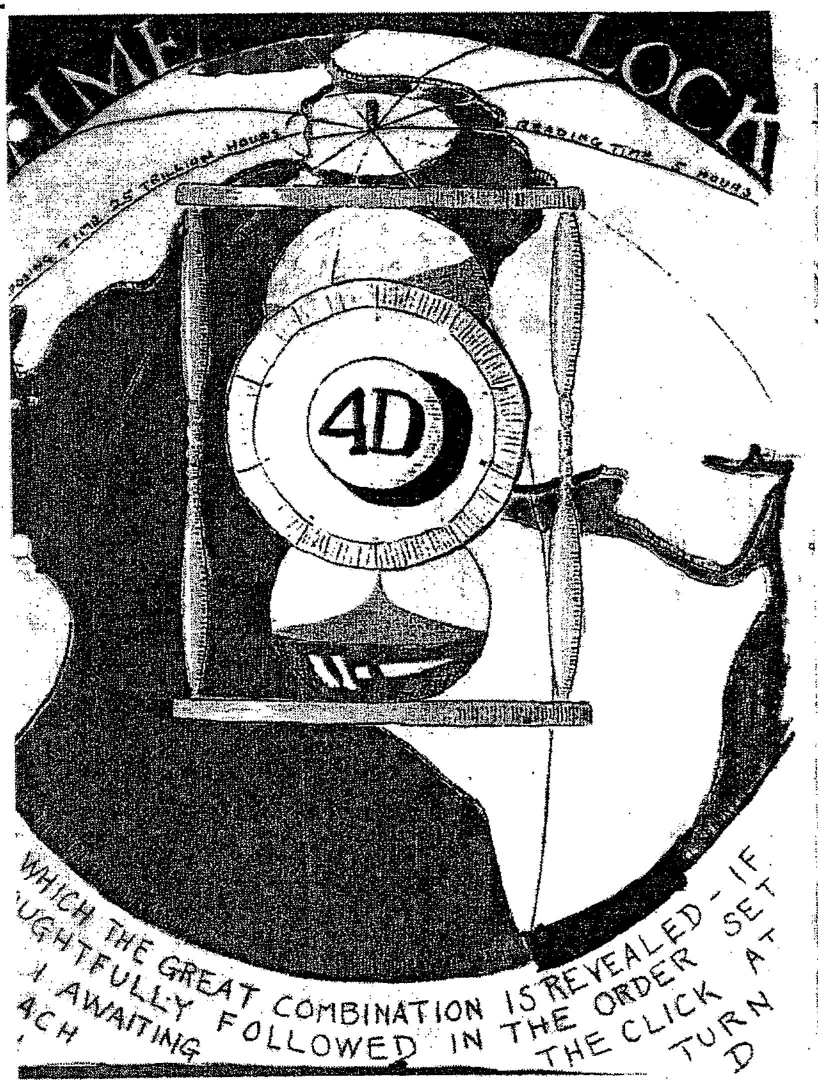


Fig.1.04a Emblems of Apocalyptic time. Cover page of *4D Timelock* (1928). Source: BFI-MSS 28.01.0.

Fig.1.04b A cartoon close-up of humans in an hourglass. Source: BFI-MSS 28.01.0.



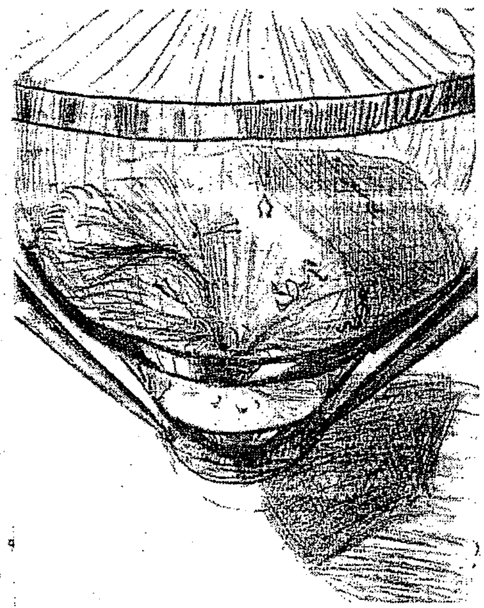


Fig.1.05a 4D House, patent application, 1928. Source: J. Ward ed., The Artifacts of R. Buckminster Fuller, Vol.1 p.58.

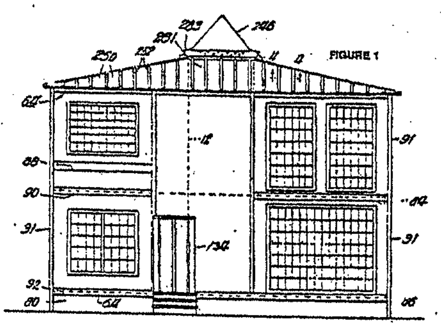


FIGURE 1

THE 4D HOUSE*

My invention relates to buildings and the erection thereof and includes among its objects and advantages the application of mass-production methods facilitated by changes in the building itself of such a nature as to make its completed parts capable of convenient transportation.

In the accompanying drawings:

Fig. 1 is a front elevation of a two-story house according to the invention.

Fig. 2 is a central sectional view to the same house.

Fig. 3 is a plan view of the framework supporting the second floor.

Fig. 4 is a detail section on line 4–4 of Fig. 1.

Fig. 5 is a floor plan of the first floor of the house.

Fig. 6 is a plan of the second floor of the house.

Fig. 7 is a detail section indicating one method of assembling a corner joint between the panels forming the outside wall.

Fig. 8 is a vertical section of the outer edge of the ceiling of second floor and roof.

Fig. 9 is a similar section of the outer edge of the floor of the second floor.

Fig. 10 is a similar section of the outer edge of the floor of the first floor.

Fig. 11 is a section on line 11–11 of Fig. 8, chiefly in plan view.

Fig. 12 is a section on line 12–12 of Fig. 10.

Fig. 13 is a vertical section of the partition forming the ceiling of the first story and the floor of the second story.

Fig. 14 is a vertical section of the central column in a plane at right angles to that of Fig. 2.

Fig. 15 is a section on line 15–15 of Fig. 13.

Fig. 16 is a side elevation.

Fig. 17 is a plan view of a unitary one-piece bathroom.

Fig. 18 is a section of a floor construction.

Fig. 19 is a section of a construction for an inside partition.

Fig. 20 is a section of a construction for an outside wall.

*Application abandoned by Buckminster Fuller, leaving prior art evidence in patent office files.

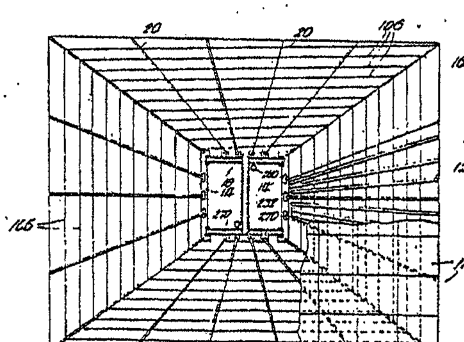


FIGURE 3

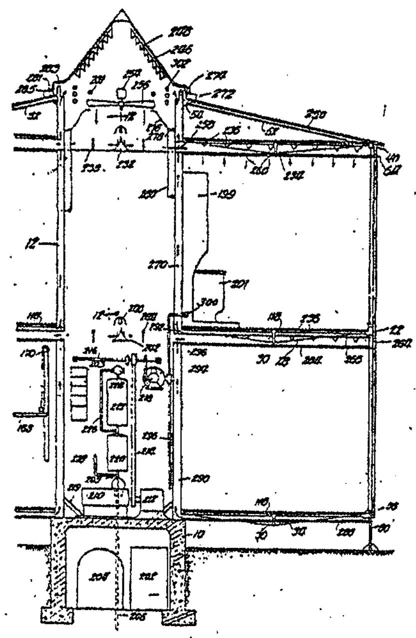


FIGURE 5

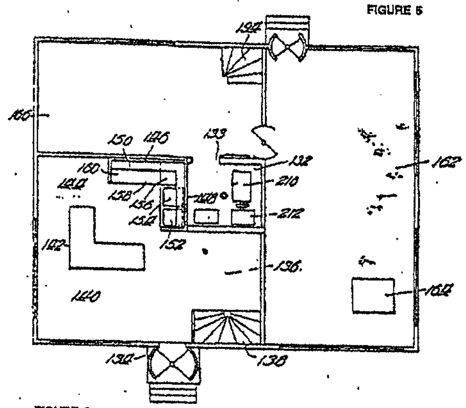


FIGURE 6

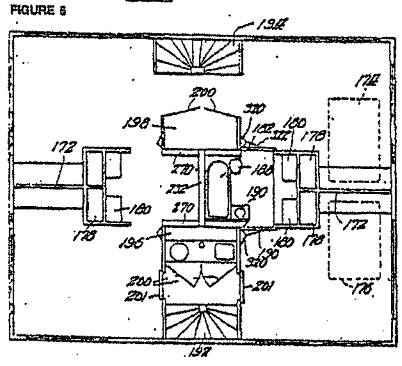
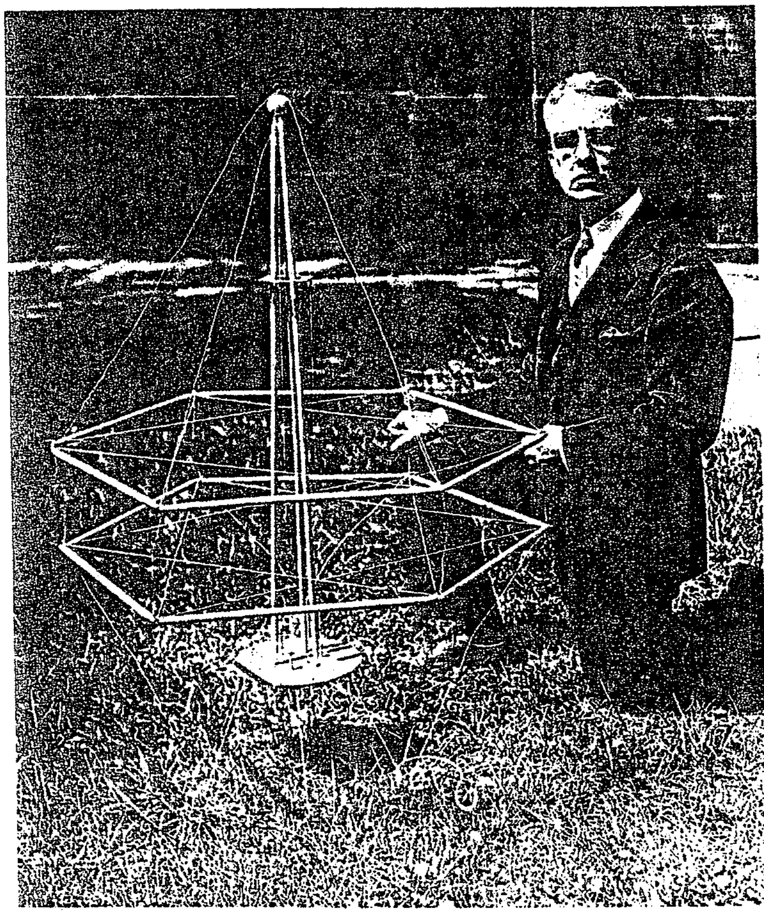


Fig.1.05b First model for the Dymaxion House for the Marshall Field Exhibition, ca. April 1929. Source: BFI-MSS.28.01.0

Fig.1.05c Fuller with structure of second model, ca. 1930-31. Source: BFI-MSS 28.01.0.



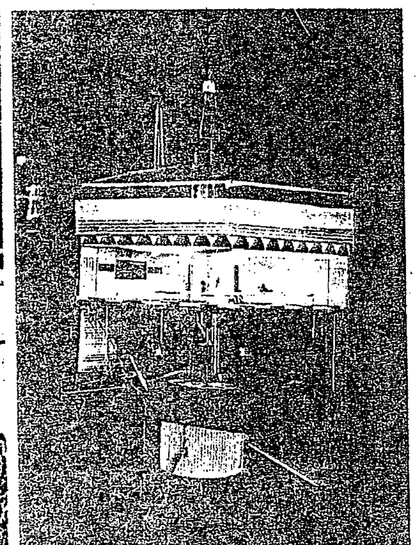


Fig.1.05d Sequence of assemblage, second model, ca. 1930-31. Source: BFI-MSS 28.01.0.

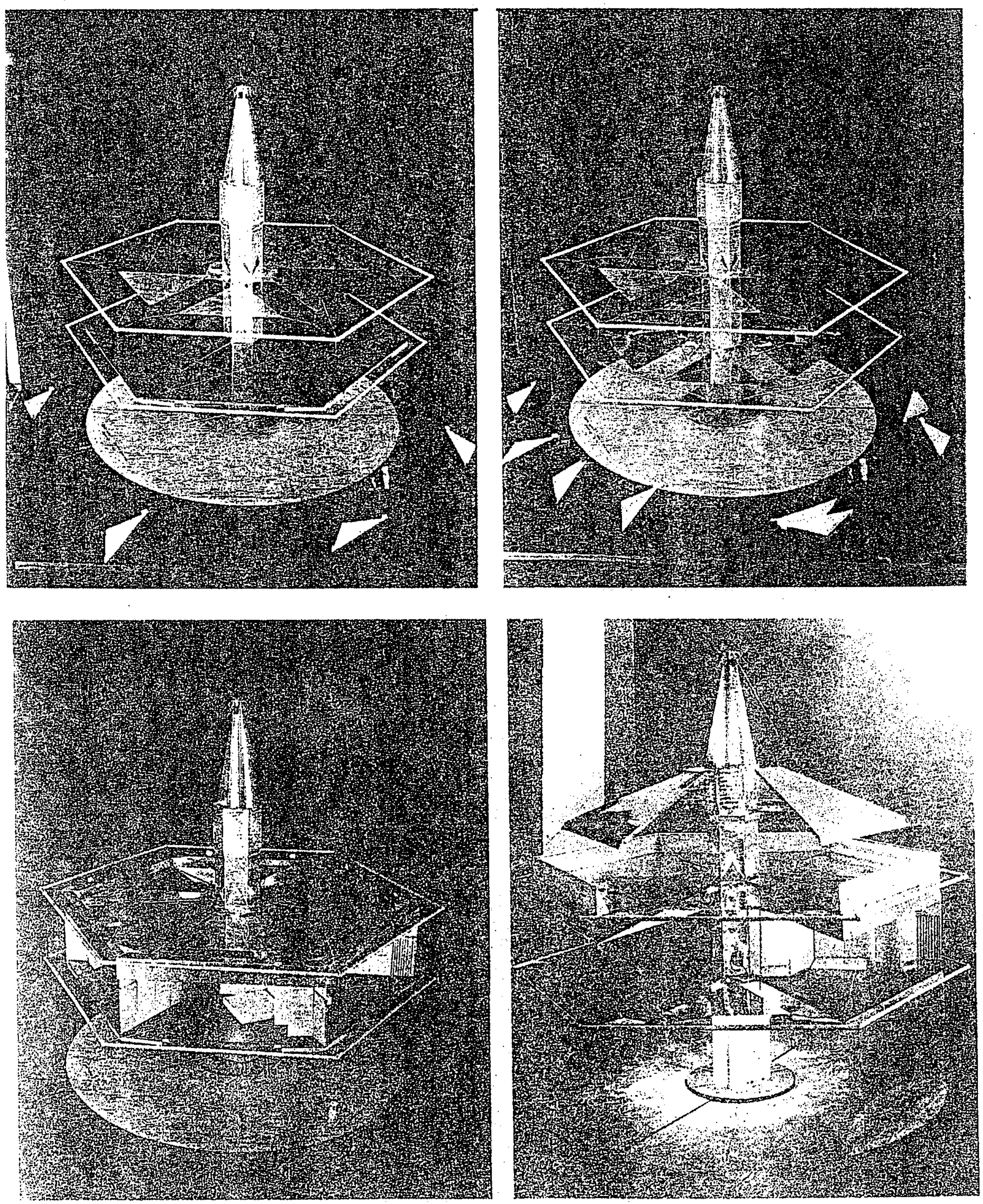


Fig.1.06a Rendering of three 4D towers by Lee Atwood, ca. 1928. Source: BFI-MSS 28.01.0.

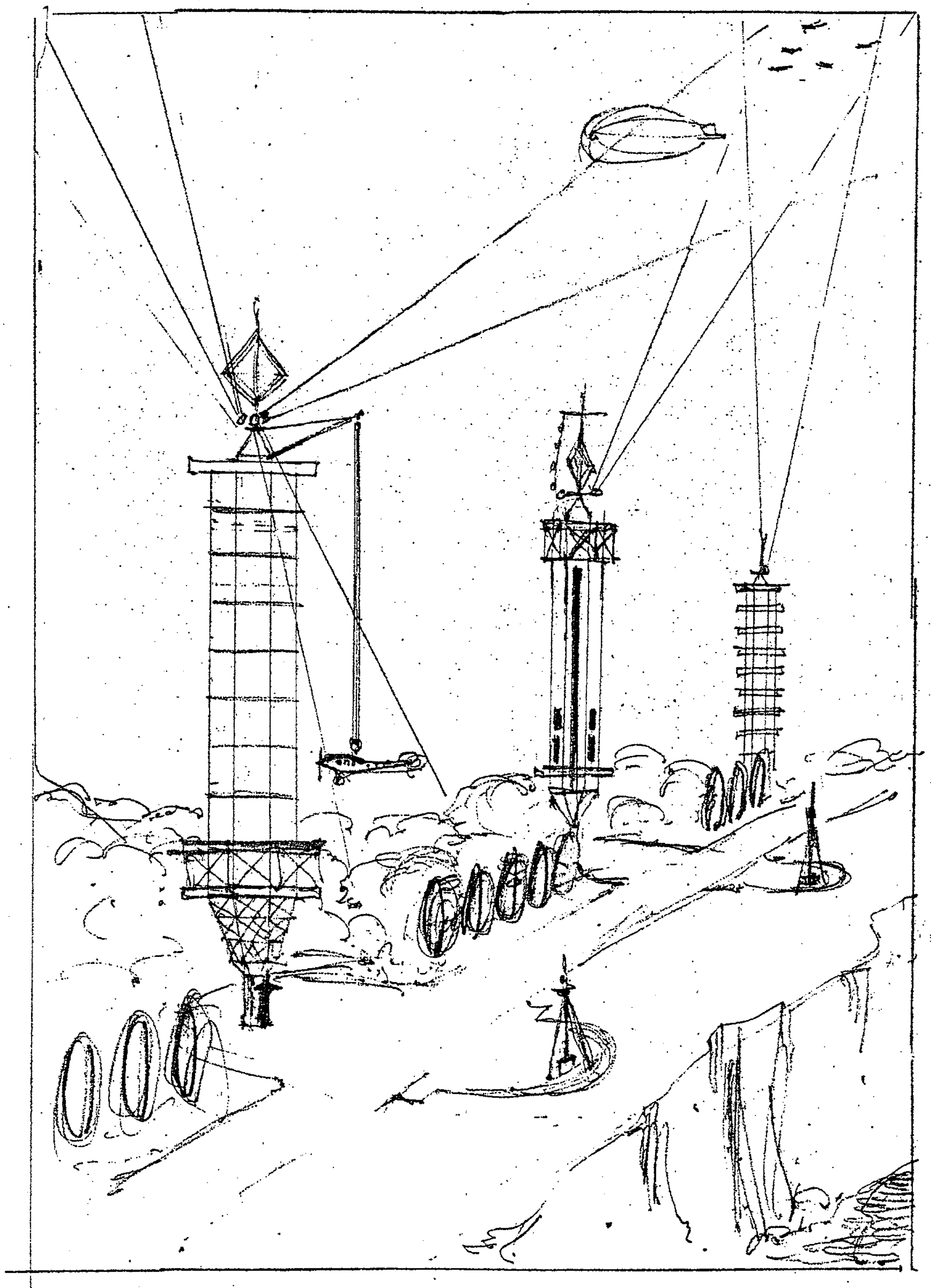


Fig.1.06b Cartoon of a comparison between a 4D tower and a traditionally crafted house, ca. 1928.
Source: BFI-MSS 28.01.0.

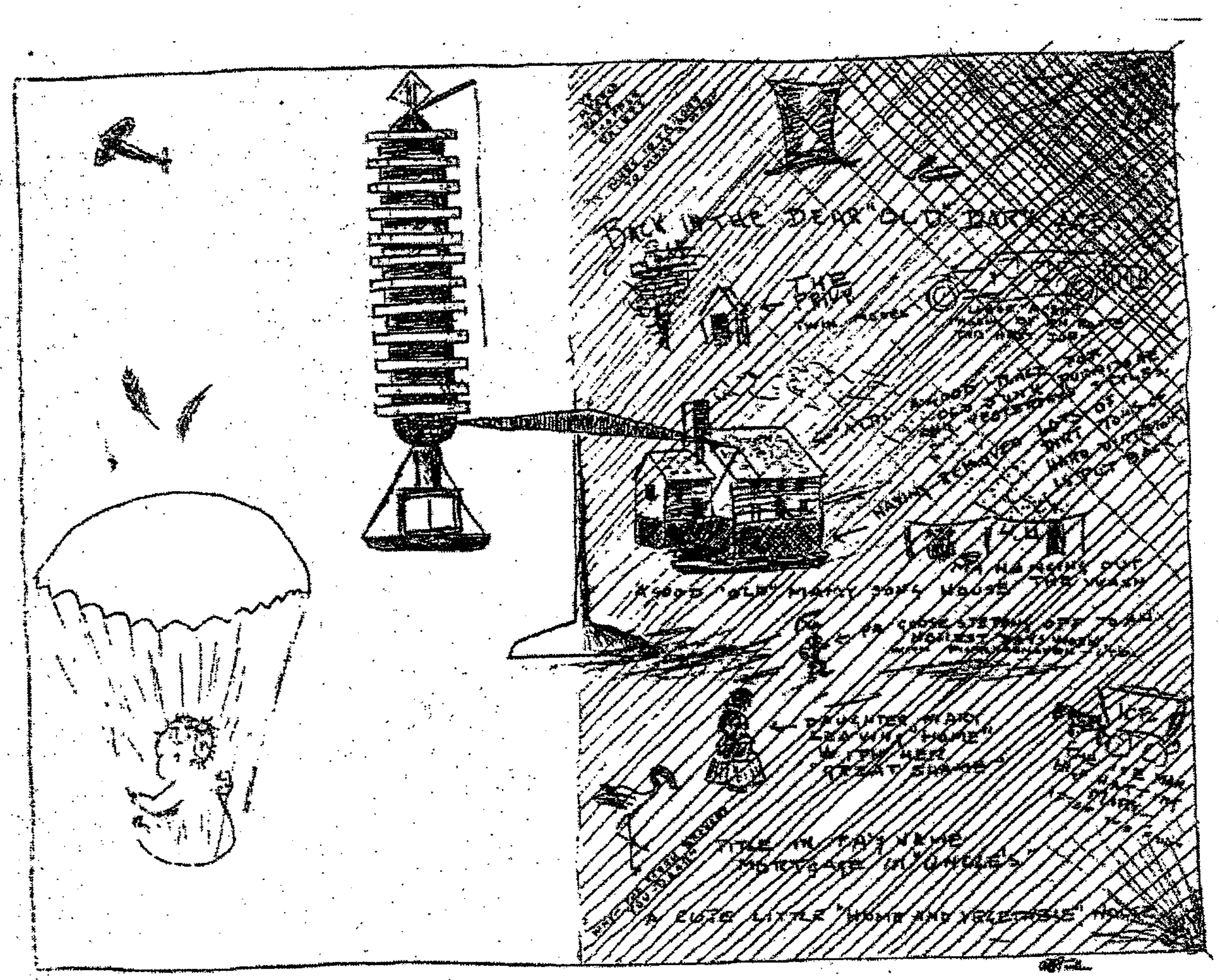


Fig.1.07 Studies for the trademark logo for 4D Corporation. Source: BFI-MSS 28.01.0.

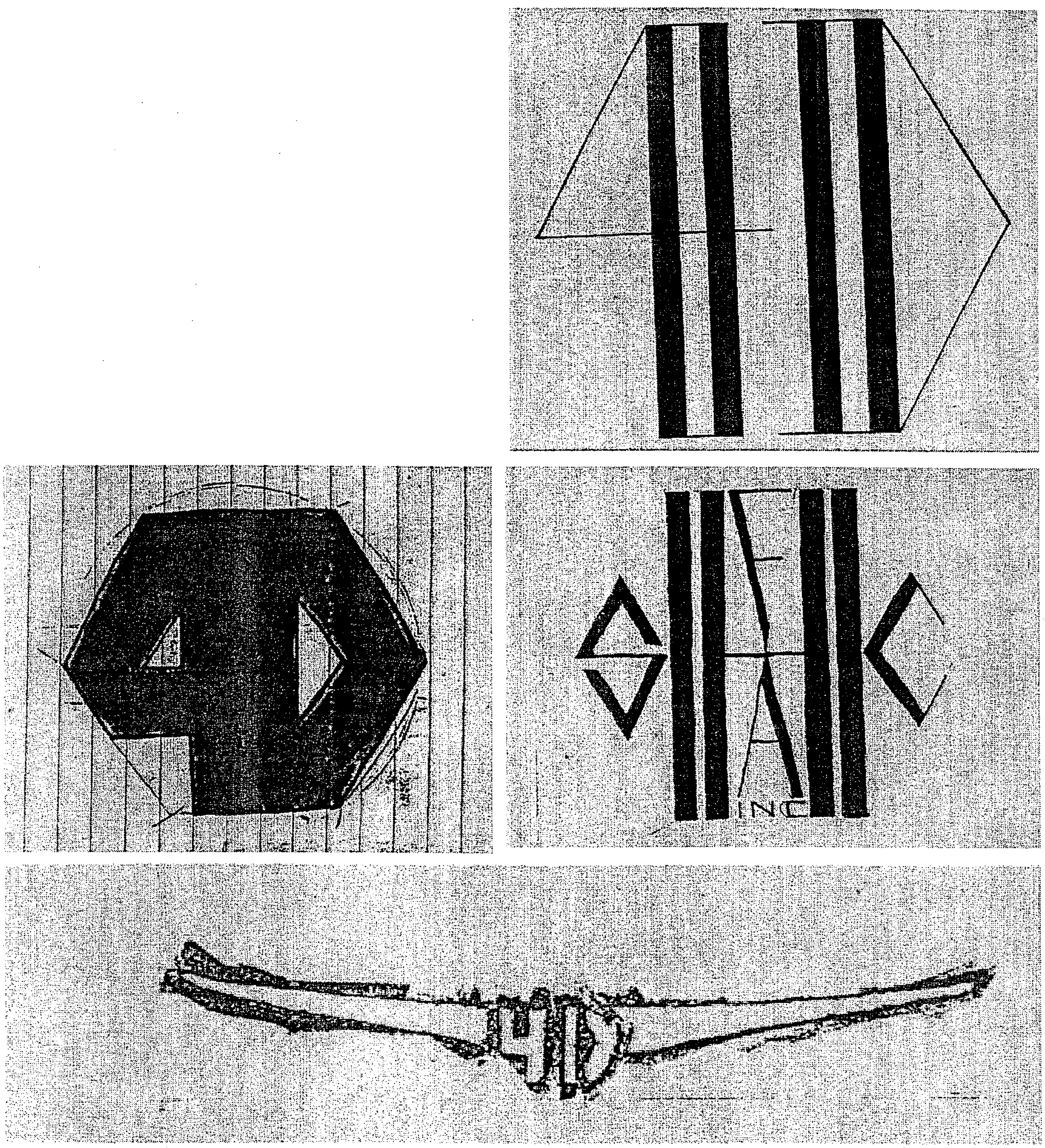
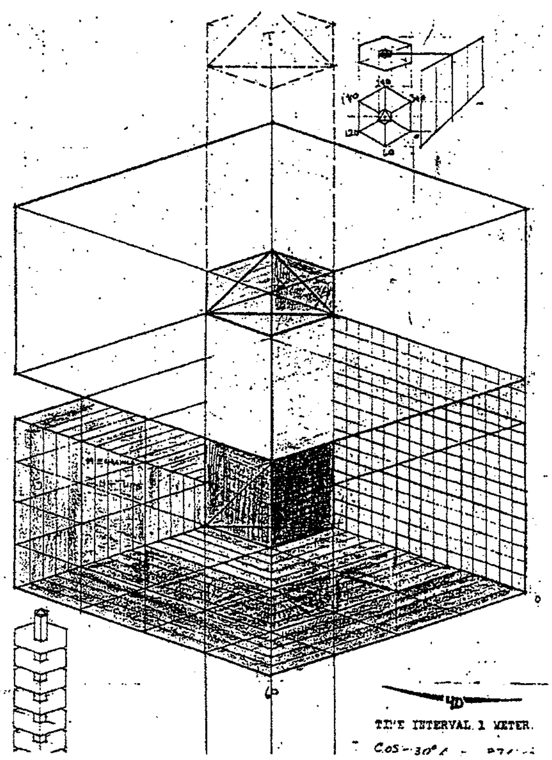


Fig.1.08a Nomenclature for a 4D tower. Source: BFI-MSS 28.01.0.
Fig.1.08b Sketch for a 5T-4P, 4D tower. Source: BFI-MSS 28.01.0.



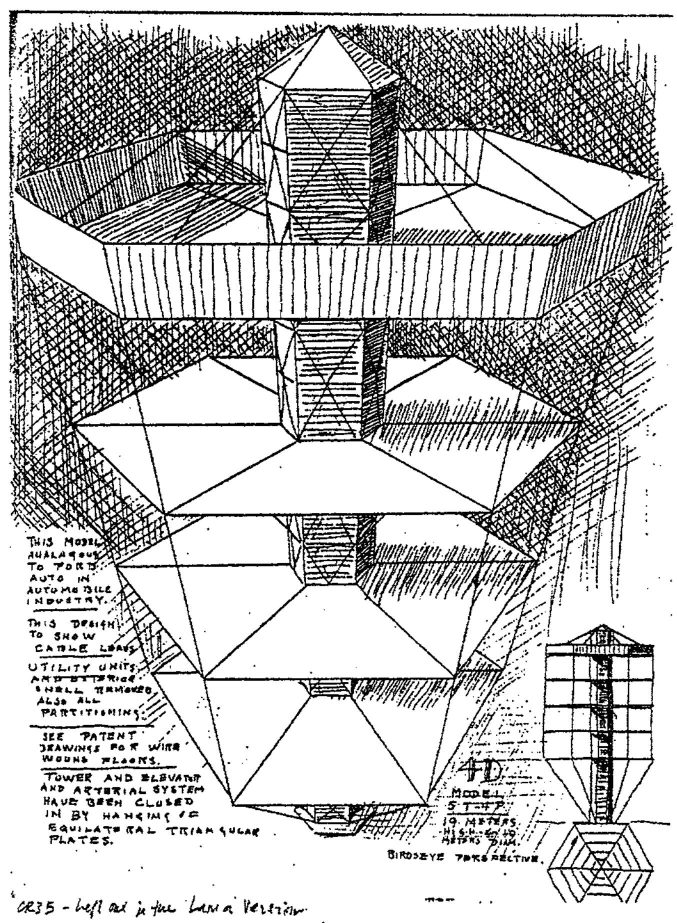


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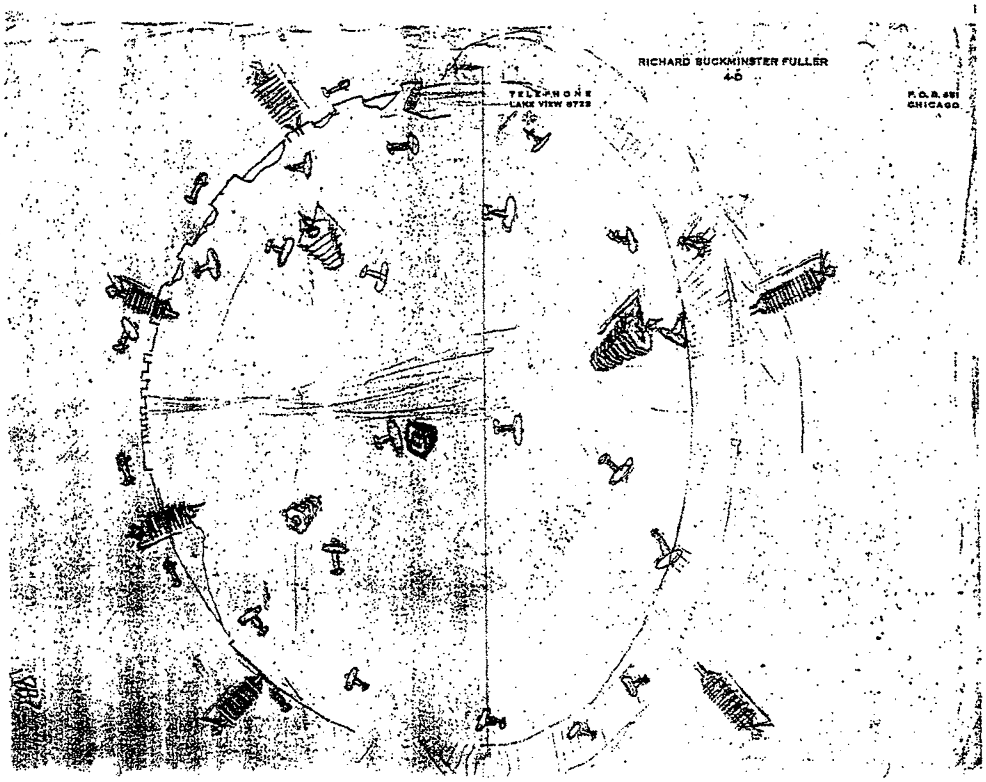
Fig.1.08c World-around 4D tower service, ca. 1928. Source: BFI-MSS 28.01.0.

Fig.1.08d Close-up of a tower with a "Goodrich Baby" dirigible, ca.1928. Source: BFI-MSS 28.01.0.



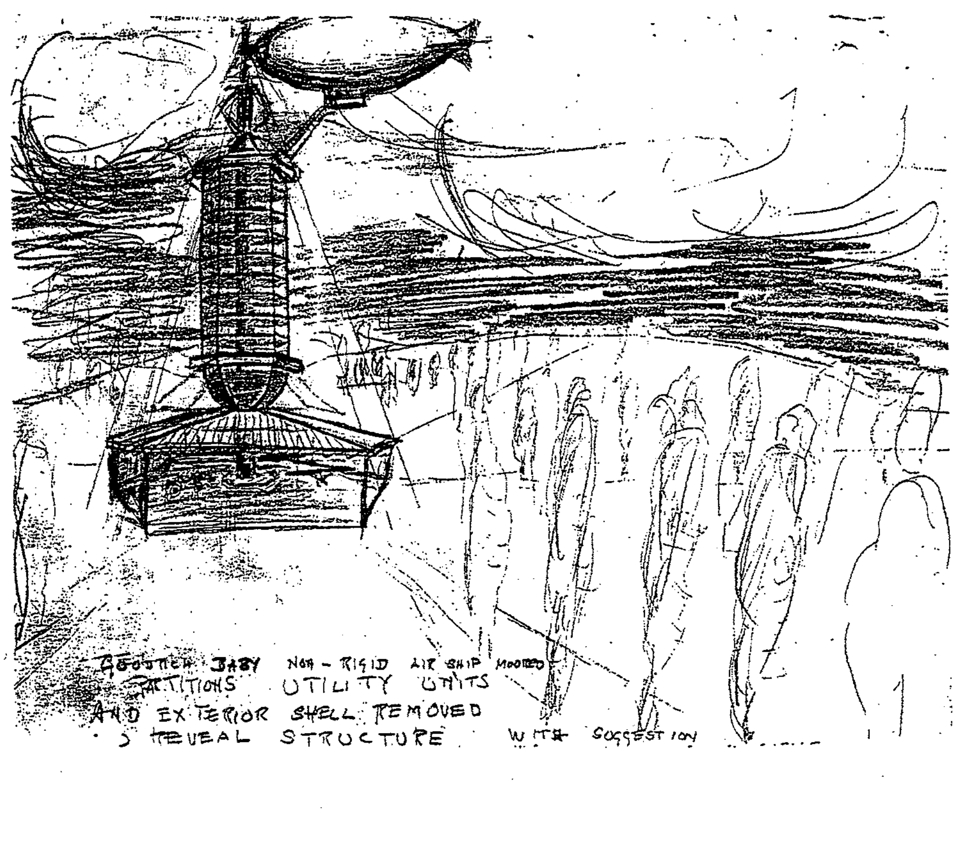
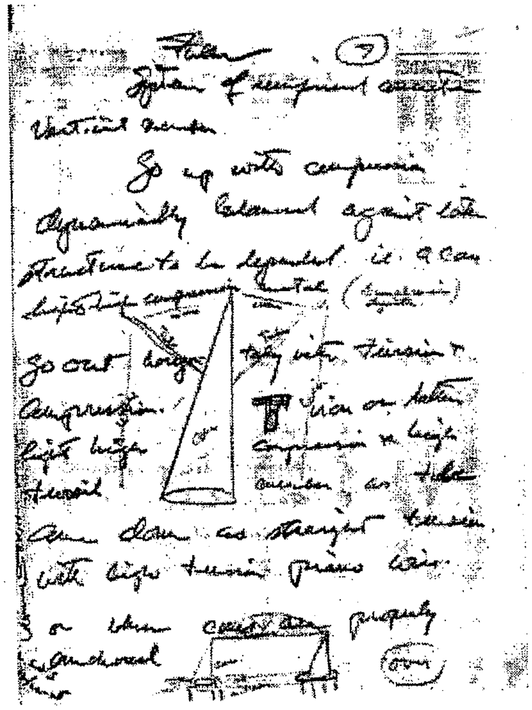


Fig.1.09a Sketch for the 4D House, ca. Feb. 1928. <u>Source:</u> BFI-MSS 28.01.0 (Folder VI Notes 4).



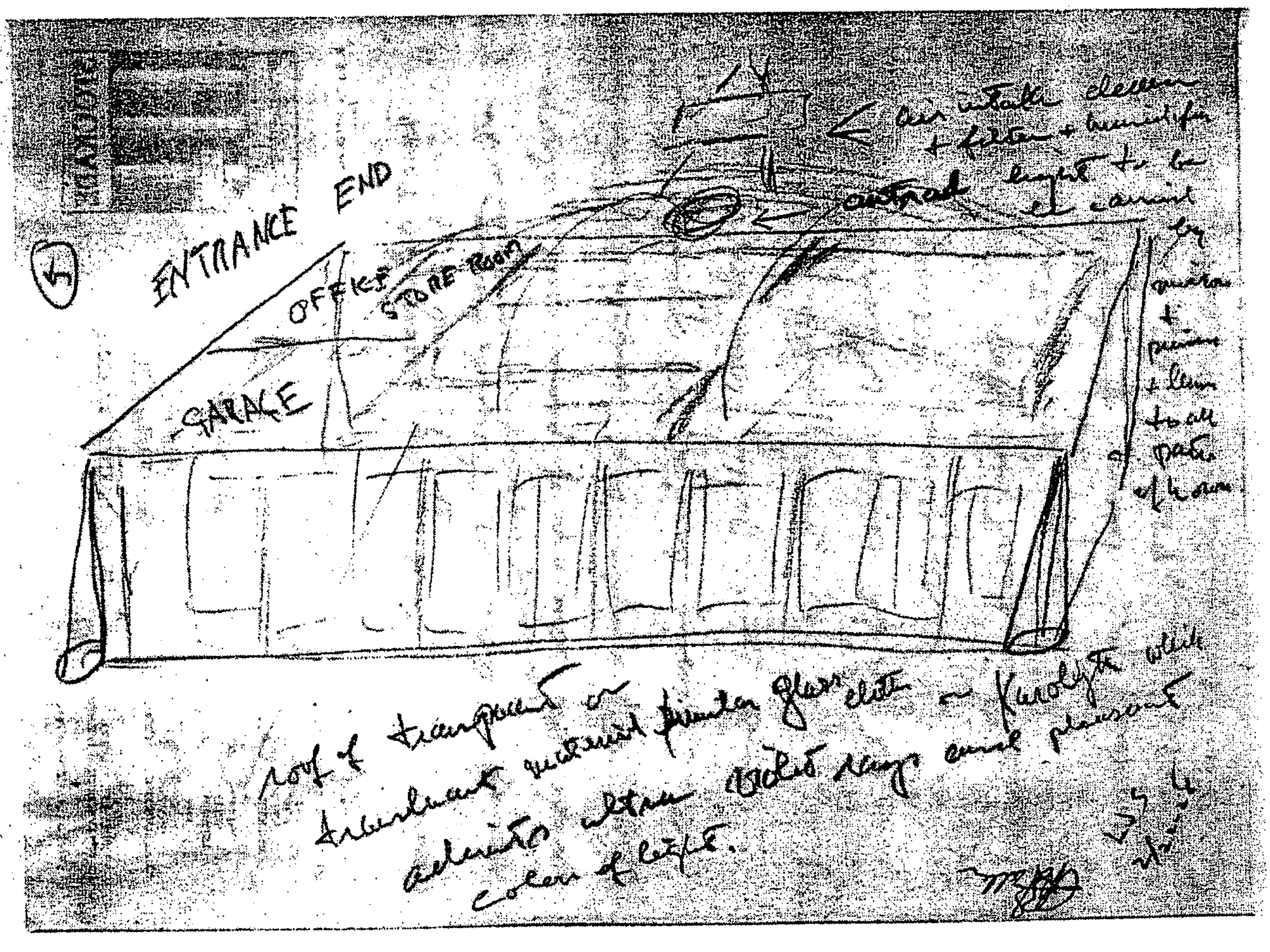


Fig.1.09b Sketch for the 4D House, ca. April 1928. <u>Source:</u> BFI-MSS 28.01.0 (Folder I).

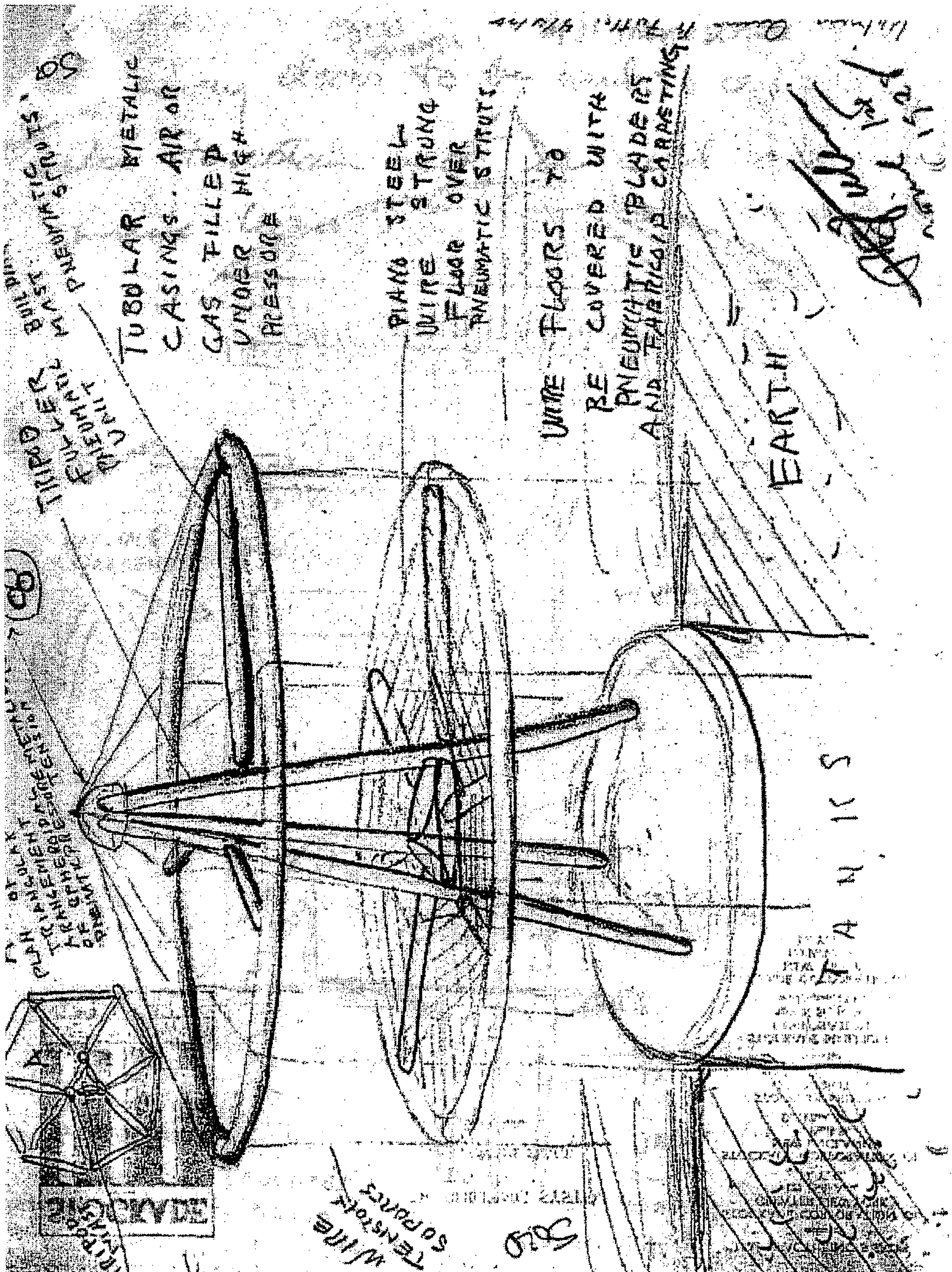
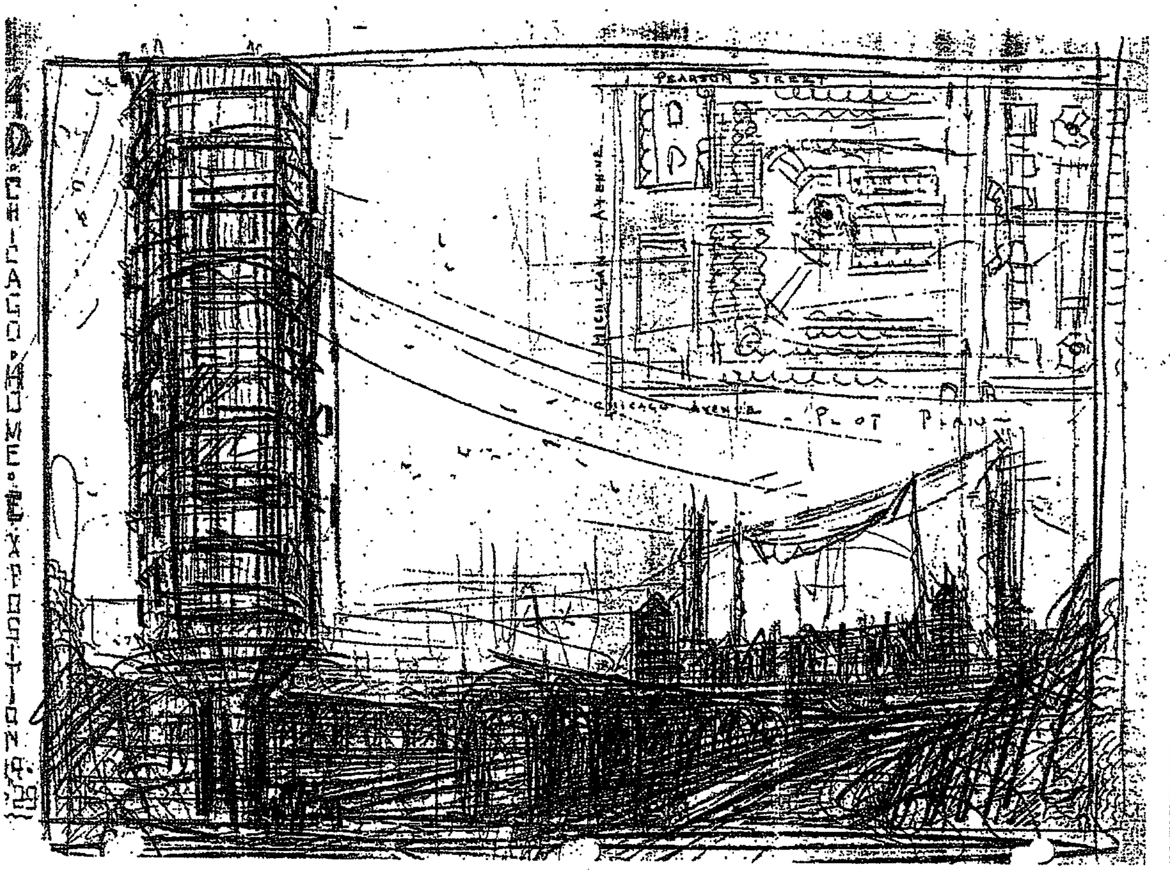


Fig.1.09c Sketch for 4D-Tower for Chicago Home Exhibition 1929 [probably by Robert Paul Schweikler (Dean of Arch., Carnegie Tech)]. Source: BFI-MSS 28.01.0 (Folder I).

Fig.1.09d Sketch for 4D-Tower for Chicago Home Exhibition 1929 [probably by Robert Paul Schweikler (Dean of Arch., Carnegie Tech)]. Source: BFI-MSS 28.01.0 (Folder I).



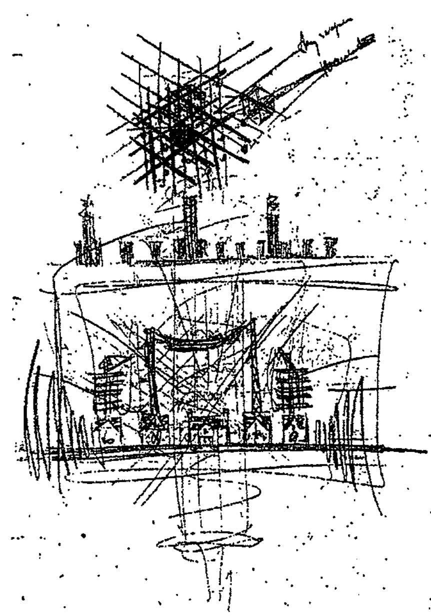


Fig.1.09e Bathroom design at Pierce Foundation-Buffalo, ca. May 1932. Source: BFI-CR39.

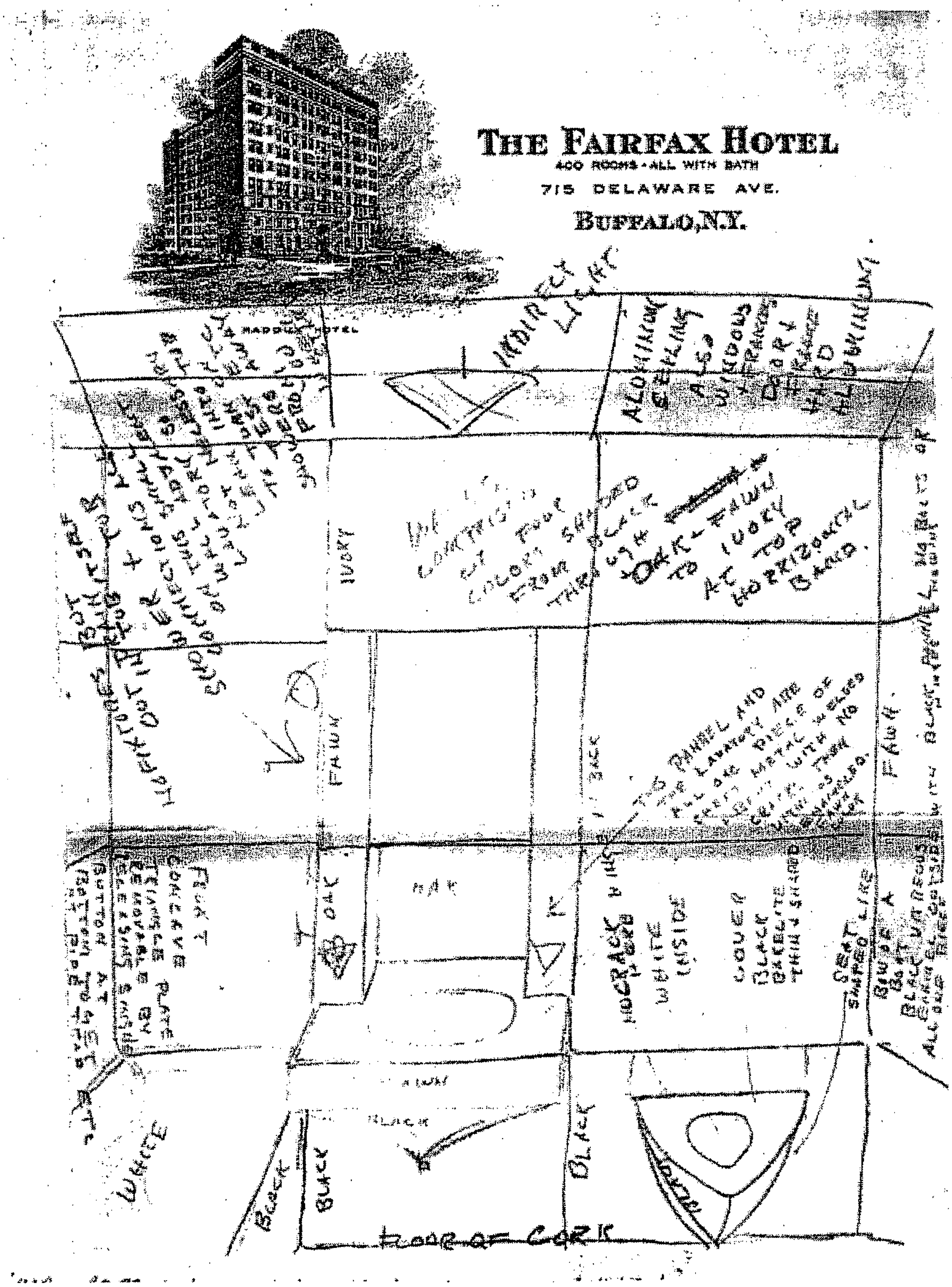


Fig.1.09f Toilet-bowl design at Pierce Foundation-Buffalo, N.Y., ca. July 1931. <u>Source:</u> BFI-CR40.

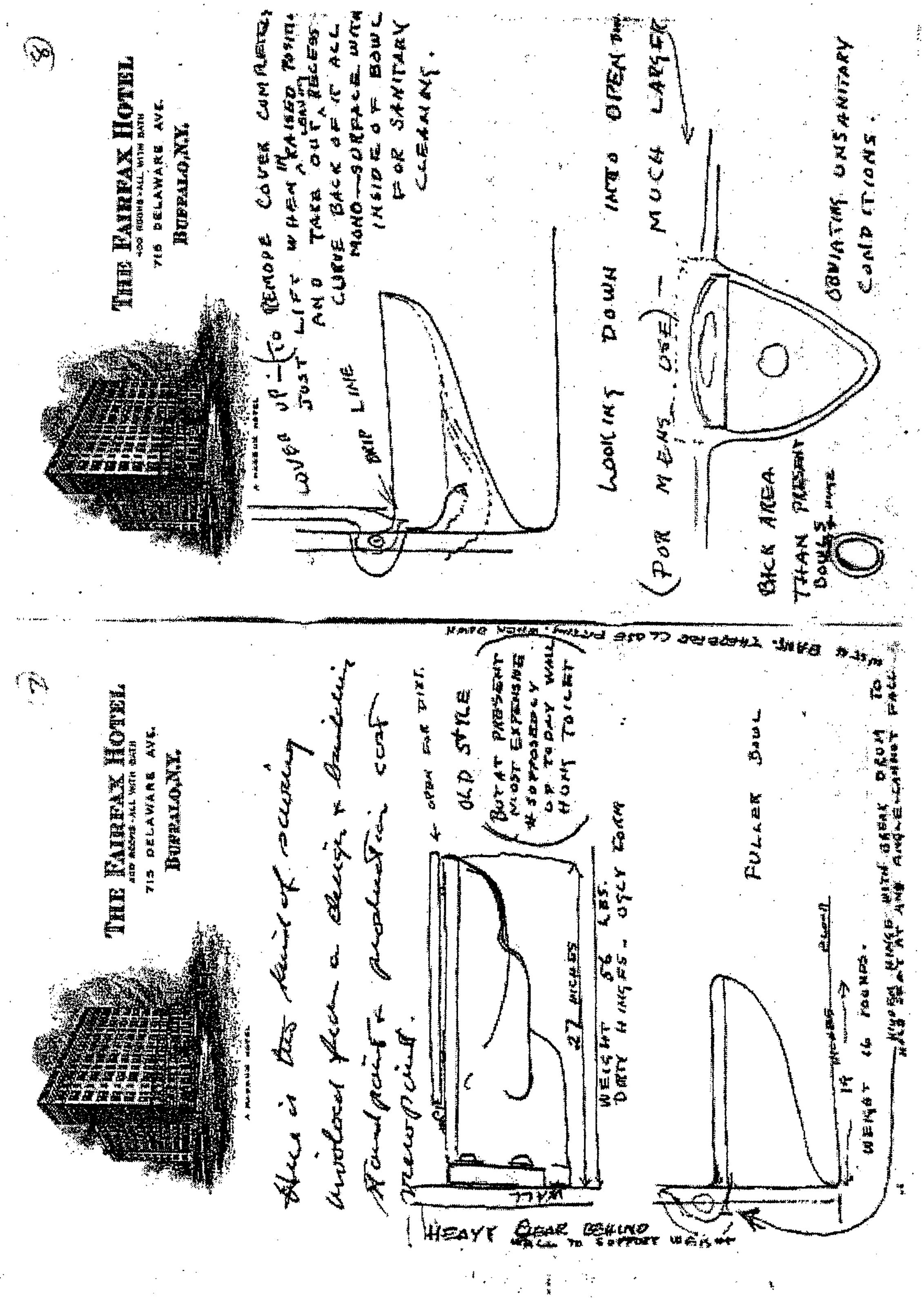
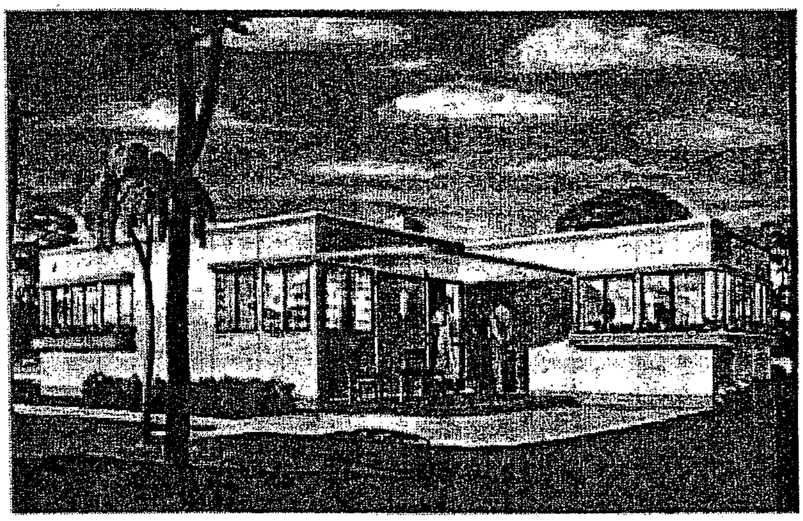


Fig.1.09g Advertisement of General House/Fortune. Source: *Time*, 4 July 1932.



This five-room steel house will sell for $[illegible] completely equipped if General Houses carries out the plans for mass production and installment selling revealed in FORTUNE for July, industrializing the housing industry by combining the facilities of Pullman, General Electric, American Radiator, Container Corp., Pittsburgh Plate Glass, Concrete Engineering, the Curtis Cos. Inc., and Thomas A. Edison, Inc.

THE DESTINY OF A GREAT JOURNAL

. . . . . is written in the times it serves. FORTUNE, conceived at the end of the old era, born, in 1930, at the beginning of the new, finds itself at the center of an altered world. The industrial and economic subjects with which it deals are the subjects around which the times revolve. And FORTUNE's human and vivid treatment of those subjects is the treatment which the times demand.

THERE COULD be no more convincing proof of FORTUNE's position and FORTUNE's destiny than the fact that its July issue was selected as the medium for the announcement of one of the most significant industrial events of this generation—the formation of a company which will co-ordinate the facilities of great manufacturers in the production and sale, by mass-fabrication methods, of a low-cost house.

AMERICAN INDUSTRY, in the midst of the Second Industrial Revolution and at the crisis of its career, turns more and more to FORTUNE not only for the facts it requires but for the vivid and comprehensive and uninfluenced publication of such news as it has to announce. For FORTUNE, the voice of no industrial interest and the organ of no industrial party, is concerned solely with the complete and accurate presentation of the contemporary economic and industrial and social history of its times.

Fortune

[FORTUNE IS NOT SOLD AT NEWSSTANDS : THE SUBSCRIPTION PRICE IS TEN DOLLARS THE YEAR : ADDRESS CIRCULATION DEPARTMENT, 350 EAST 22ND STREET, CHICAGO, ILLINOIS]

Fig.1.10 Organization chart of Fuller's Structural Study Associates (SSA), ca.1932. Source: BFI-CR42.

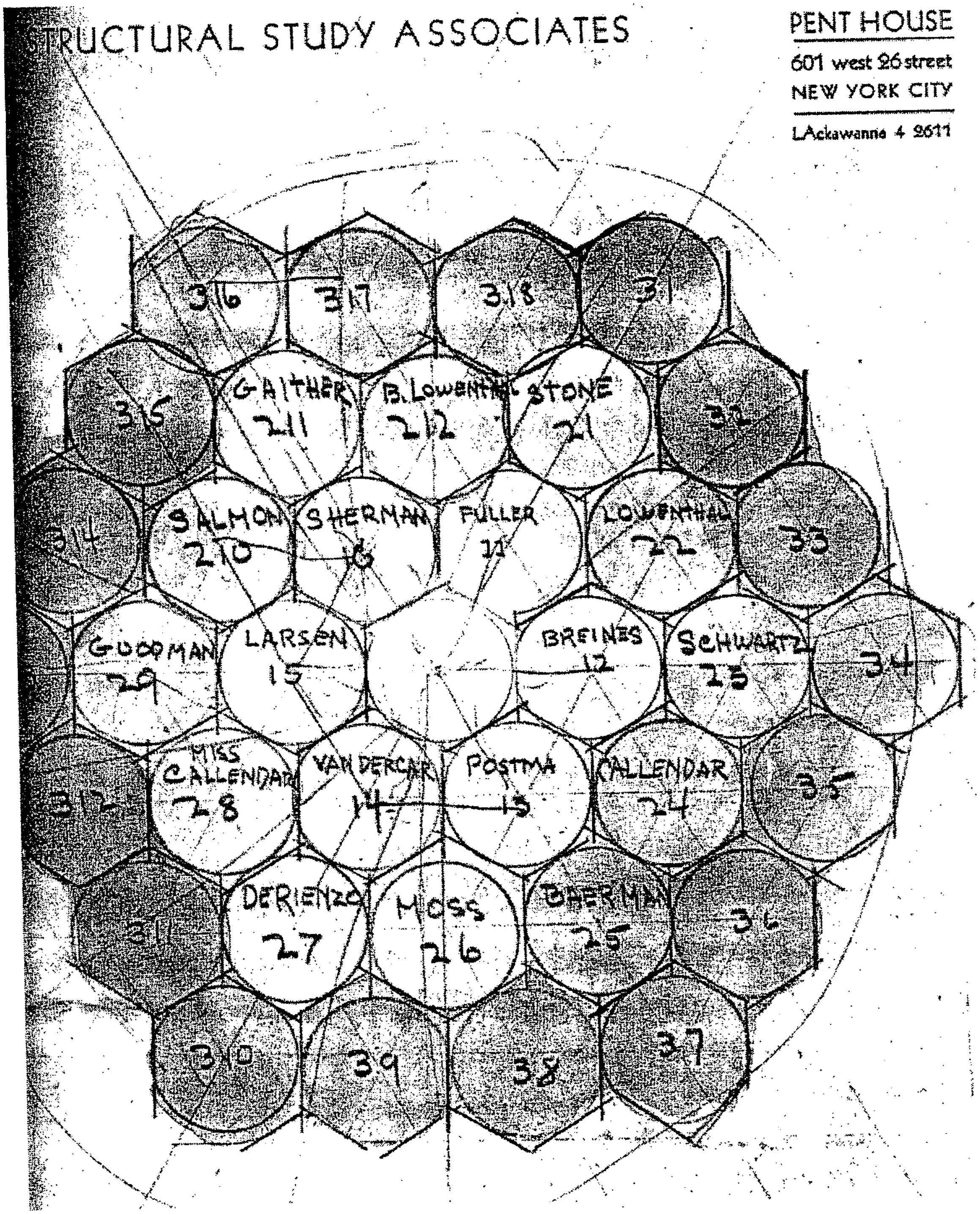


Fig.1.11 Dymaxion Dwelling Unit (DDU). Source: "Building for Defense ... 1000 Houses at $1,200 each," *The Architectural Forum*, June 1941.

MAN OF THE MONTH ...

BUILDING OF THE MONTH ...

PRODUCT OF THE MONTH ...

BUILDING FOR DEFENSE ... 1,000 HOUSES A DAY AT $1,200 EACH

promised by biggest sheet steel fabricator. Buckminster Fuller dreams up a grain bin, invents a trim three-room defense house, a six-man steel tank. The "Dymaxion" is totally demountable.

Fig.1.12 The Butler grain-bin. Source: "Butler Farm Equipment" catalogue, ca.1941.

Fig.1.13 Dymaxion Dwelling Unit (DDU) for advanced bases, ca. May 12, 1942. <u>Source:</u> BFI-CR86.

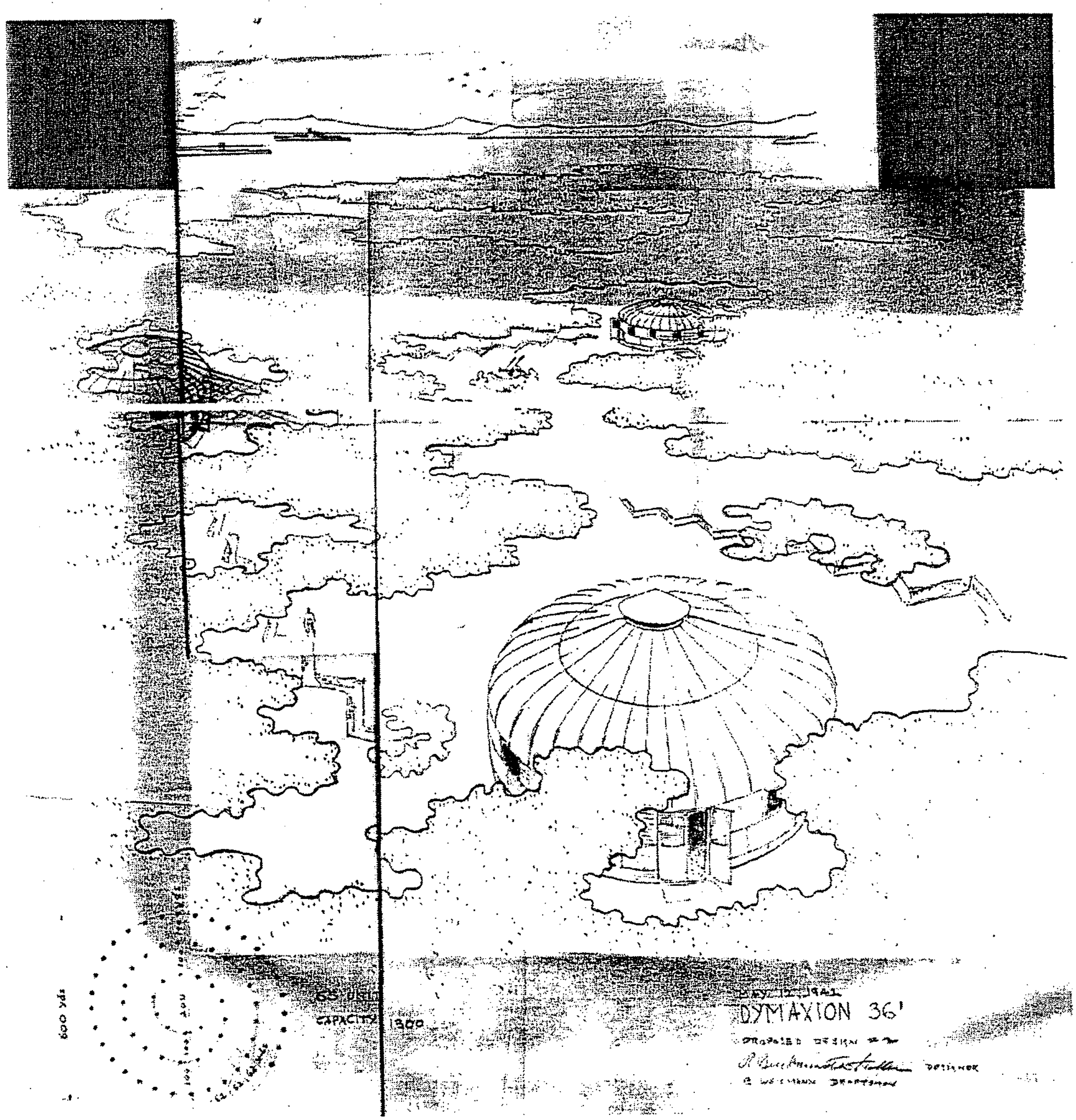


Fig.1.14a Dymaxion Dwelling Unit (DDU) in the Persian Gulf. <u>Source:</u> R.W. Marks, *The Dymaxion World of Buckminster Fuller* (1960), p.119.

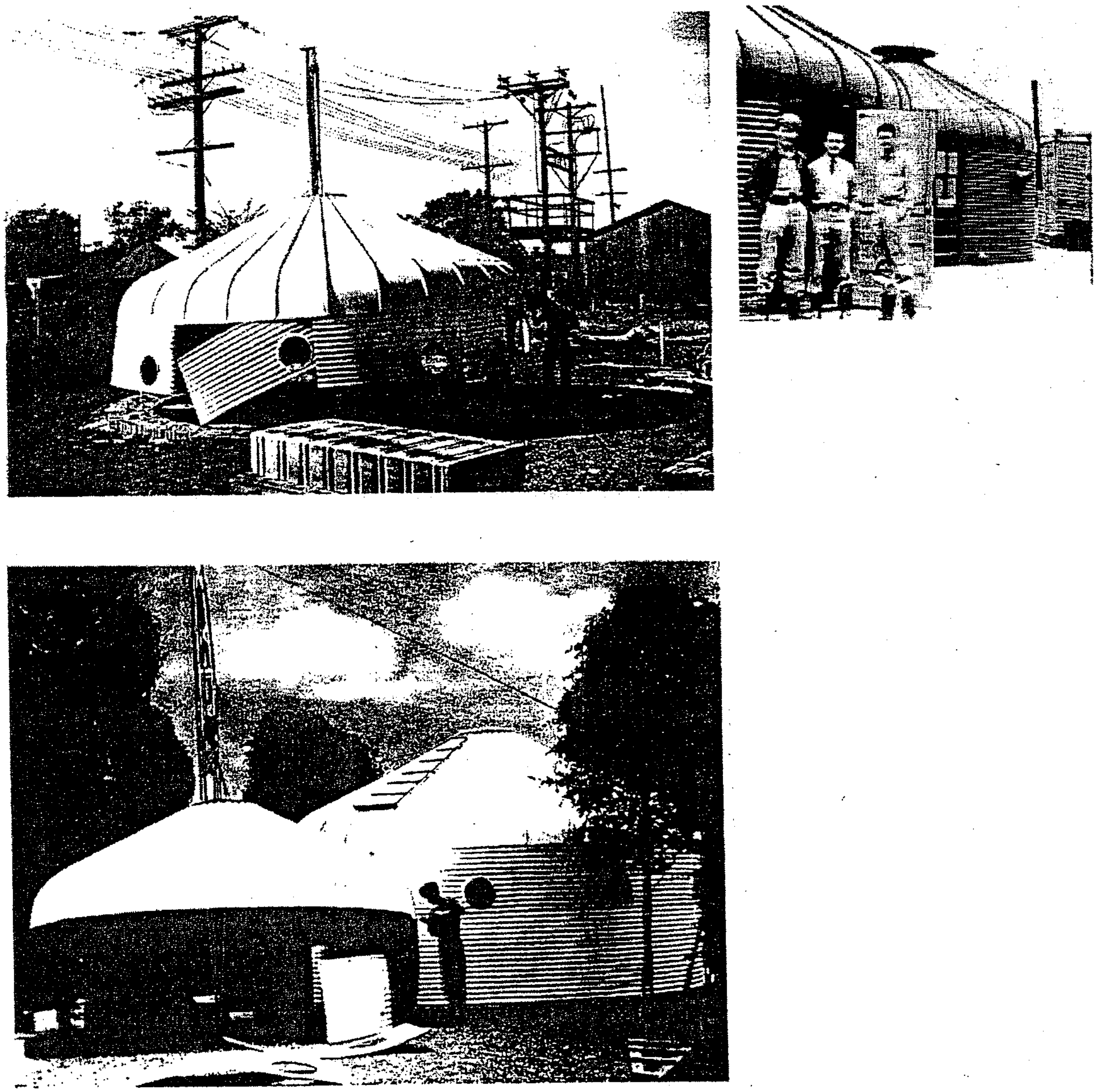
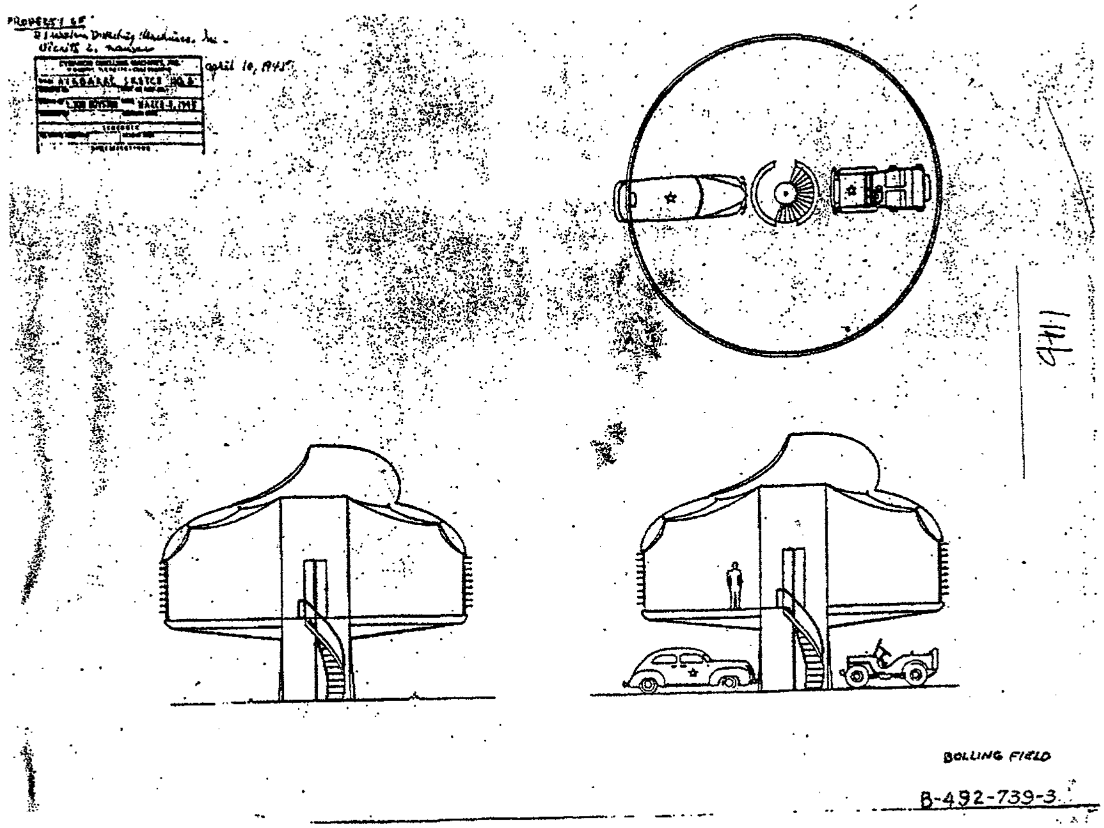


Fig.1.14b Officer's quarter (Airbarac Version), DDM ca. April 1945. Source: BFI-CR86[?].
Fig.1.14c Hospital & Dormitory (Airbarac Version), DDM, ca. April 1945. Source: BFI-CR86[?].



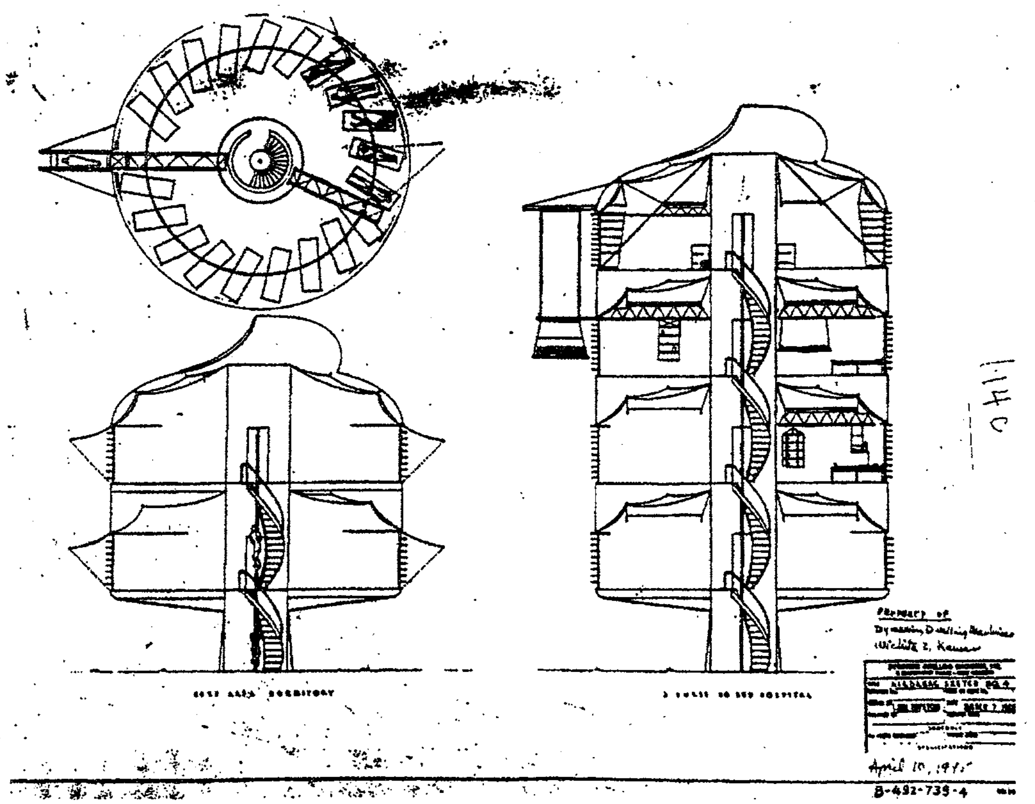
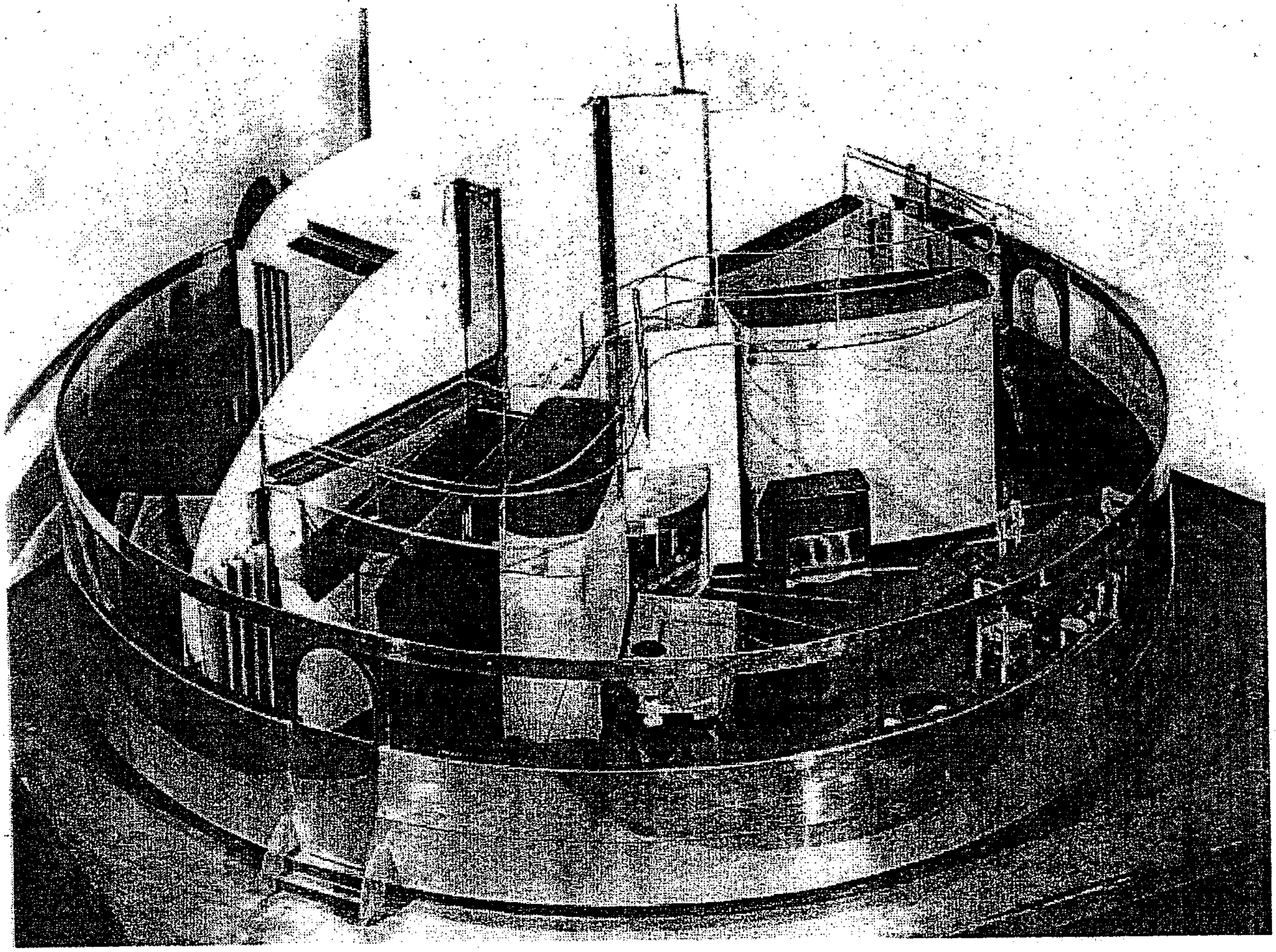


Fig.1.14d DDM-Fuller House ("Wichita House"), ca. April 1945. Source: BFI-CR86[?].
Fig.1.14e DDM-Fuller House ("Wichita House"), ca. April 1945. Source: BFI-CR86[?].



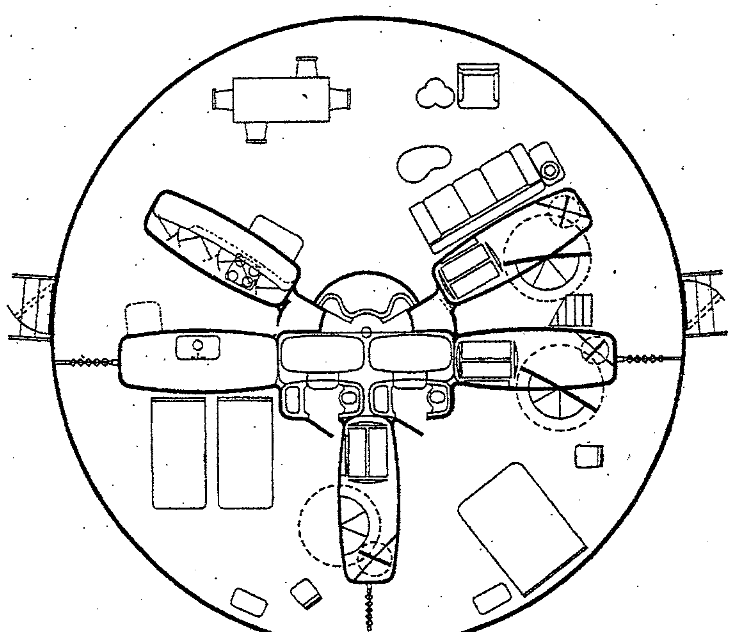


Fig.1.15 DDU at the MoMA. Source: MoMA, Department of Architecture & Industrial Art pamphlet, ca. October 1941.

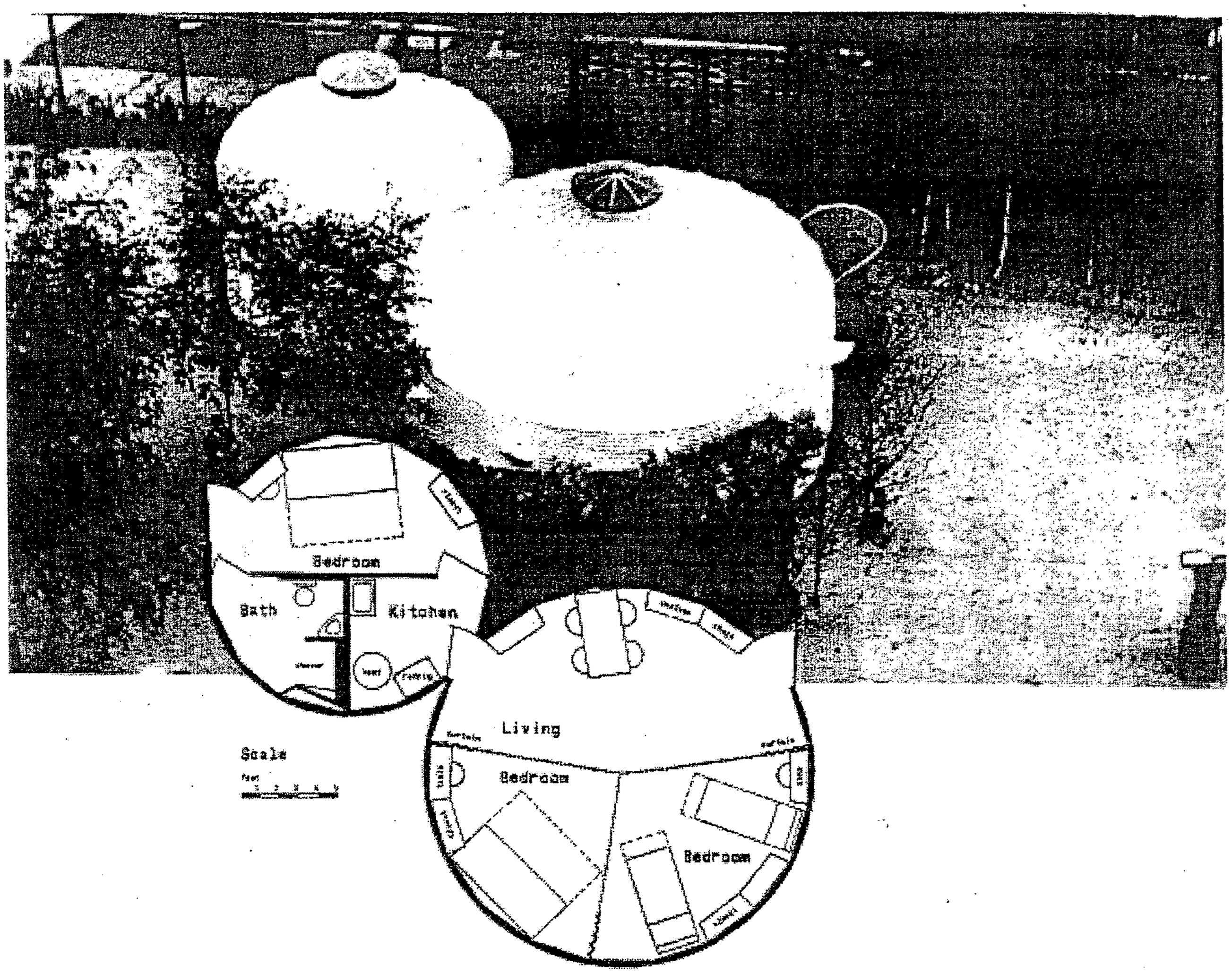


Fig.1.16a *SHELTER*, May & November 1932.

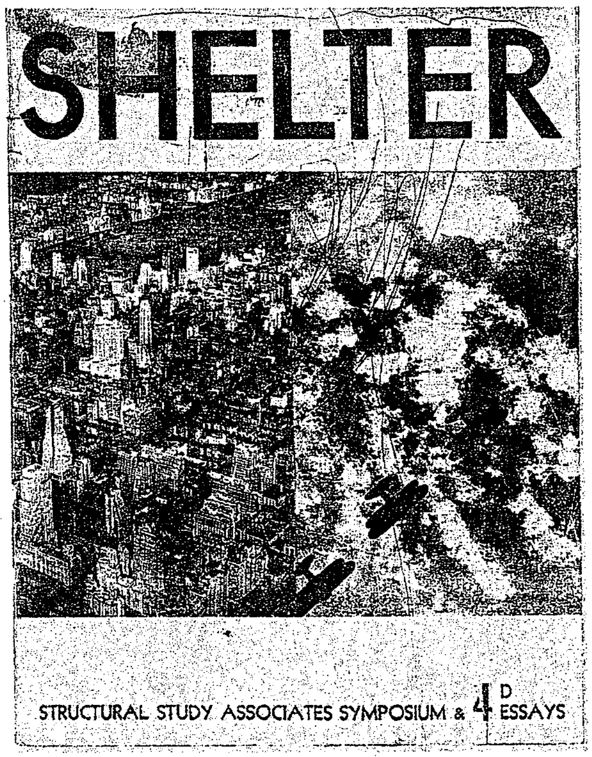


Fig.1.16b Illustrations from Knud Lönberg-Holm's "Monuments and Instruments." Source: *SHELTER*, May 1932, pp.6-9.

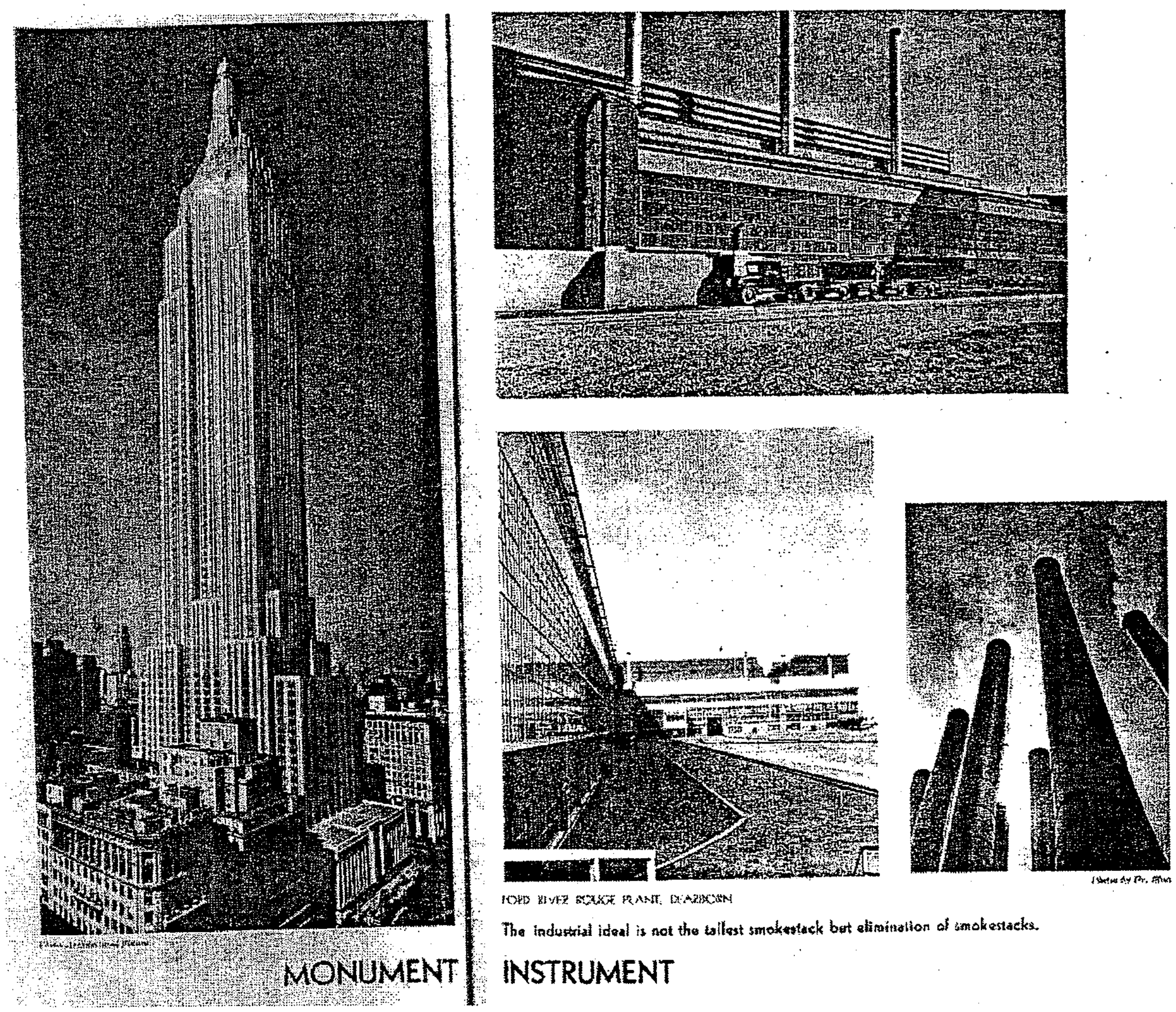
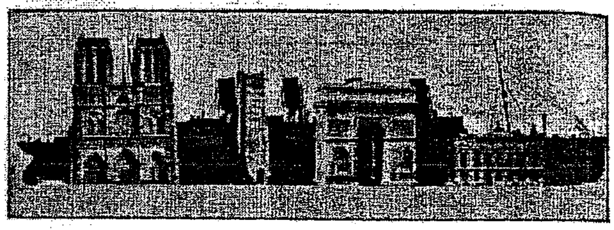


Fig.1.16c Cunarder "Aquitania," Classical Greek architecture, automobiles. Source: Le Corbusier, "Towards a New Architecture," pp.86-87, 124-125.

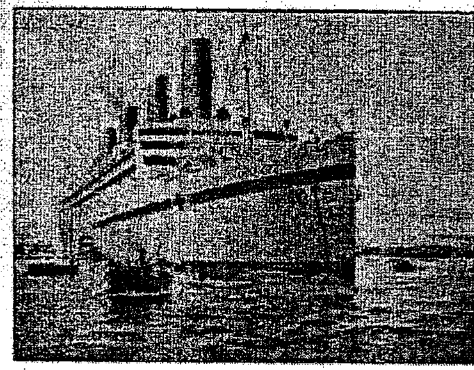
86 TOWARDS A NEW ARCHITECTURE



THE CUNARDER "AQUITANIA," WHICH CARRIES 3,600 PERSONS, COMPARED WITH VARIOUS BUILDINGS

shop and forge have conceived and constructed these formidable affairs that steamships are. We land-lubbers lack the power of appreciation and it would be a good thing if, to teach us to raise our hats to the works of "regeneration," we had to do the miles of walking that the tour of a steamship entails.

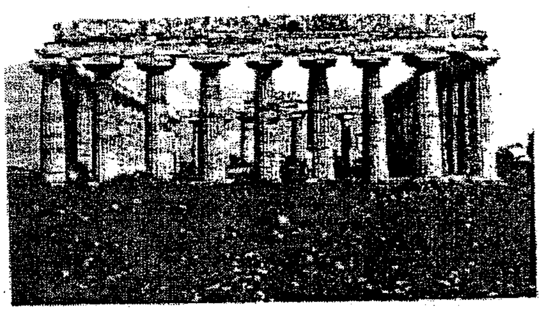
EYES WHICH DO NOT SEE 87



THE CUNARDER "AQUITANIA"

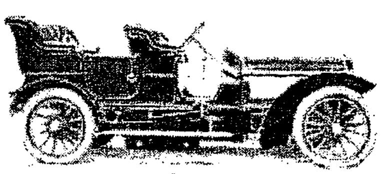
In a town like Prague, for example, an old enactment imposes a wall-thickness of 14 inches at the top storey of

124 TOWARDS A NEW ARCHITECTURE



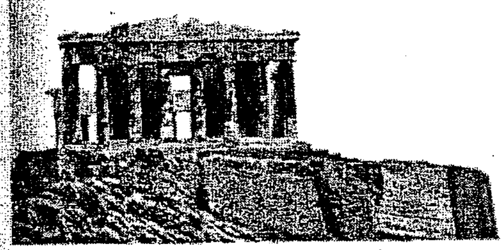
PAESTUM, 600–550 B.C.

When once a standard is established, competition comes at once and violently into play. It is a fight; in order to win you must do better than your rival *in every minute point*, in



HUMBER, 1907

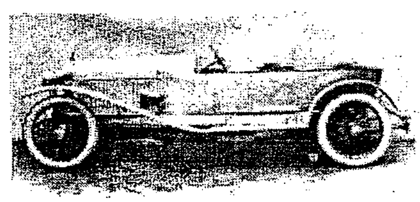
AUTOMOBILES 125



THE PARTHENON, 447–434 B.C.

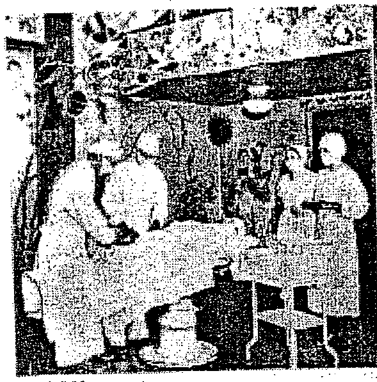
the run of the whole thing and in all the details. Thus we get the study of minute points pushed to its limits. Progress.

A standard is necessary for order in human effort.



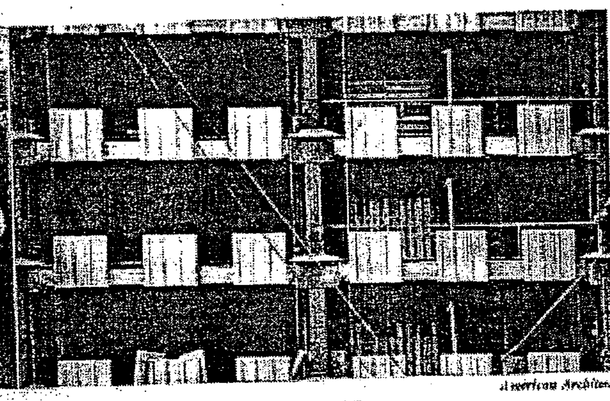
DELAGE, "GRAND-SPORT," 1921

Fig.1.16d "Chronic Disorders of Architecture." Source: *SHELTER*, May 1932, p.19.



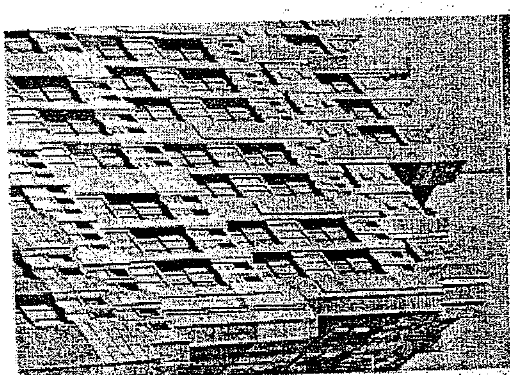
Hospital Management

1: RINGWORM



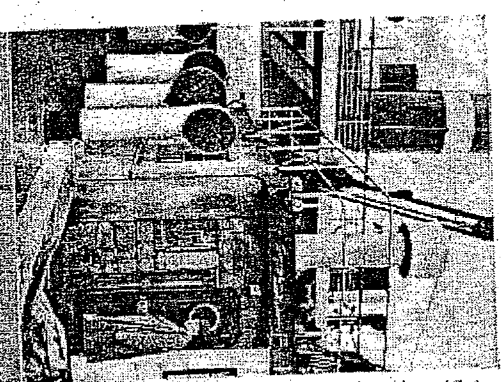
American Architect

2: PILES



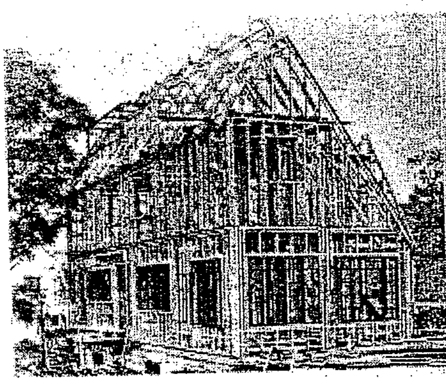
Contemporary American Architects

3: ECZEMA



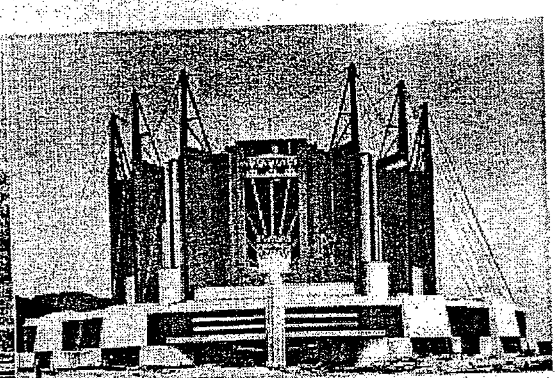
The Architectural Review

4: CANCER



House and Garden

5: SPINAL MENINGITIS



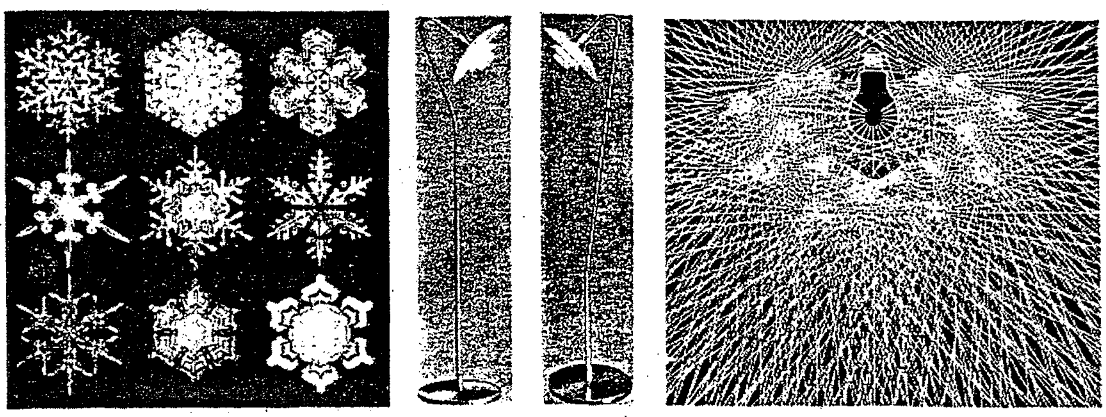
Progress

6: INFANTILE PARALYSIS

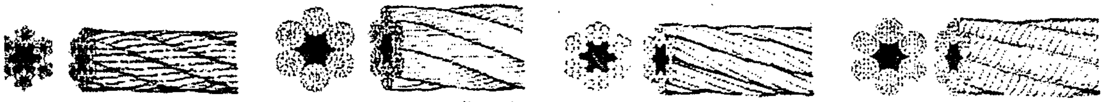
Figure 3, Captioned "Fairyland Operating Room". Figure 4, "High Art on The High Seas". Figure 5, "Skyscraper Methods Have Been Adapted For Home Building. Stage In The Erection Of A Steel Framed House."

CHRONIC DIS-ORDERS OF ARCHITECTURE

Fig.1.16e Dynamics of hexagons in cable strands. <u>Source:</u> *SHELTER*, Nov. 1932, p.106.



4 5 6 P. H. Hexsiamer



7 Tiller or Hand Rope — American Special Hoisting Rope Type "R" — Galvanized Iron or Steel Guy Rope (6x7, 1 Hemp Core). — Steel Clad Hauling Rope

'WHAT DO YOU SEE?''—TELEOLOGICAL-DEMONSTRATION

Tension, gravity, timing, streaming, continuity, evolution, rhythm of relative identity, etc.—typical specific correlation.—The dynamics of he hexagon (force diagram of circle) found in (A) "Centralization" as demonstrated in unification by circular-agglomeration (cable strands); in B) "Decentralization" as demonstrated in expansion—by crystalization (snowflakes); in (C) "Abstraction" as demonstrated in elemental-synthesis hydrocarbon-coronene). (Coronene recently developed, unknown in nature. Atomic structure circle of 6 hexagons ("crown"), each consisting of 6 carbon atoms with 12 hydrogen atoms on circumference.) Pictures above. (1 and 2) Olympic games events—girls diving, and sailing aces. (4) Snowflakes, invariably six-sectored, never identical. (5 and 6) Scientific P. H. diffusing lights.

Fig.1.17 Fred Keck's twelve-sided *House of Tomorrow*.

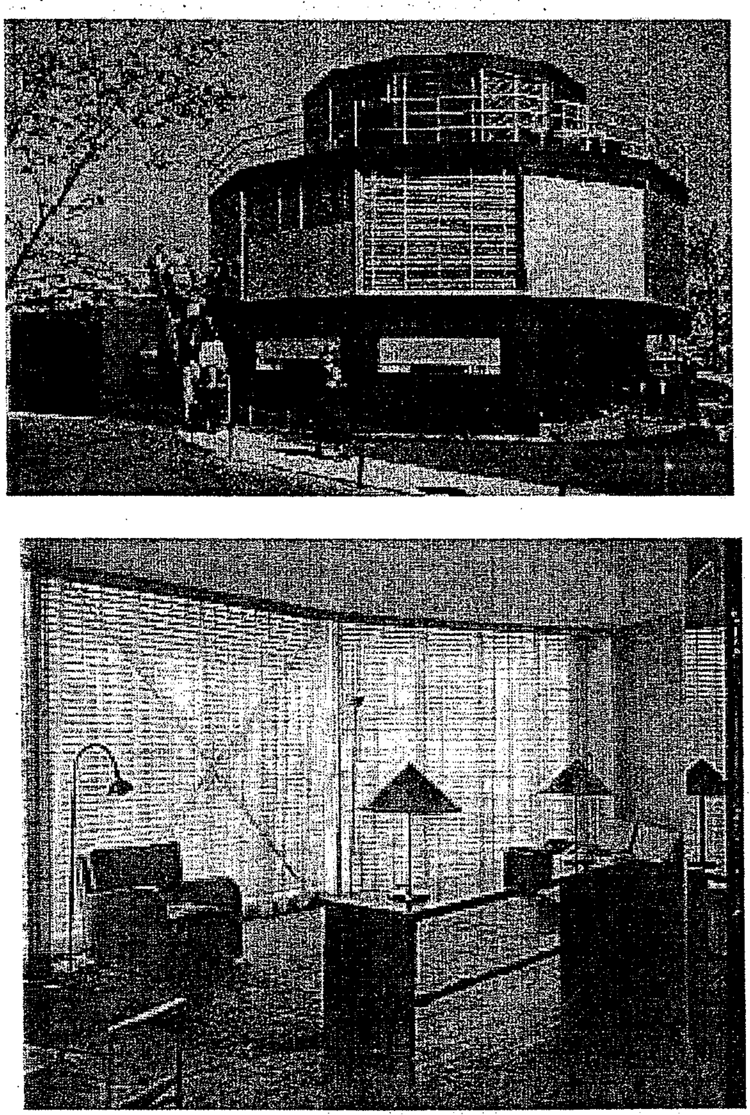


Fig.2.00a Plan & Elevation. Geodesic Patent, U.S. Patent #2,682,235. Source: J. Ward ed., The Artifacts of R. Buckminster Fuller, Vol. 3, p.200.

June 29, 1954 R. B. FULLER 2,682,235

BUILDING CONSTRUCTION

Filed Dec. 12, 1951 6 Sheets-Sheet 1

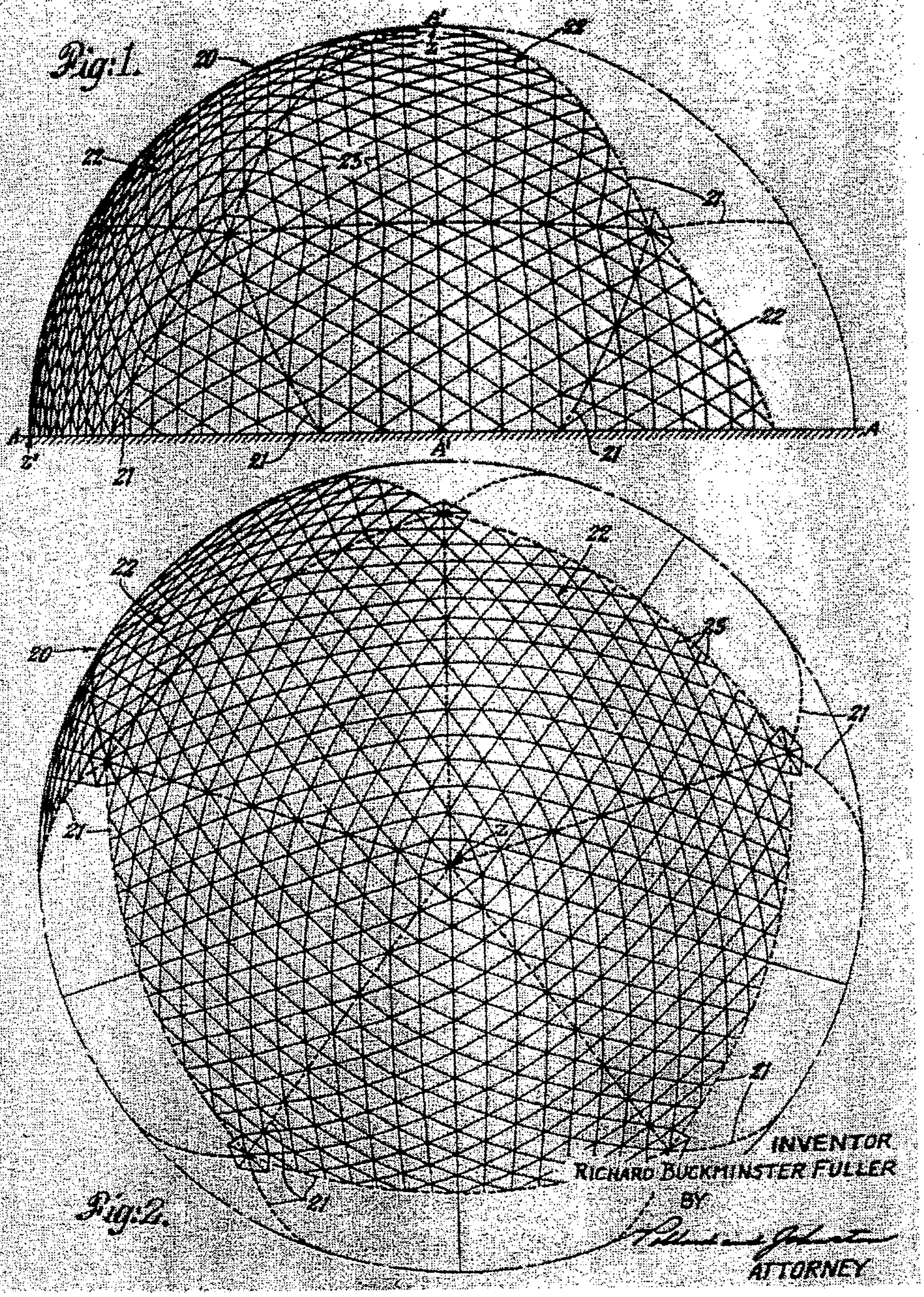
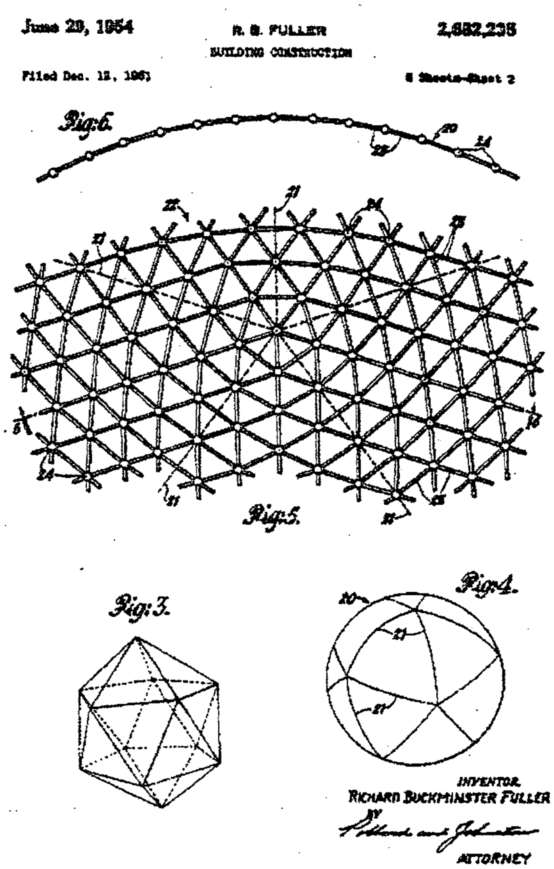
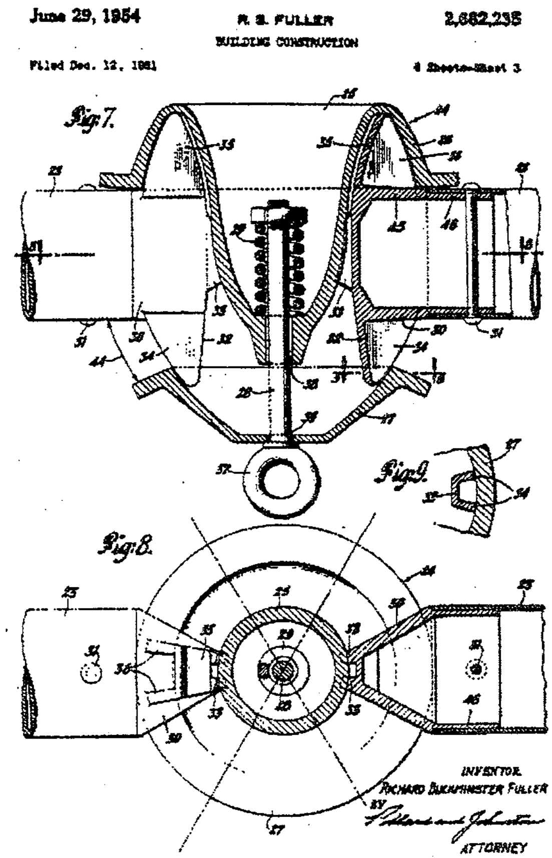


Fig.2.00b Joint & Skinning details. Geodesic Patent, U.S. Patent #2,682,235. Source: J. Ward ed., The Artifacts of R. Buckminster Fuller, Vol. 3, p.201.





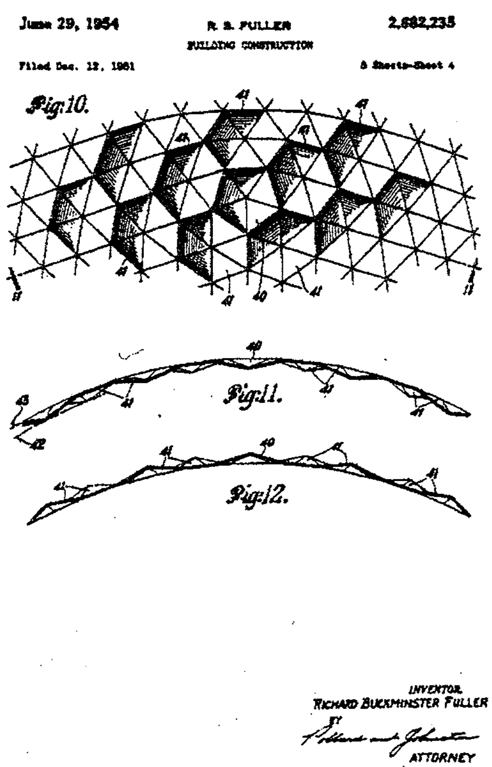
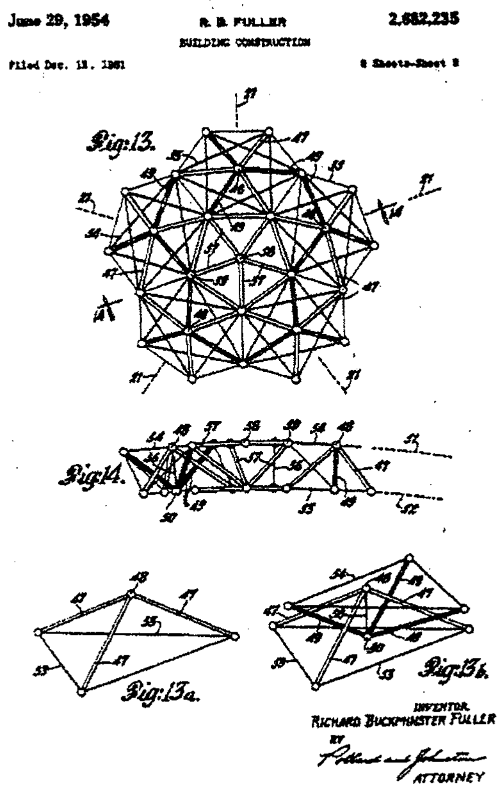


Fig.2.00c Joint & Skinning details. Geodesic Patent, U.S. Patent #2,682,235. Source: J. Ward ed., The Artifacts of R. Buckminster Fuller, Vol. 3, p.202.



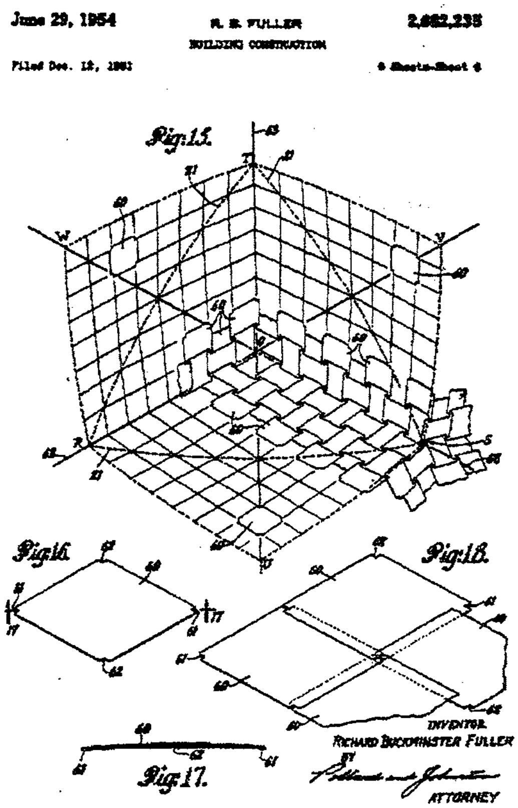


Fig.2.00d Domes and frequency normenclature. Source: R. B. Fuller, "Problem of Industrial Logistics," ca. 1952 in BFI-EJA Green.

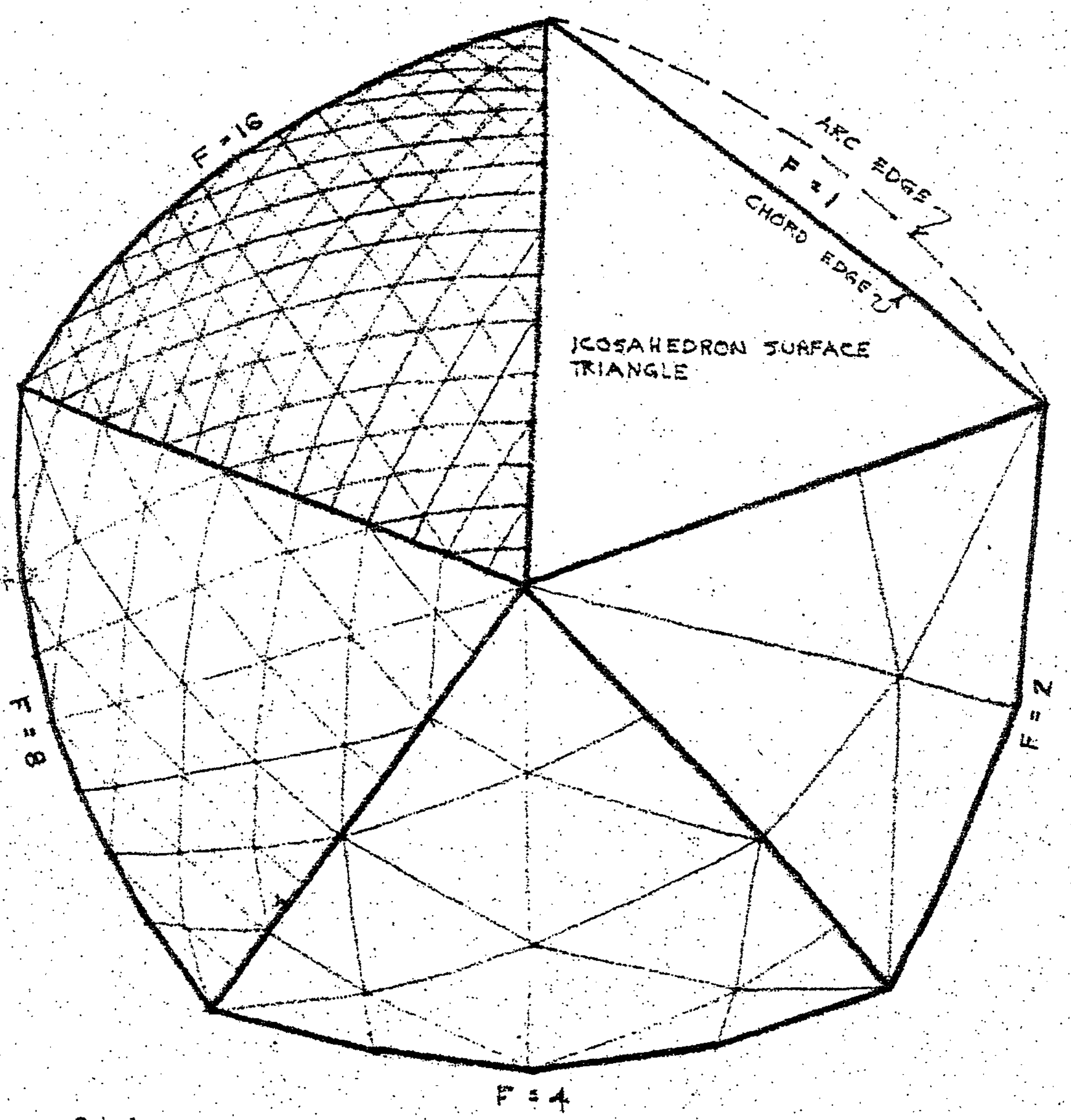


Fig.2.00e Class I & II geodesic dome sub-divisions of base triangles. <u>Source</u>: Domebook 2, Dec. 1971.

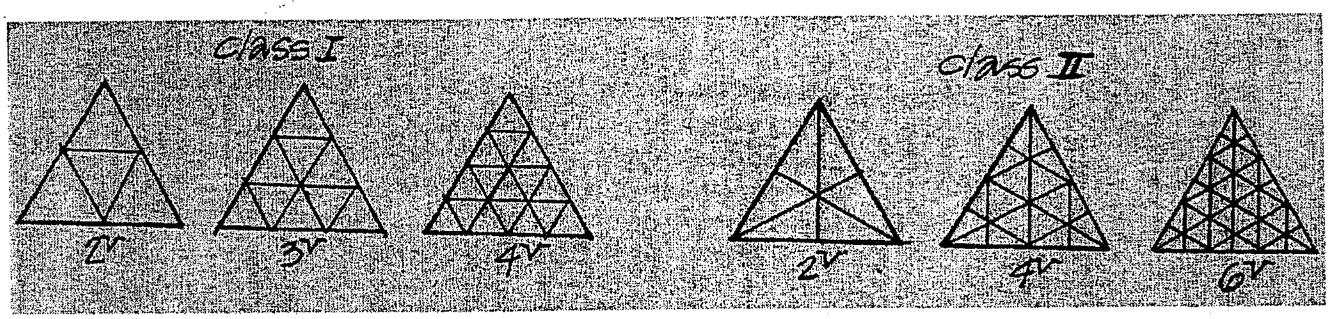


Fig.2.01 "Suppine 50," Fuller with mock-up of 31-GC geodesic sphere, BMC, July 1948. <u>Source:</u> BFI- Photo #B-2-1.

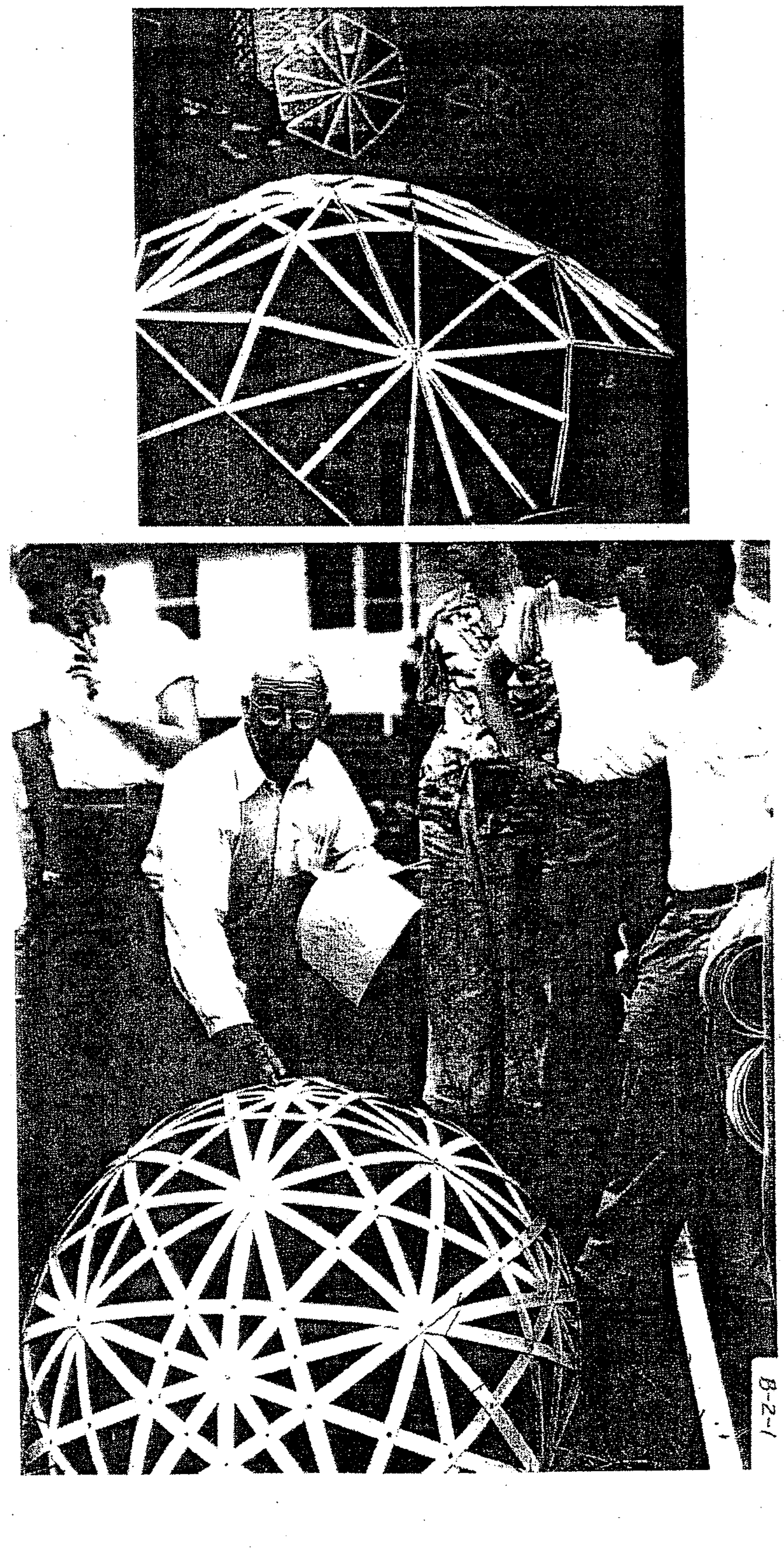
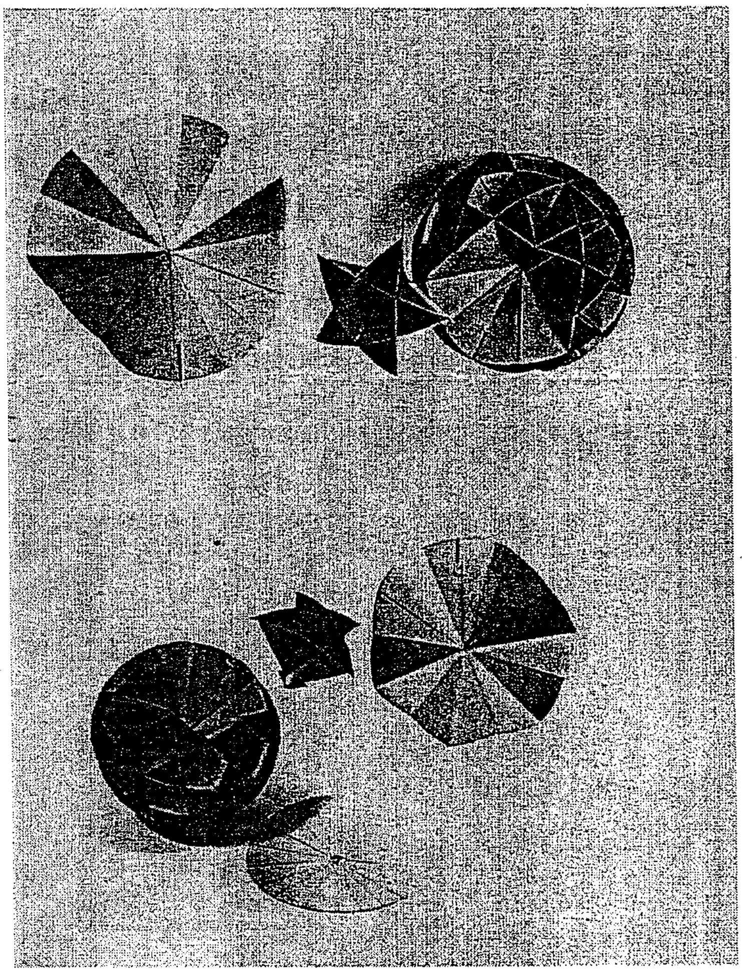
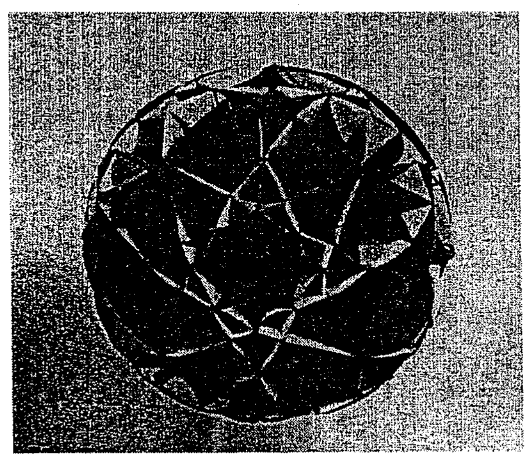


Fig.2.02 Bow-tie model of GC-geodesic sphere, ca. 1948. Source: BFI-EJA Blue Trunk.





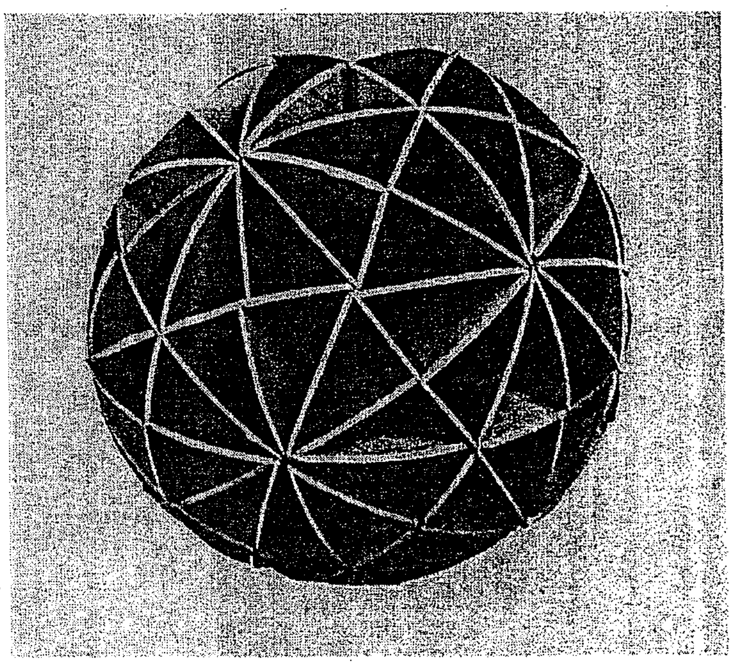


Fig.2.03 R.B. Fuller, Sketch of spherical triangle, ca. February 20' 48. Source: BFI-EJA Blue Trunk.

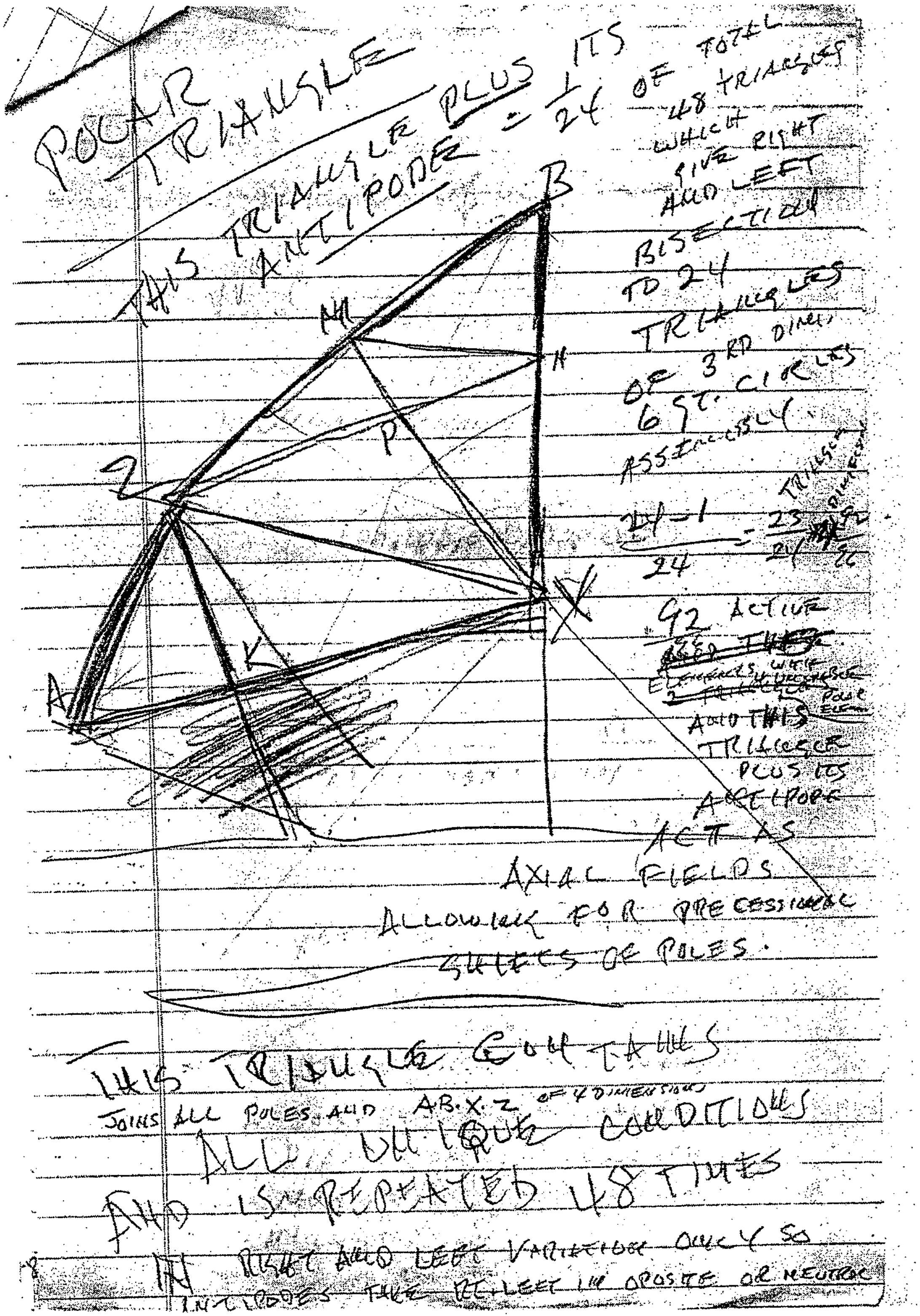
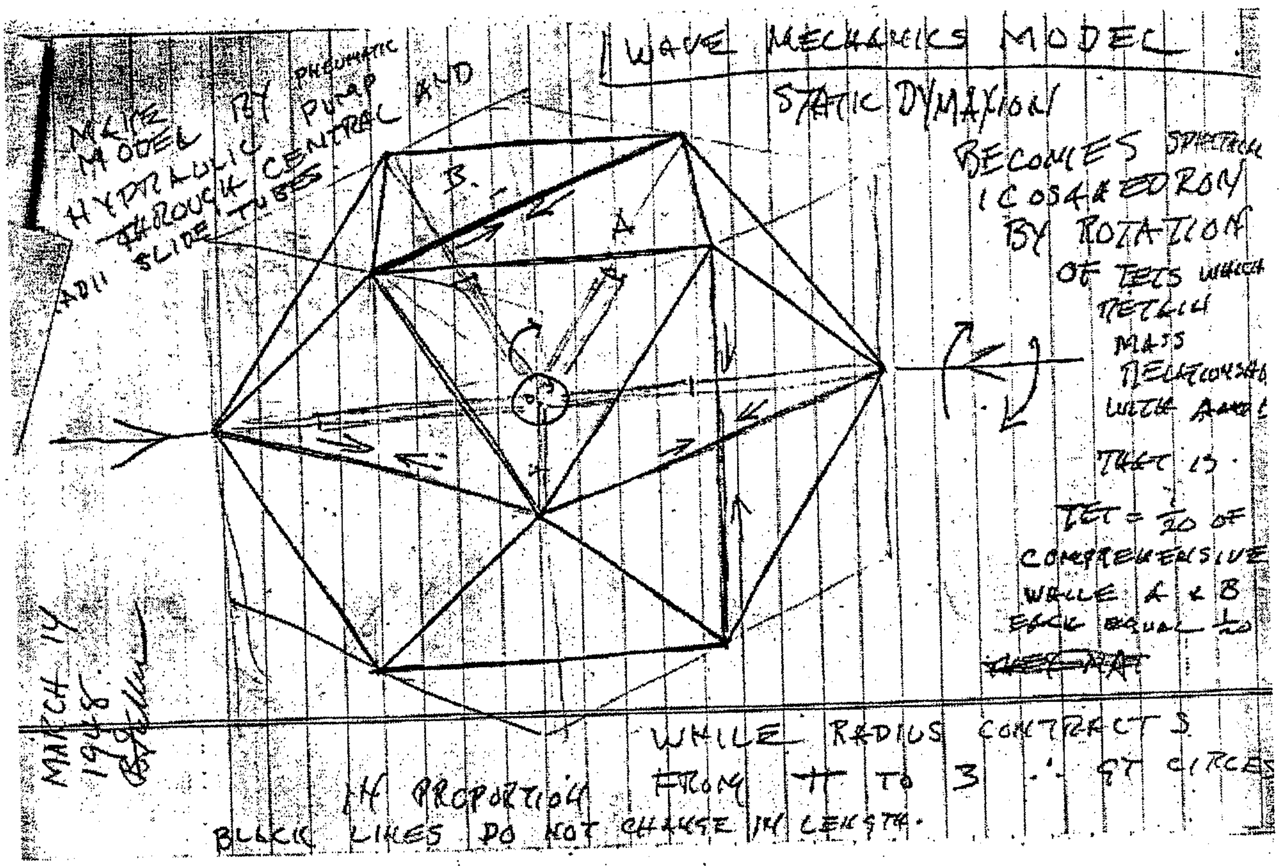


Fig.2.04a R.B. Fuller, Wave-mechanics model, "Jitter-bug," ca. March 14' 48. Source: BFI-EJA Blue Trunk.



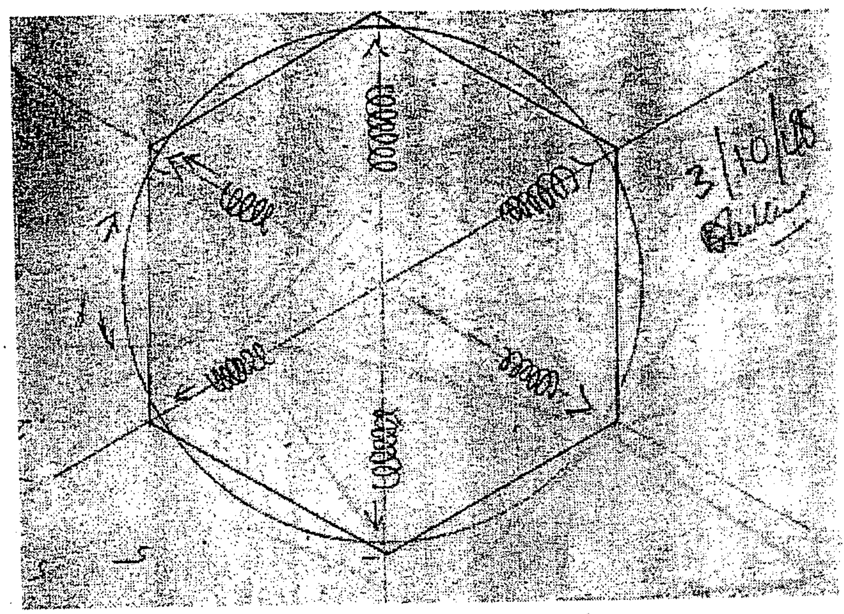


Fig.2.04b Photograph of Jitterbug model, Plexiglas tape and metal rods, undated (attributed to D. Richter). Source: BFI-EJA Blue Trunk.

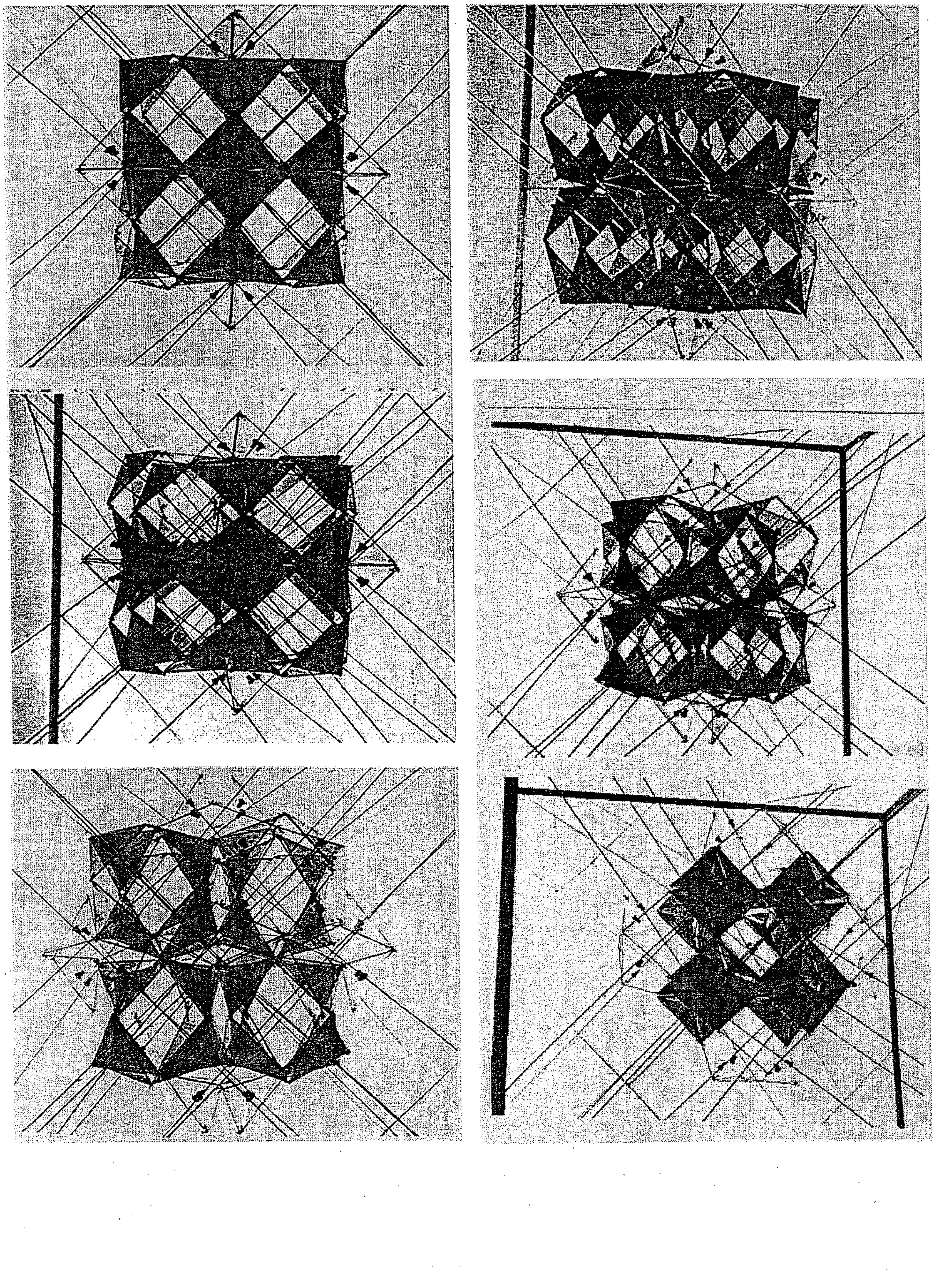
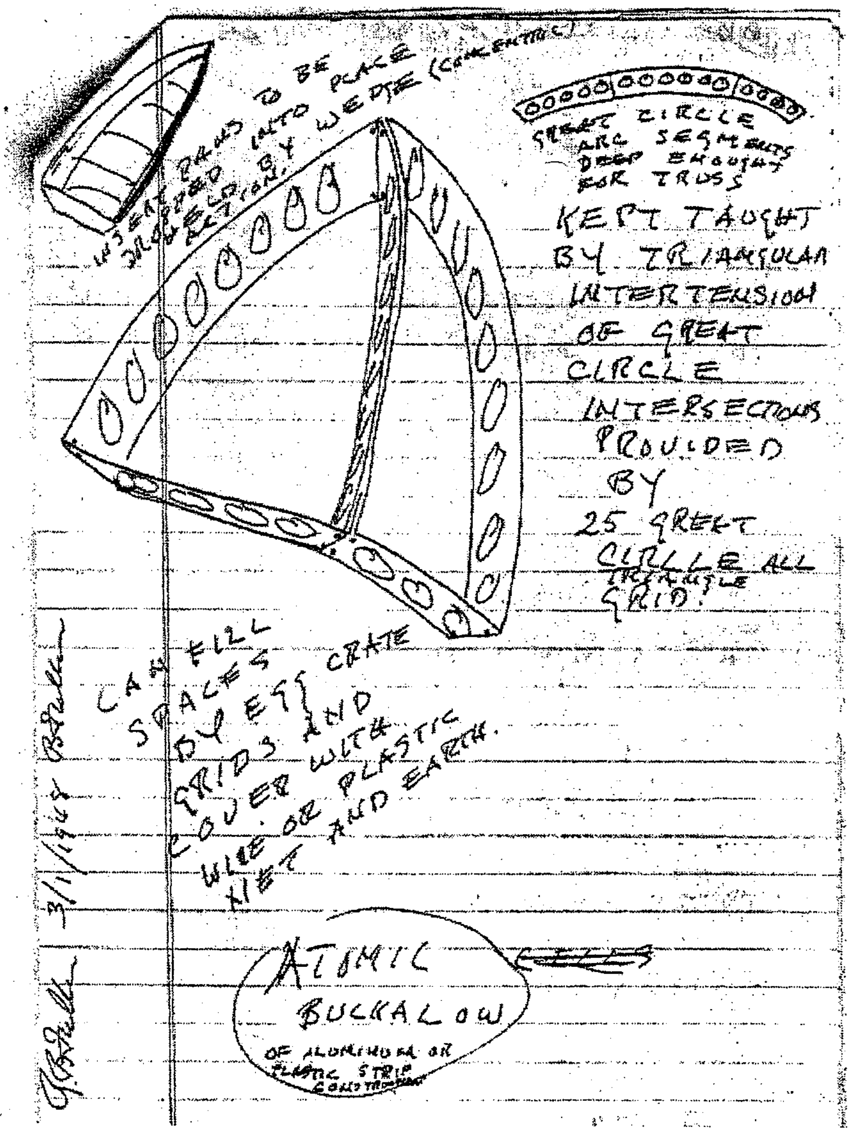
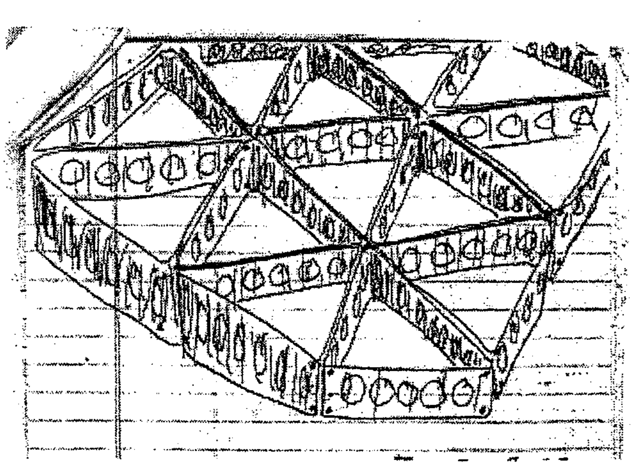


Fig.2.05a R.B. Fuller, Sketch of Great Triangular segments, "Atomic Buckalow," ca. March' 48.
Source: BFI-EJA Blue Trunk.





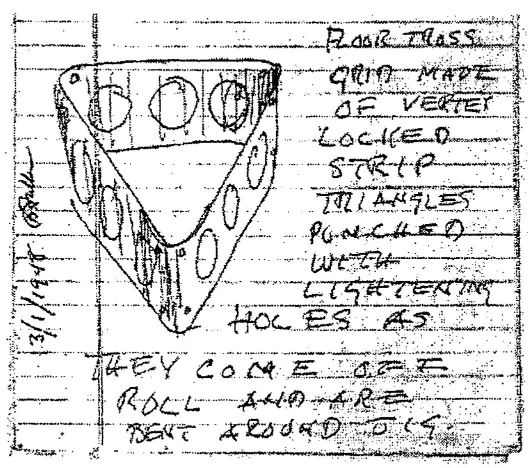
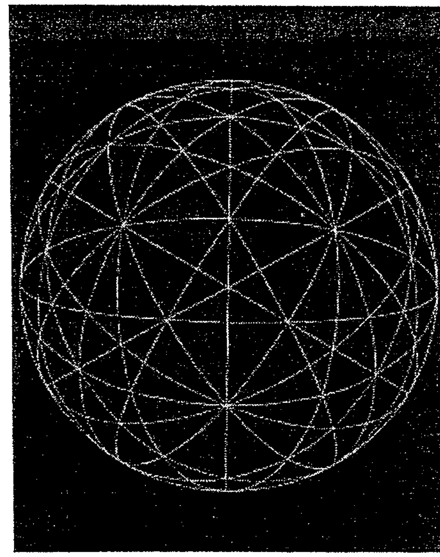


Fig.2.05b 31 Great-circle. Source: J. Ward. ed. The Artifacts of R. Buckminster Fuller, Vol. 3, p.5.
Fig.2.05c 31 Great-circle. Source: J. Ward. ed. The Artifacts of R. Buckminster Fuller, Vol. 3, p.6.2.



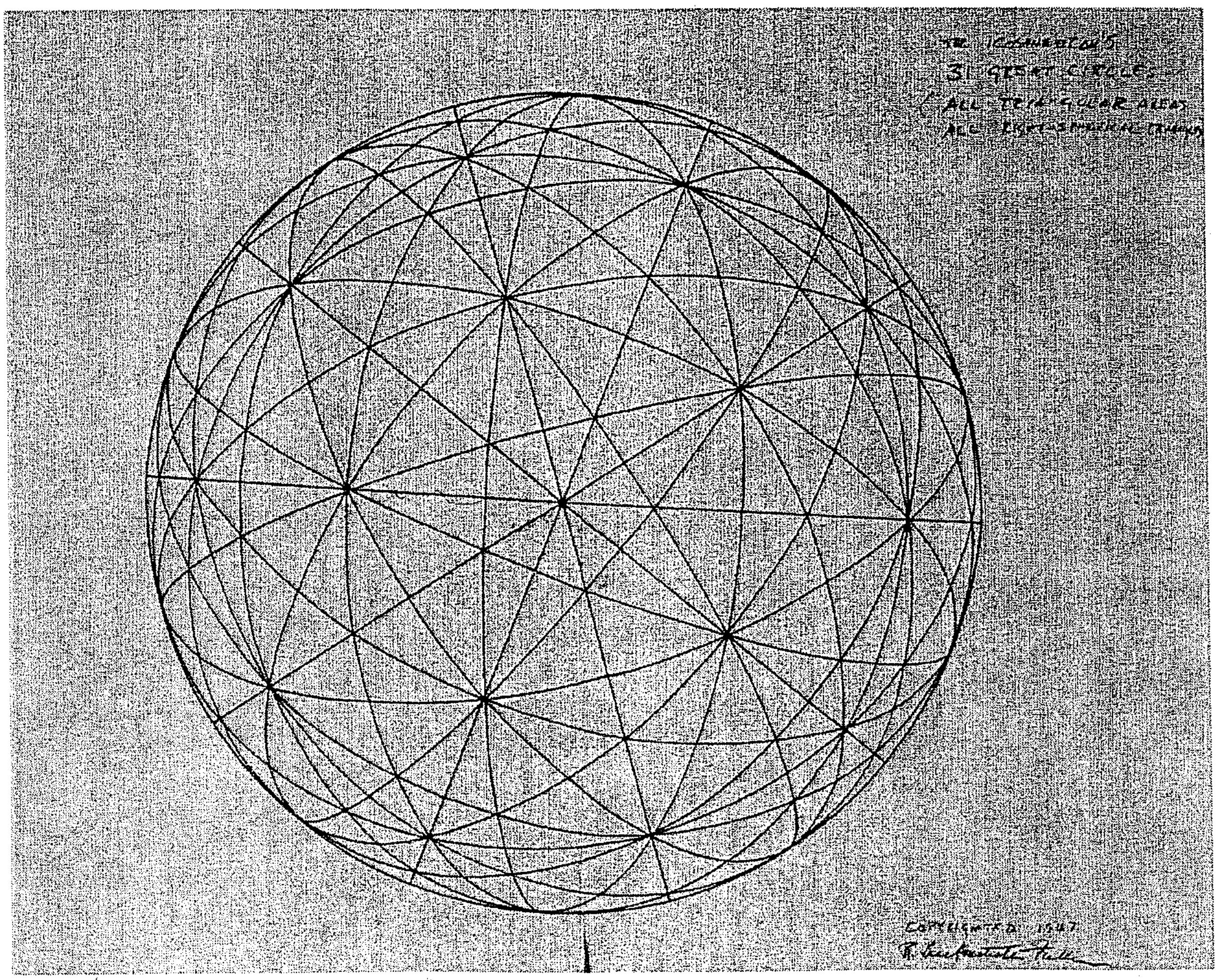


Fig.2.06 R.B. Fuller, Sketch of "Private Sky," 5/15/48. <u>Source:</u> BFI-EJA Blue Trunk.

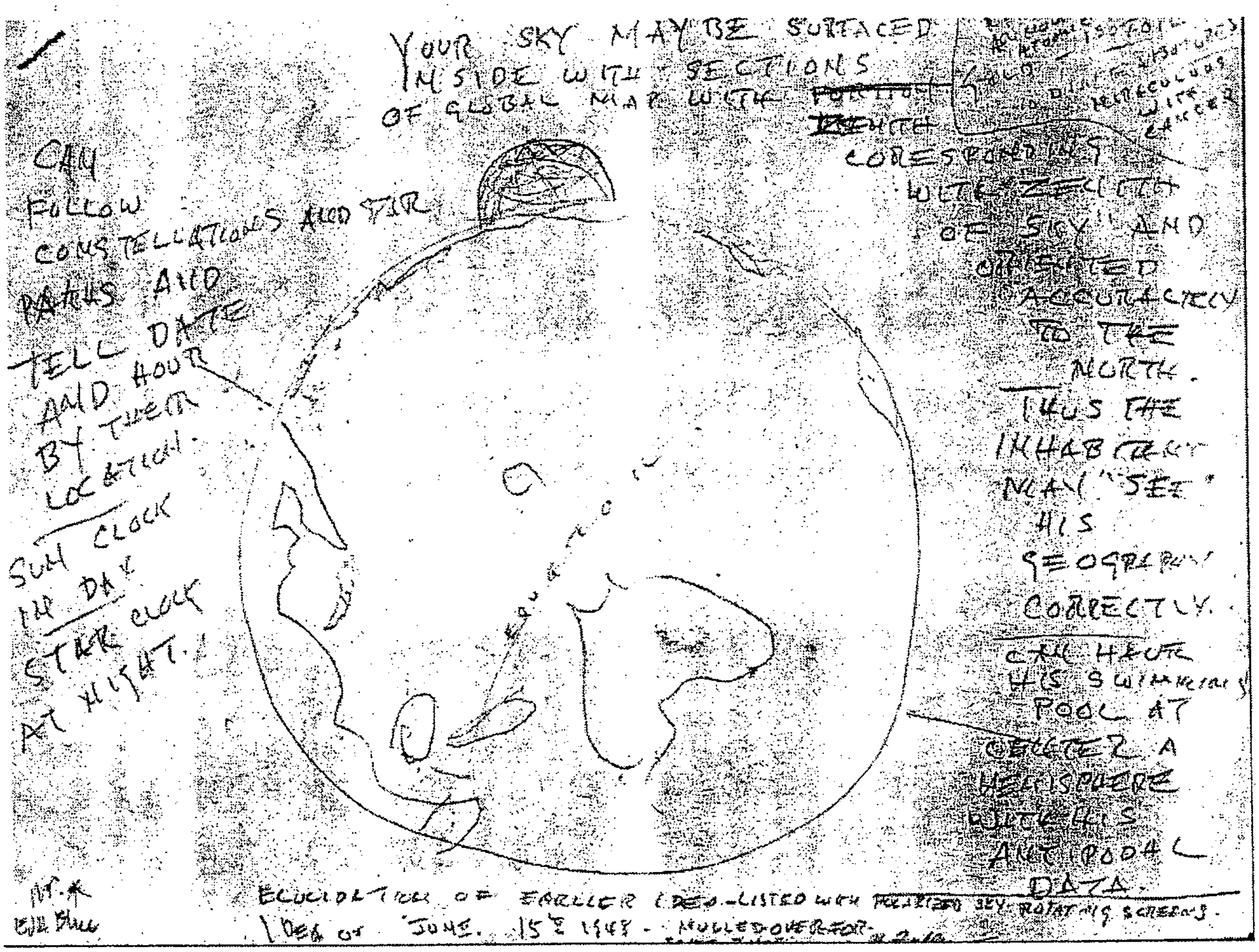


Fig.2.07 R.B. Fuller, Sketch of "Private Sky," 5/27/48. Source: BFI-EJA Blue Trunk.

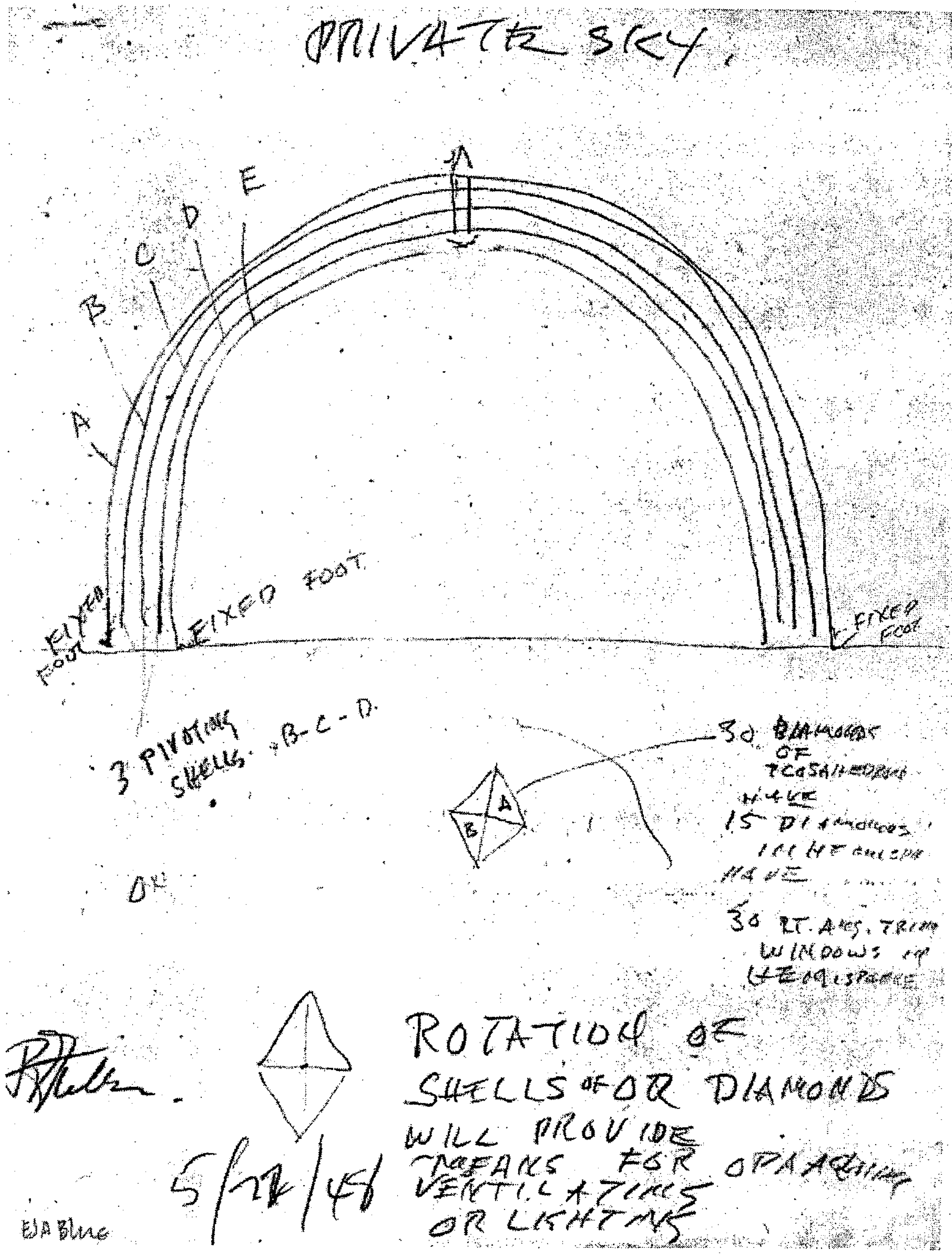


Fig.2.08 R.B. Fuller, Sketch of Tensegrity mast, 3/1/48. <u>Source:</u> BFI-EJA Green Trunk.

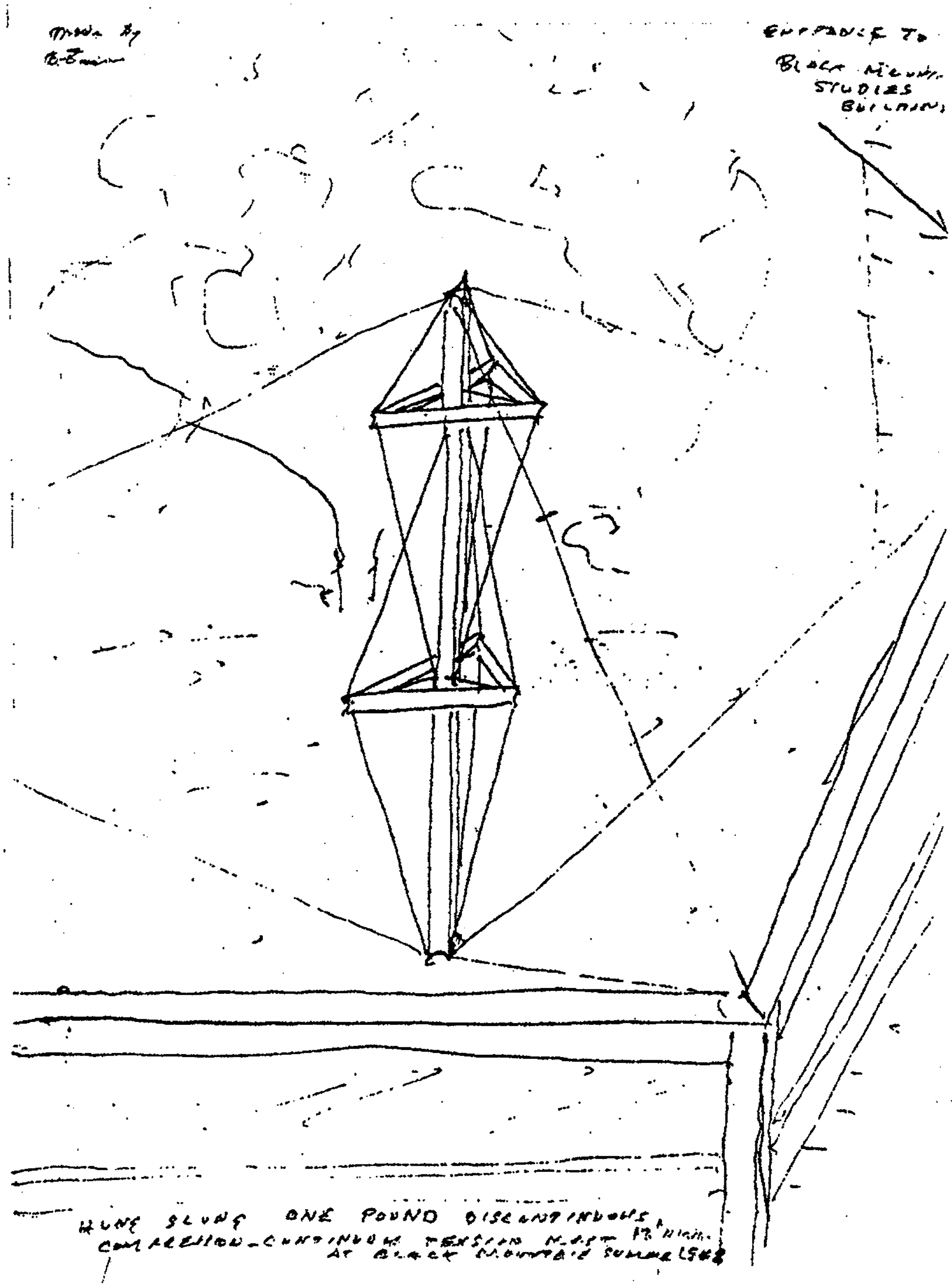


Fig.2.09a R.B. Fuller, Diagram of 25 Great Circles, ca. February 1948. Source: BFI-EJA Blue Trunk.

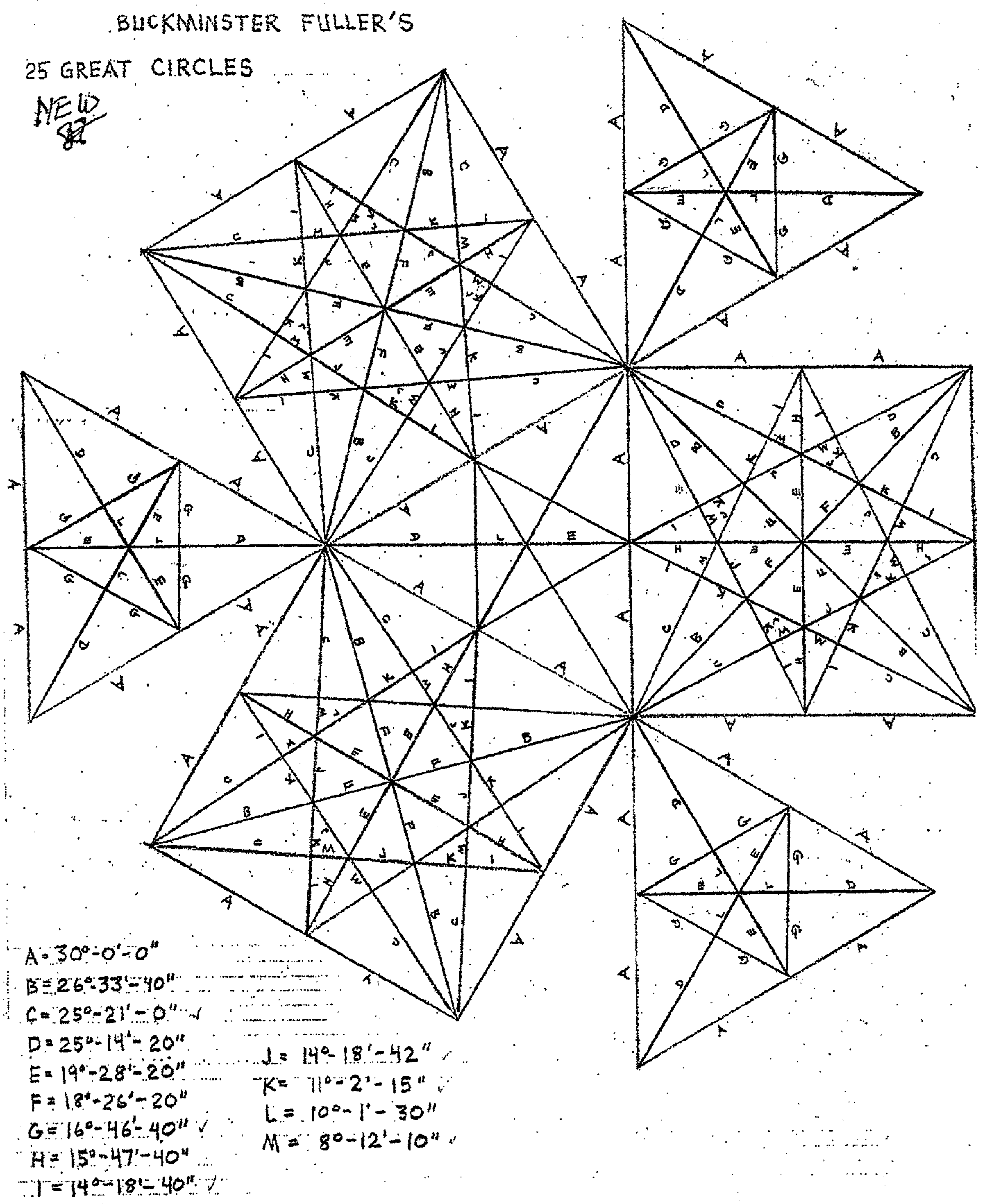


Fig.2.09b R.B. Fuller, Model of Dymaxion (VE) and Icosahedron, undated. Source: BFI-EJA Blue Trunk.

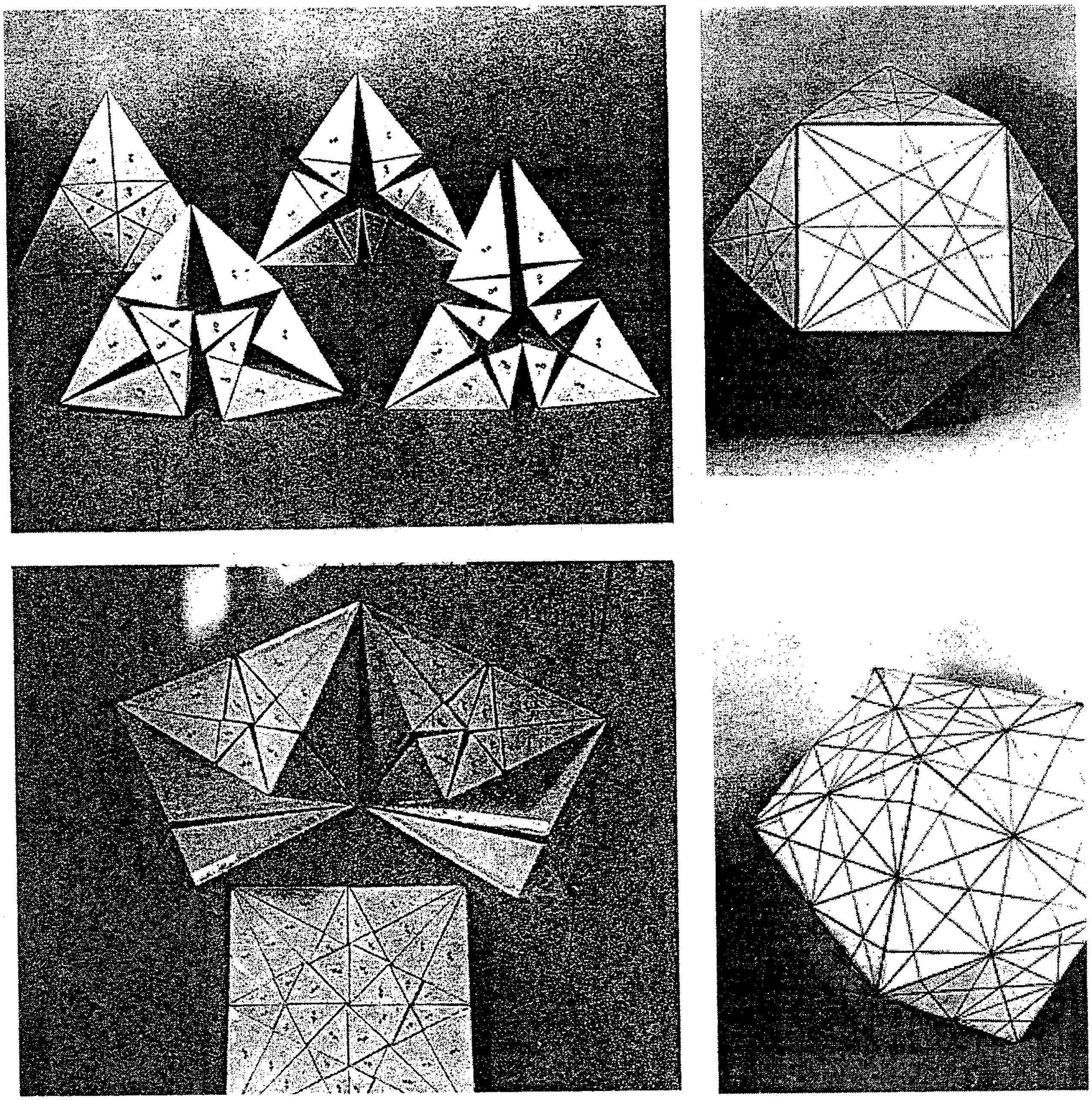


Fig.2.09c Fuller and his models, ca. 1950 (MIT?). <u>Source:</u> BFI Photo #F-3-96.

Fig.2.10a R.B. Fuller, Model to illustrate planar to spherical triangle relationships. Source: BFI-EJA Blue Trunk.

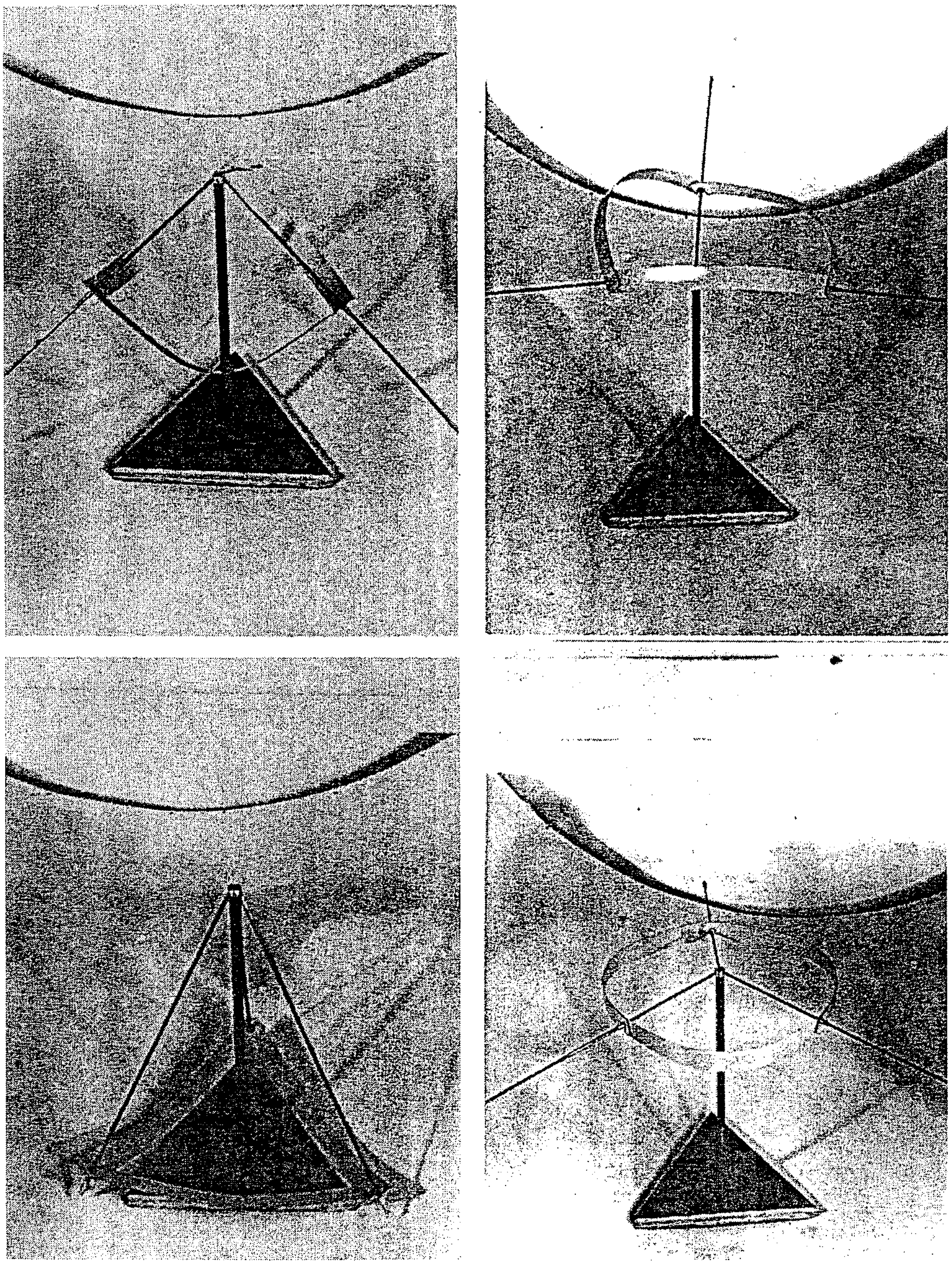
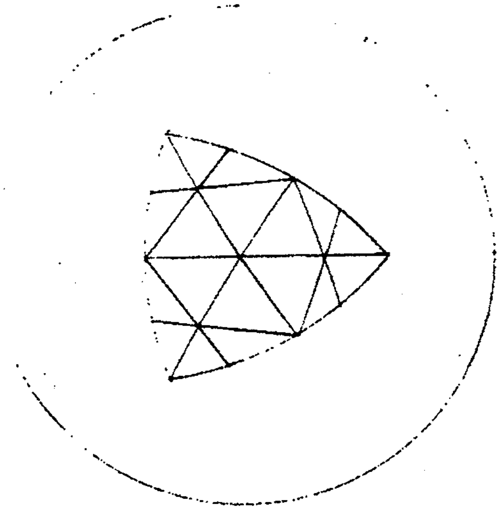


Fig.2.10b Great Circle Mapping. Source: J. Ward. ed. The Artifacts of R. Buckminster Fuller, Vol.3, p.13. [Also in R. B. Fuller, "Project - Noah's Ark 2", ca. August 1950, BFI-MSS.

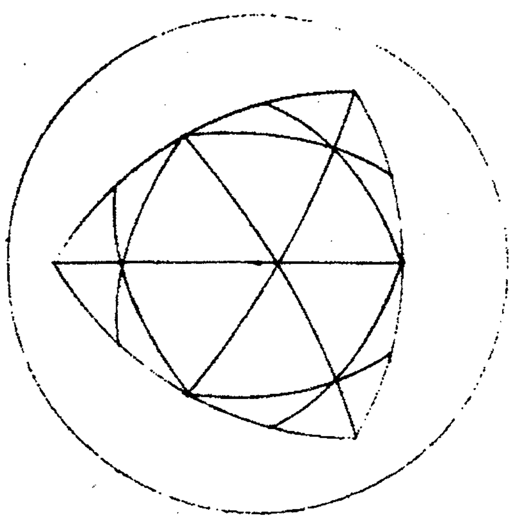
FIG. 8. a)



ONE SPHERICAL EQUIANGULAR Δ
OF THE ICOSAHEDRON'S 20.
VERTEX OF MAIN SURFACE ANGLE 72°

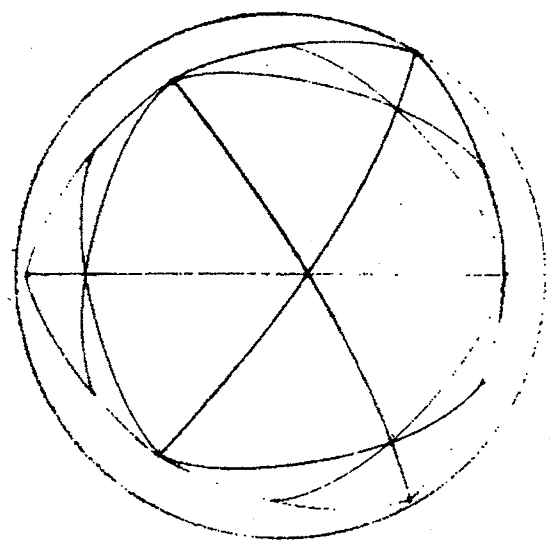
14 THE GEODESIC REVOLUTION, PART 1

FIG. 8 b)



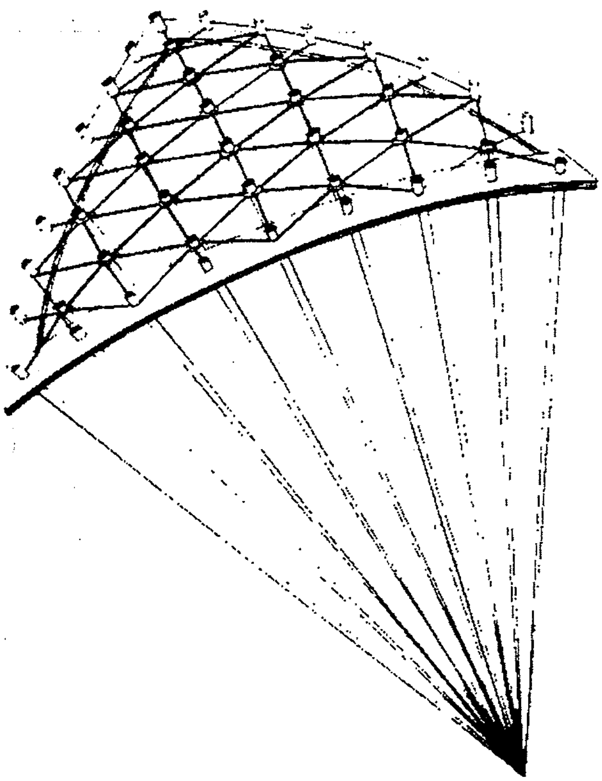
ONE SPHERICAL EQUIANGULAR Δ
OF THE OCTAHEDRON'S 8
VERTEX OF MAIN SURFACE ANGLE 90°

FIG. 8 c)

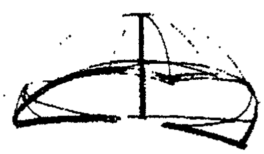


ONE SPERICAL EQUIANGULAR Δ
OF THE TETRAHEDRON'S 4
VERTEX OF MAIN SURFACE ANGLE 120°.

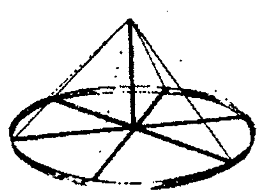
Fig.2.10c Great Circle Mapping. Source: J. Ward. ed. The Artifacts of R. Buckminster Fuller, Vol.3, p.14. [Also in R. B. Fuller, "Project - Noah's Ark 2," ca. August 1950, BFI-MSS].



b)



d) ONE SPHERICAL EQUIANGULAR Δ ALMOST 180°



e) ONE SPHER[illegible] EQUIA[illegible] OF THE HEMISPHERES TWO VERTEX OF MAIN SURFACE ANGLE EQUALS 180°

f.) PICTURE OF MILK DROP SPLASH (D'ARCY THOMPSON) IDENTICAL TO PHOTOGRAPH OF BUBBLE COLAPSE.

FIG. 9

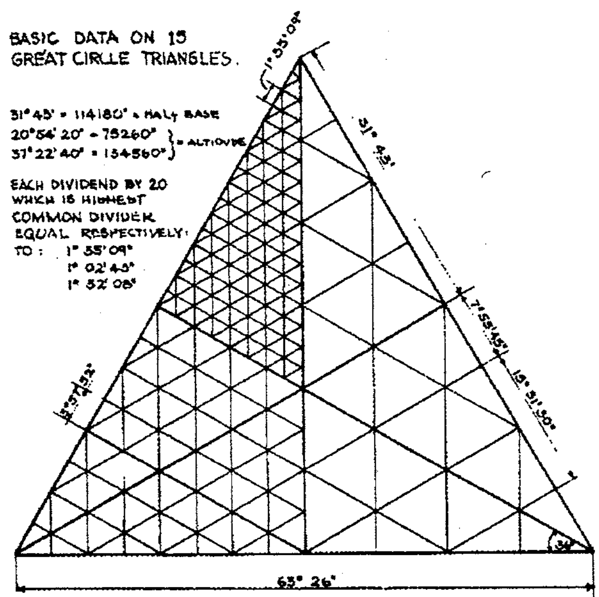


Fig.2.10d Egg-crate assembly. Source: J. Ward. ed. The Artifacts of R. Buckminster Fuller, Vol.3, p.49.2.

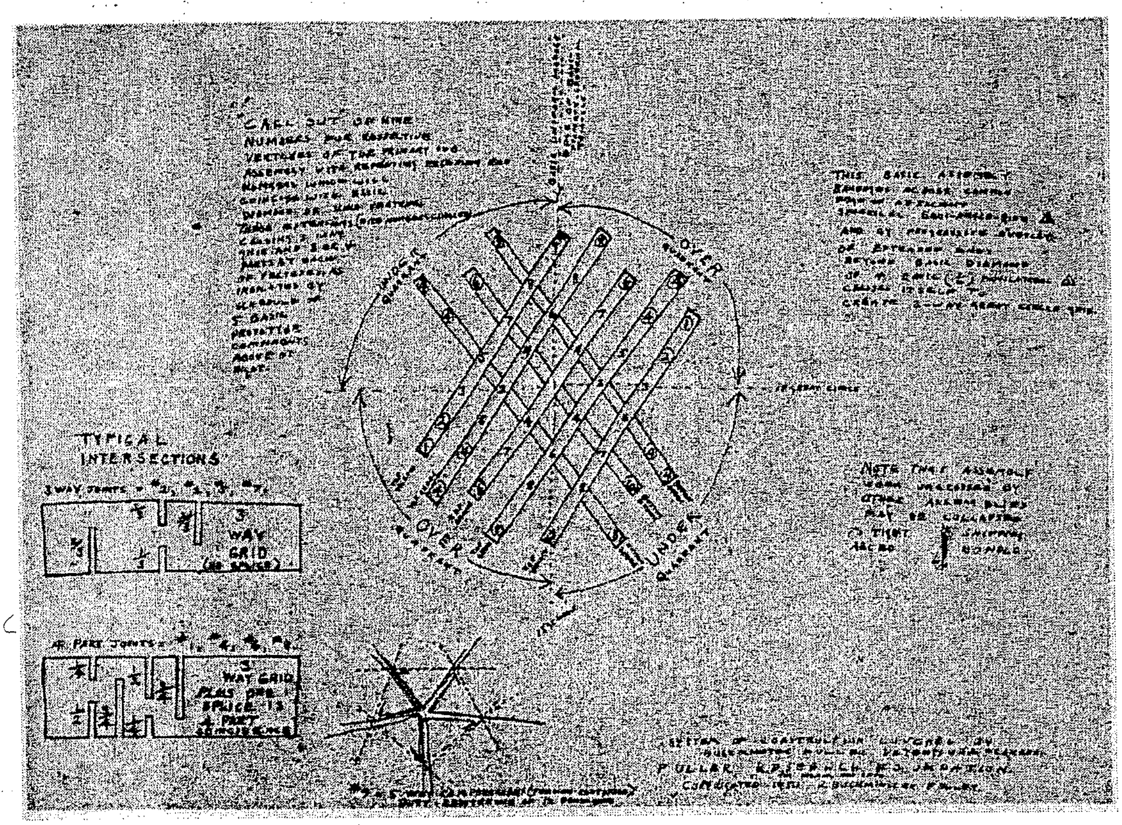


Fig.2.10e Egg-crate assembly. Source: J. Ward. ed. The Artifacts of R. Buckminster Fuller, Vol.3, p.50.1.

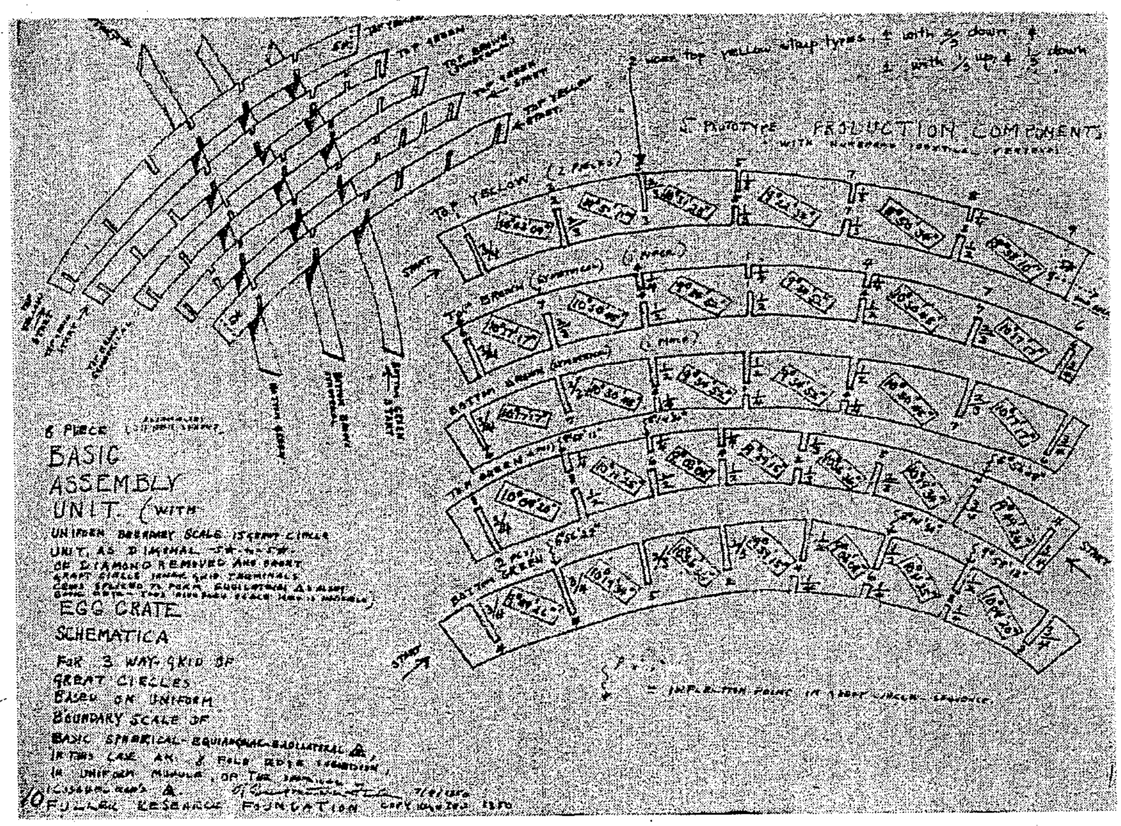
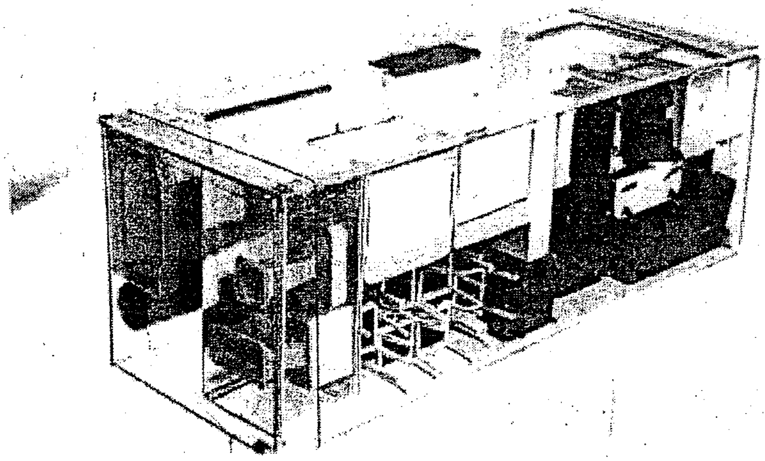


Fig.2.11a Fuller with GC-geodesic & autonomous packages (TBI), BMC, ca. 1949. Source: BFI-[?].



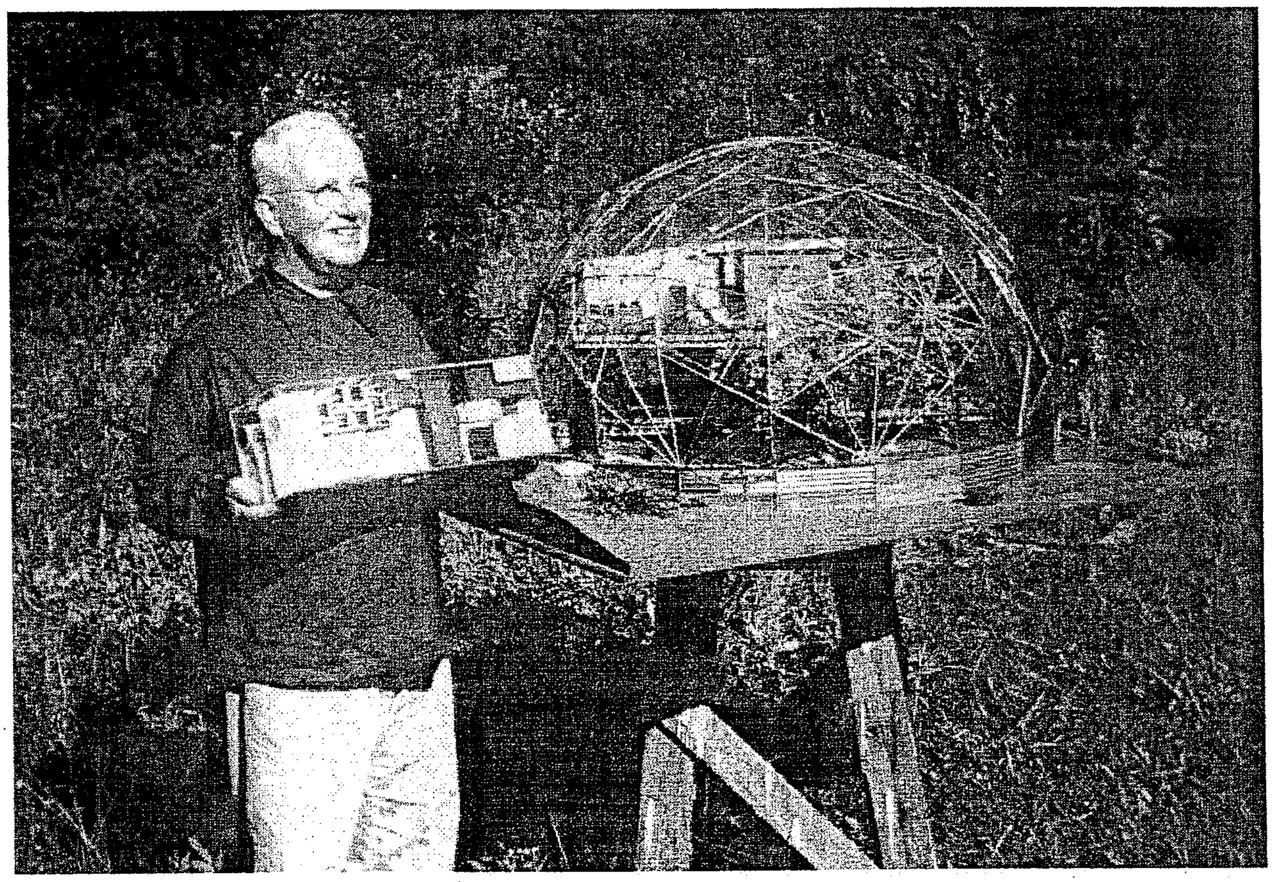


Fig.2.11b Invention of Gills for Private Sky Dome. Source: BFI-EJA Blue Trunk

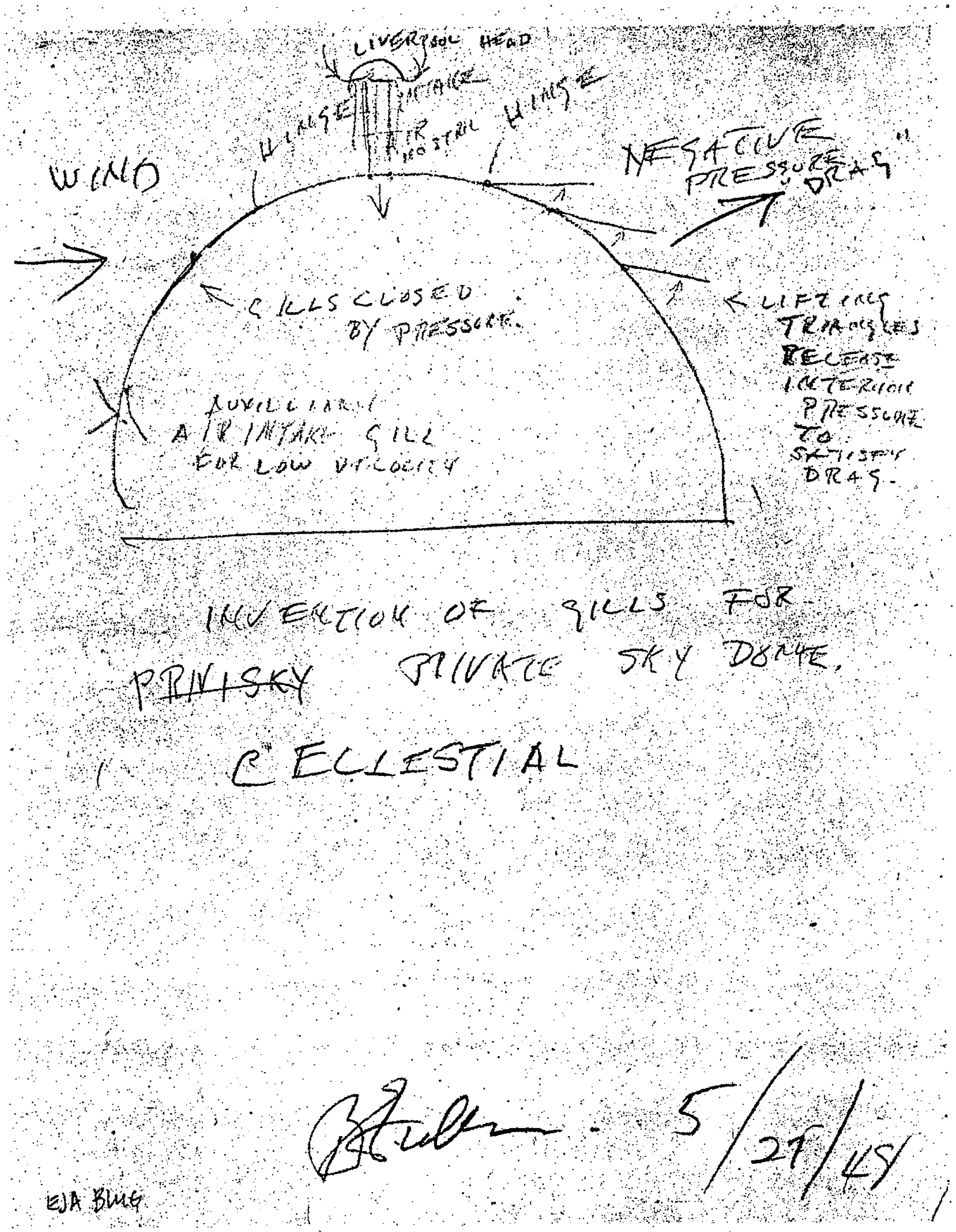


Fig.2.12a Expense Account of the College Dome, ca. December 1954. Source: BFI-CR172.

		TOTAL	UNIVERSITY	INDUSTRY	FULLER	
Cornell	May '52	$1,000	400.		600.	
NSCC	Jan '53	2,500	—	—	2,500.	
Minn	Feb '53	3,000	600.	400.	1,600.	
Oregon	April '53	5,000		4,700.	300.	
Princeton	Oct '53	3,587.04	2,000.	—	1,587.04	3,587.04
Minn	Nov '53	6,815.44	1,600.	3,400	1,815.44	1,815.44
NSCC	Jan '54	8,970.35	500.	6,000	2,470.35	2,470.35
Tulane	Feb '54	2,341.69	—	—	2,341.69	2,341.69
MIT	March '54	2,966.59	—	—	2,966.59	2,966.59 ~~707.35~~
VPI	April '54	707.35	—	—	707.35	707.35 ~~974.16~~
Mich	April '54	974.16	—	—	974.16	974.16
Cornell	May '54	2,483.77	—	500.	1,983.77	1,983.77
Wash	Dec. '54	~~10,833.29~~ 11,333.29	250.	7,000.	2,383.29	2,383.29

6,000.
500.
2,470.35
8,970.35

3400
1,600
1,815.44
6,815.44

2,800.

200
100
50
350.00

10,833.29
500.00
11,333.29

5000.
2000.
250
2,383.29
10,633.29

200
2,383.29
250.00

500.
2483.77

1000

250

Fig.2.12b Sample of the FRF "Dymaxion License," ca. 1950. Source: BFI-CR127.

THE FULLER RESEARCH FOUNDATION

D Y M A X I O N L I C E N S E

- -

has been a member of the DYMAXION SEMINAR. The following subjects were tentatively explored:

Fluid Geography, Energetic Geometry, Industrial Logistics, Trend Navigation, Geodesic Structuring, Autonomous Dwelling Facility, Design Equity, Comprehensive History of Man's Evolutionary Extension of Faculty by Intellectual Realization in Physical Design, A Priori Responsibility of Design, Specialization in Complex of Specialisation, Designer Strategy and Initiative.

because he voluntarily assumed responsibility
in the realization of DYMAXION PHILOSOPHY of anticipatory mechanics
and the obsolescence of ignorance, inadequacy and reformative preoccupation
through creative application of principles
in augmentation of physical advantage of the individual
realizable only through the complex advantage of all, and

because he has applied for permission to operate as a developer of DYMAXION PRINCIPLES and has accompanied his application with a forfeit of one dollar,

I hereby license him to employ the designation

STUDENT DYMAXION DESIGNER

This license is non-exclusive, non-transferable and revocable at the discretion of The Fuller Research Foundation.

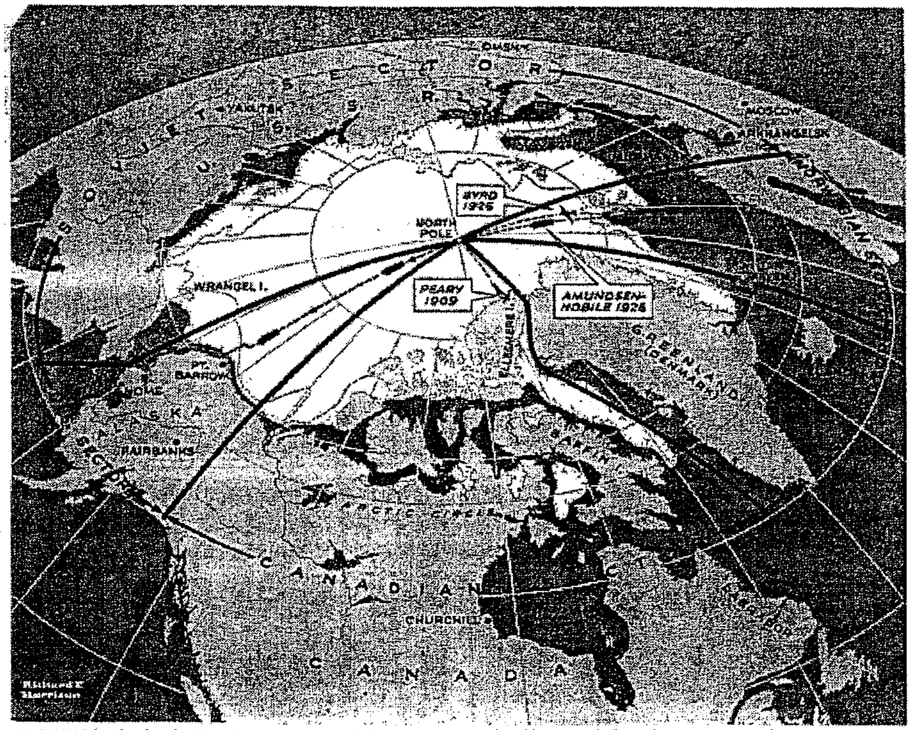
Qualification for unlimited designation may be earned through demonstrations of competence in application of DYMAXION PRINCIPLES resulting in measurable increase of the advantage of society over physical environment.

Director
THE FULLER RESEARCH FOUNDATION

- - - - - - - - - - - - -
Date

- - - - - - - - - - - - -
Place

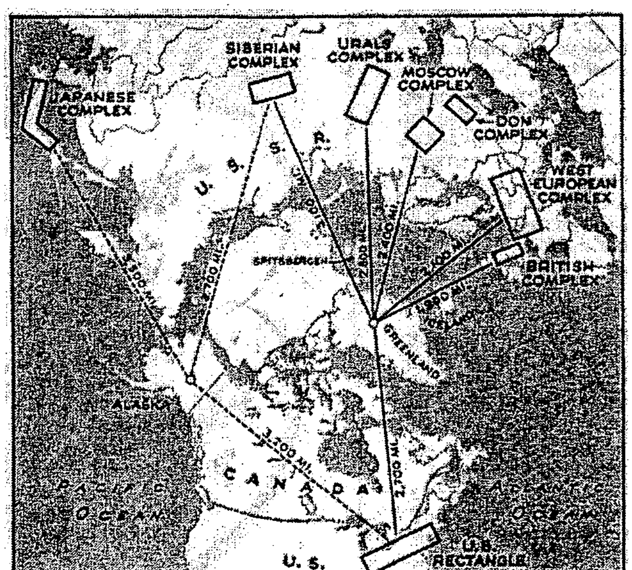
Fig.2.13 "The Polar Concept. It is revolutionizing American Strategy." Source: *LIFE*, January 20, 1947, p.61.



ARCTIC MAP shows how the region is divided between the five nations with Arctic possessions. Average summer limits of the polar ice pack are in white although pack varies in shape from year to year. Ice around edges is loose enough in summer to permit ships to enter as far as the irregular dotted line. Beyond this ice is solid.

THE ARCTIC

IT HAS BECOME THE KEY TO WORLD STRATEGY



FUTURE AIR ATTACK will probably come across North Pole because that is by far the shortest distance between the great industrial centers of the world, all of which are in the northern latitudes. Until super long-range bombers are perfected, Greenland and Alaska, also Iceland and Spitsbergen, will be of vital importance as points from which attacks could be launched either by or against U.S.

Fig.2.14a Air Ocean Rough Layout, ca. 1934. Source: BFI-M-24-23.

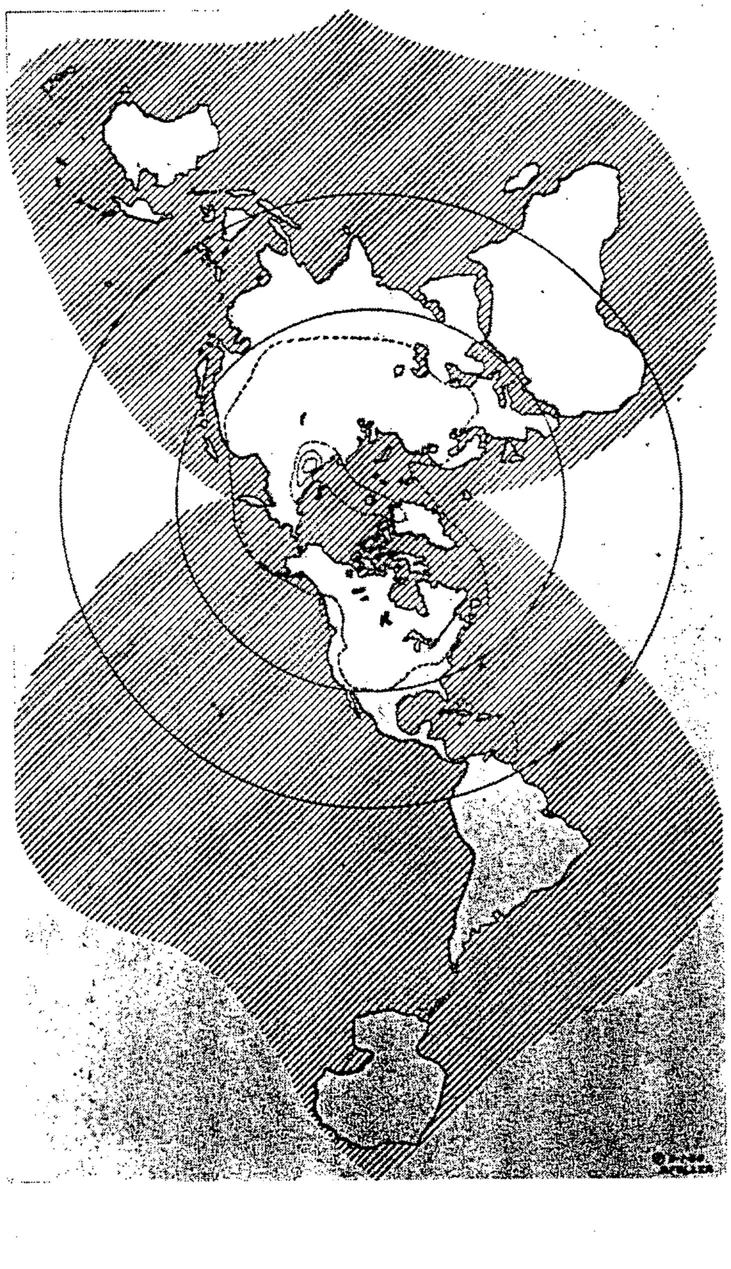
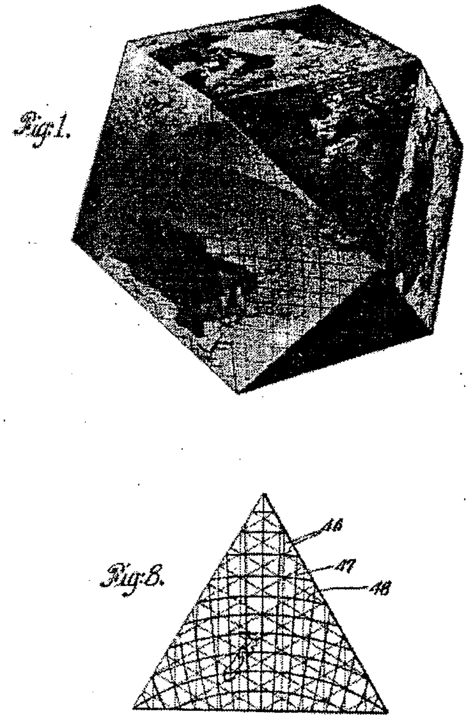


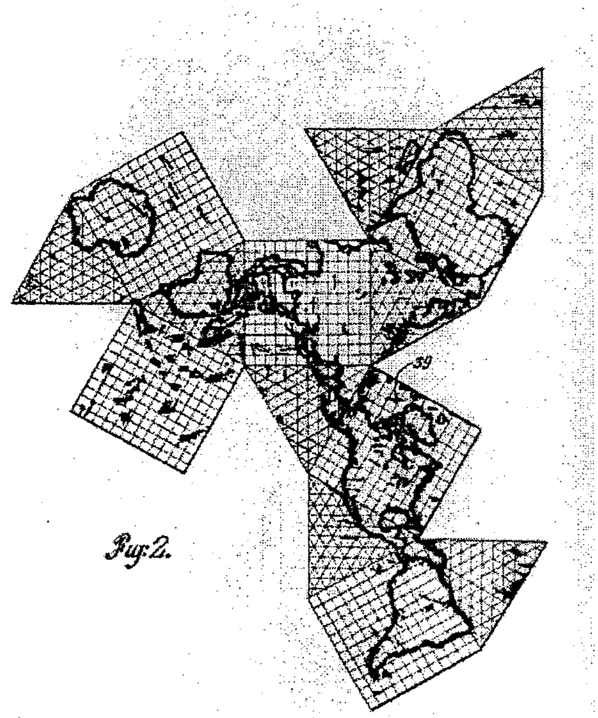
Fig.2.14b Dymaxion Map U.S. Patent #2,393, 676, January 29, 1946..

Jan. 29, 1946. R. B. FULLER 2,393,676
CARTOGRAPHY
Filed Feb. 25, 1944 5 Sheets-Sheet 1



INVENTOR
RICHARD BUCKMINSTER FULLER
BY
Donald W. Robertson

Jan. 29, 1946. R. B. FULLER 2,393,676
CARTOGRAPHY
Filed Feb. 25, 1944 5 Sheets-Sheet 2



INVENTOR
RICHARD BUCKMINSTER FULLER
BY
Donald W. Robertson
ATTORNEY

Jan. 29, 1946. R. B. FULLER 2,393,676
CARTOGRAPHY
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INVENTOR
RICHARD BUCKMINSTER FULLER
BY
Donald W. Robertson

Jan. 29, 1946. R. B. FULLER 2,393,676
CARTOGRAPHY
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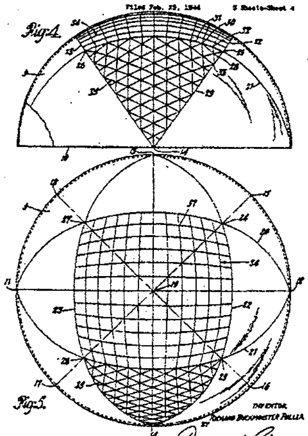
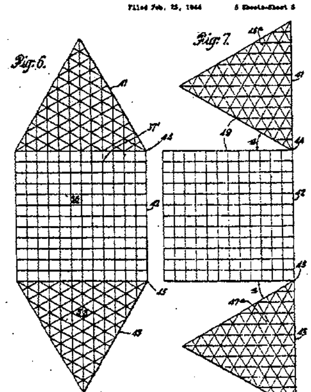


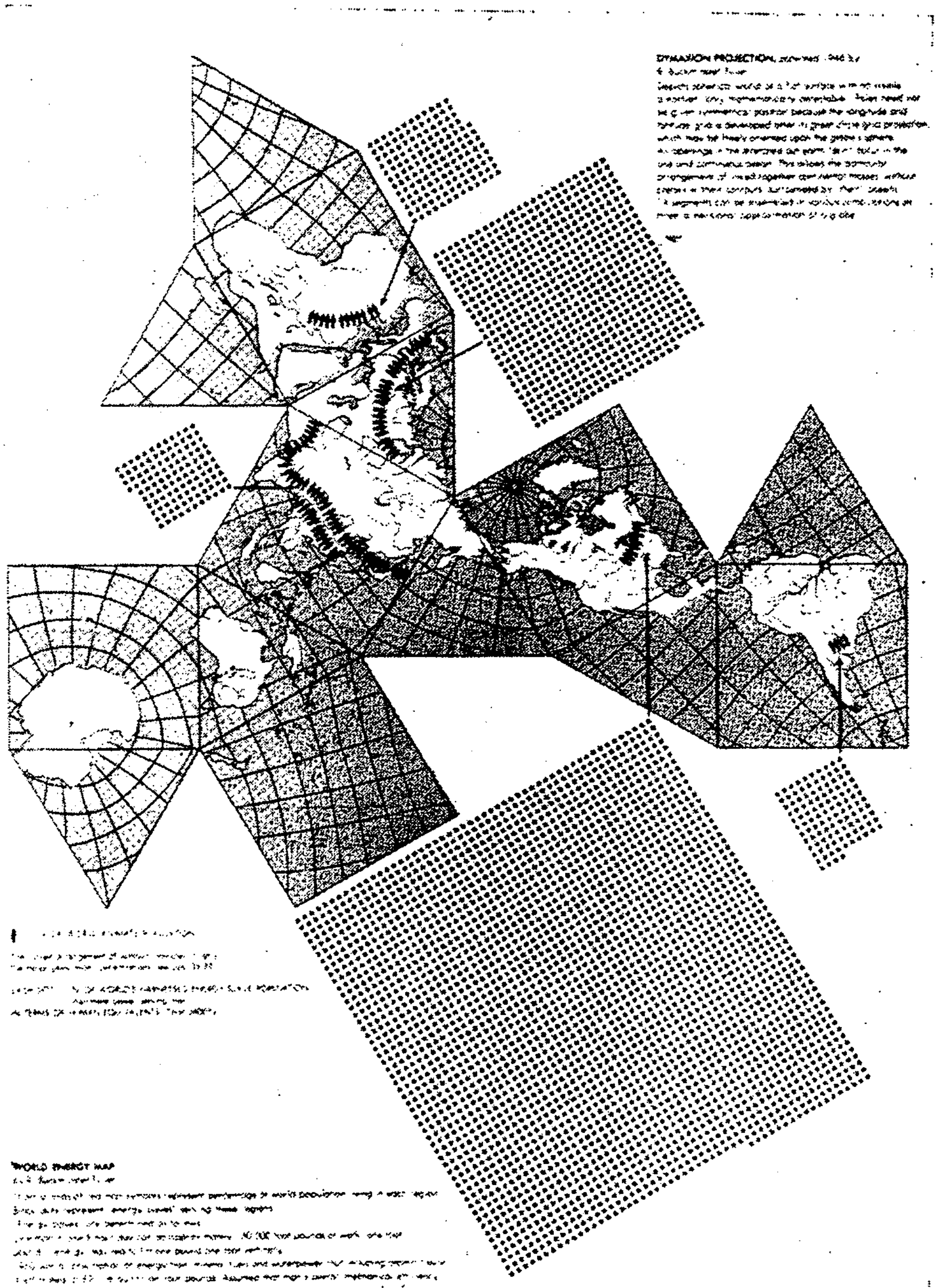
INVENTOR
RICHARD BUCKMINSTER FULLER
BY
Donald W. Robertson

Jan. 29, 1946. R. B. FULLER 2,393,676
CARTOGRAPHY
Filed Feb. 25, 1944 5 Sheets-Sheet 5



INVENTOR
RICHARD BUCKMINSTER FULLER
BY
Donald W. Robertson

Fig.2.14c Fuller's energy map reworked by Herbert Bayer, ca. 1950. <u>Source:</u> "RIBA Discourse 1958 (Experimental Probing of Architectural Initiative)," *Journal of the Royal Institute of British Architects*, October 1958.



1950 data. World Energy map designed by R. B. F., redrawn by Herbert Bayer, 1943. Each small figure represents 1 per cent of world's animate population. Each dot represents 1 per cent of world's inanimate power serving man

'Because I was interested in an air-ocean world town plan I went into many studies of mathematical projections and ways in which we could see the earth a little more ably. . . . I found a way, then, of projecting the earth in such a manner that you could see it all at once and without any visible distortion of the relative shape or sizes of the components . . . so that we had in effect one world island in one world ocean, which would then be the great unitary landing-field for the great air-ocean world'

Fig.2.14d World Map on Dymaxion Projection ca. 1946, [1944]. <u>Source:</u> "Fluid Geography," *American Neptune*, April 1944.

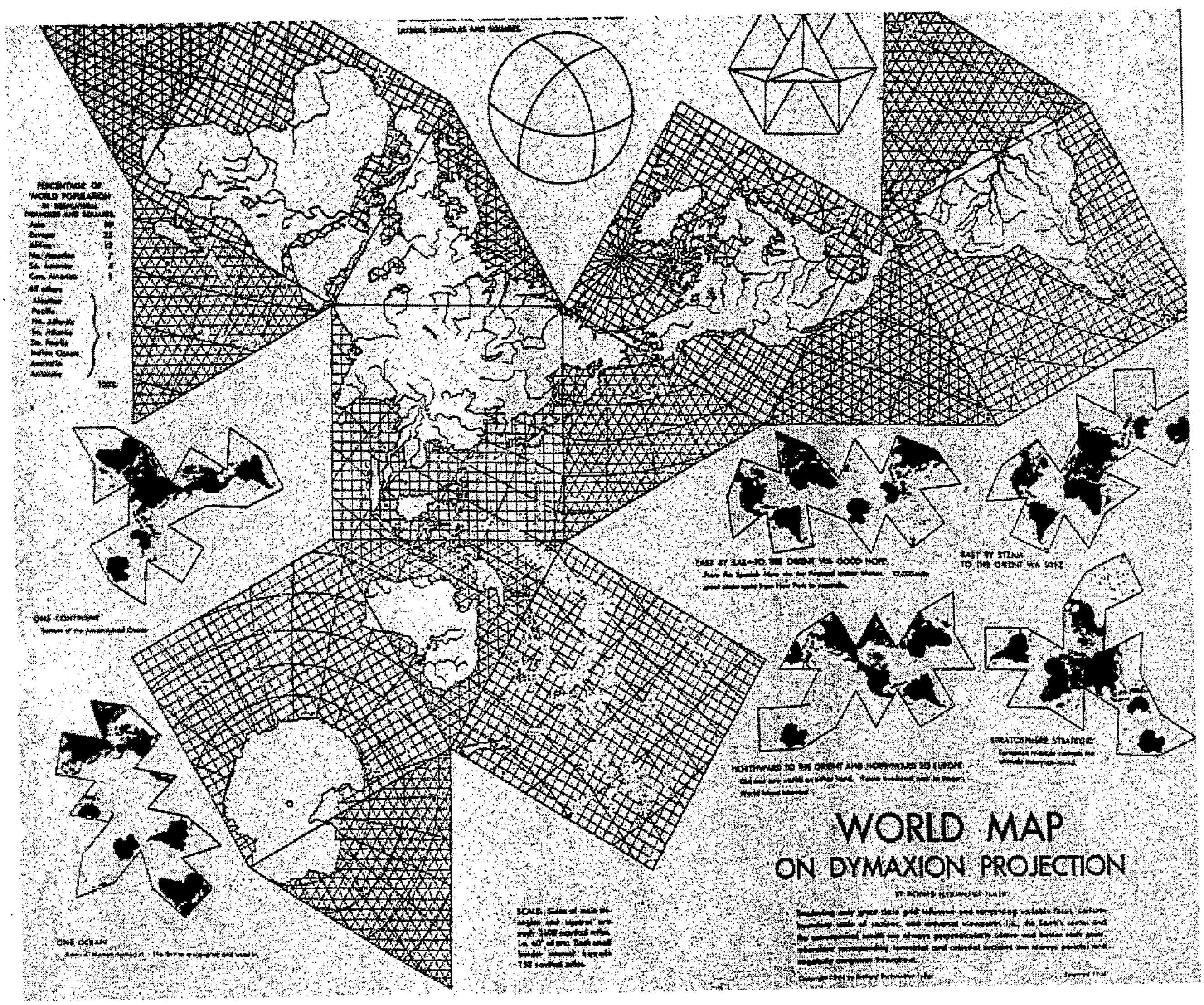


Fig.2.14e .1: "Air-wise map of the Earth." Source: "Dymaxionizing the Universe," *Architectural Record*, Oct. 1938, p.73; .2: Thumbnail sketch of a book-cover for "8-Chains." Source: BFI-CL-20, Vol. C-305; .3: W. Baird's model for "9 Chains." Source: BFI-M-24-23.

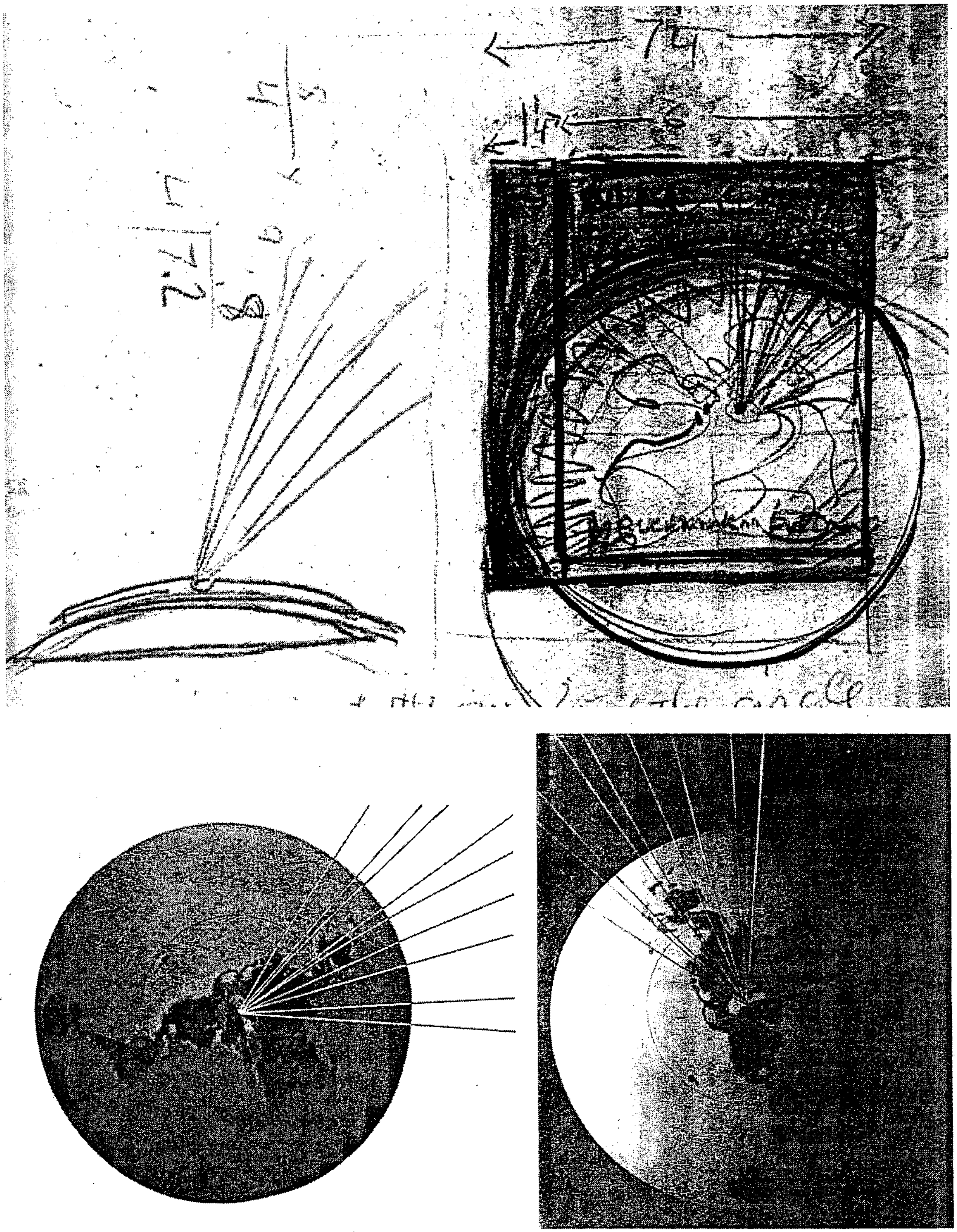


Fig.2.14f Irving Fisher's icosahedron map, "The New Near Globe." Source: "A New World Map-Globe," *CLICK Magazine*, May 1944, pp.27-31.

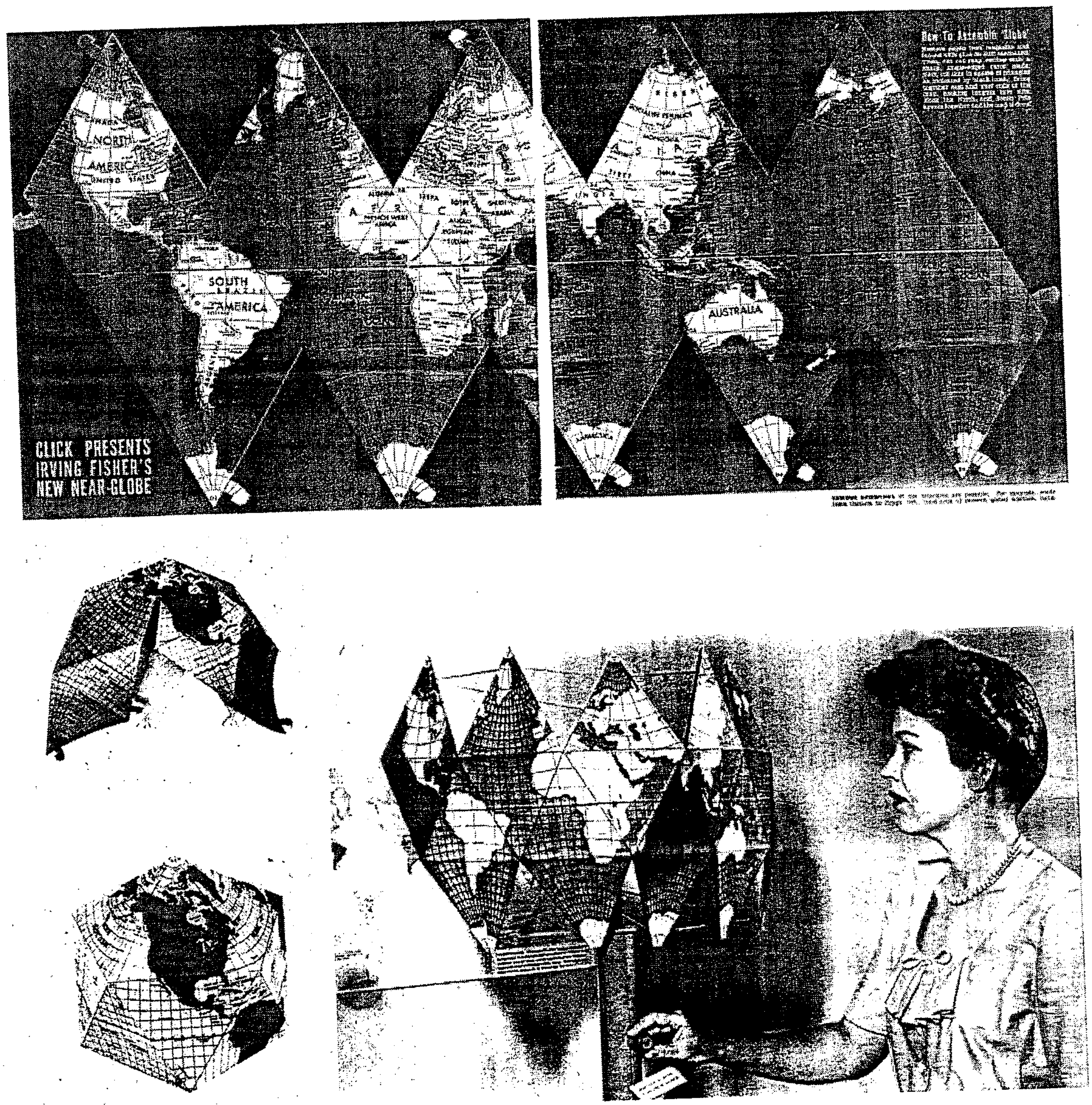


Fig.2.15 Trans-Polar Glider Project. <u>Source:</u> *LIFE*, November 30, 1942, p.61.

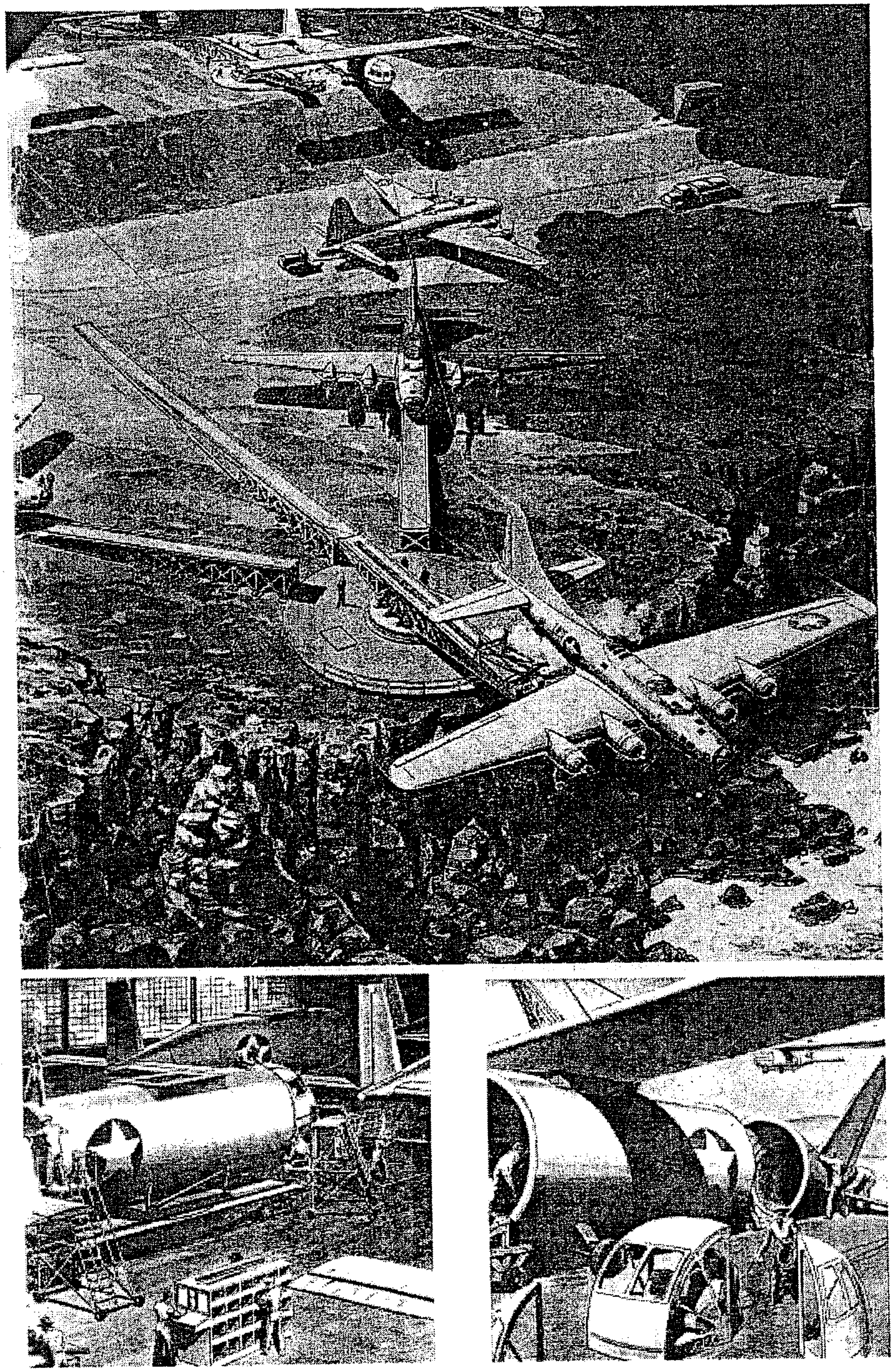
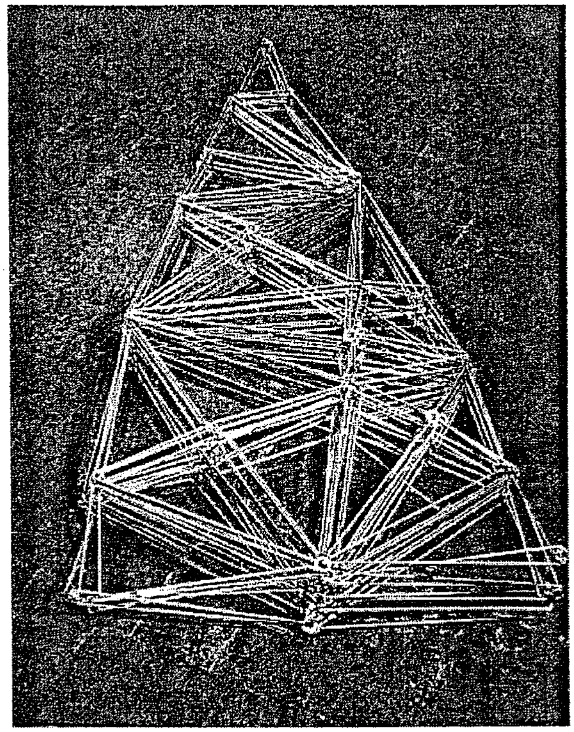


Fig.2.16a Photographs, "Necklace" 31-GC, 14-foot diameter, "Pentagon Dome," ca. February 1949 - in open and folded form. Source: BFI-Photo #P-1-4 & P-1-1.



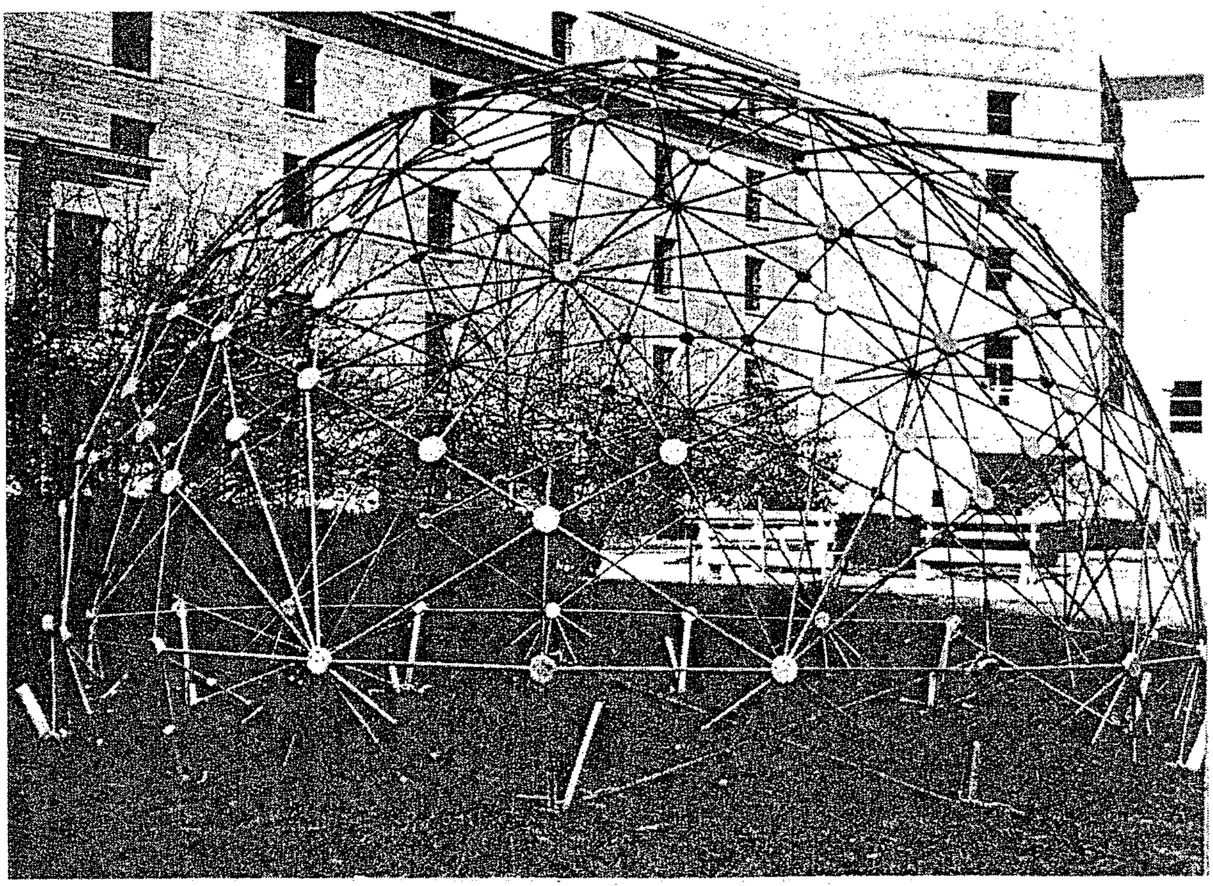
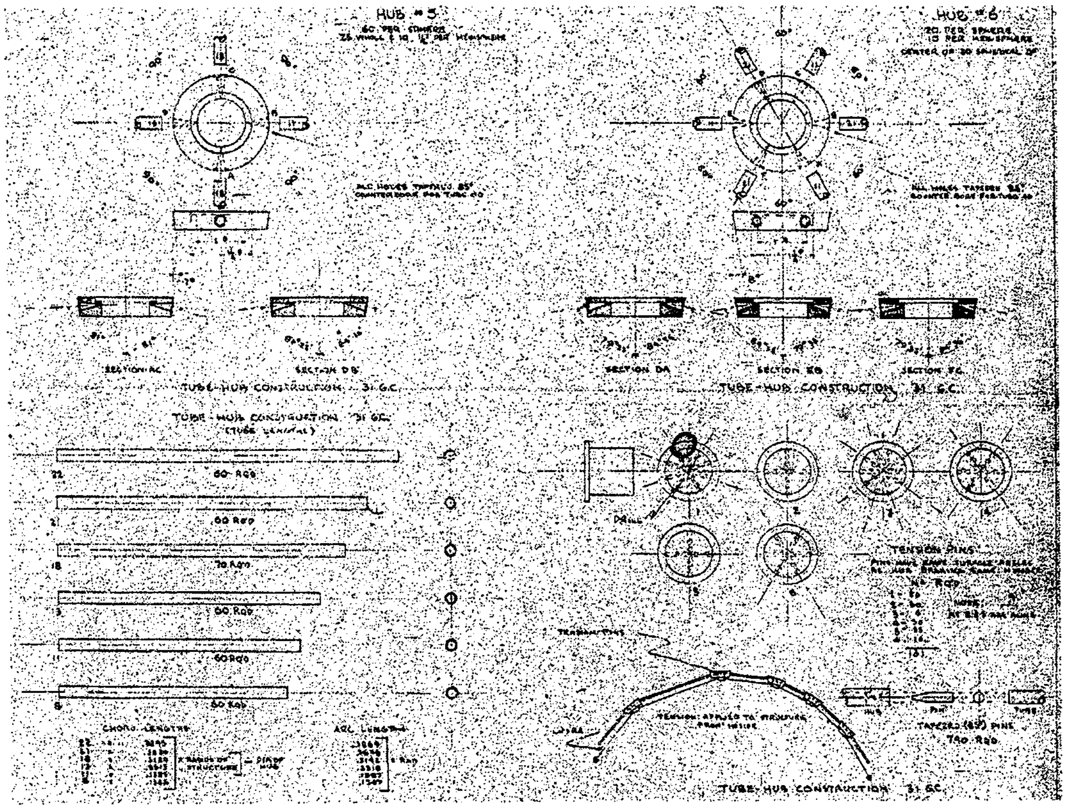


Fig.2.16b Preliminary working details, 31-GC "Pentagon Dome." Source: J. Ward. ed. The Artifacts of R. Buckminster Fuller, Vol. 3, p.28.2. [Filed as BFI-15-50]

Fig.2.16c Preliminary working details, 31-GC "Pentagon Dome. " Source: J. Ward. ed. The Artifacts of R. Buckminster Fuller, Vol.3, p.29.1. [Filed as BFI-15-51].



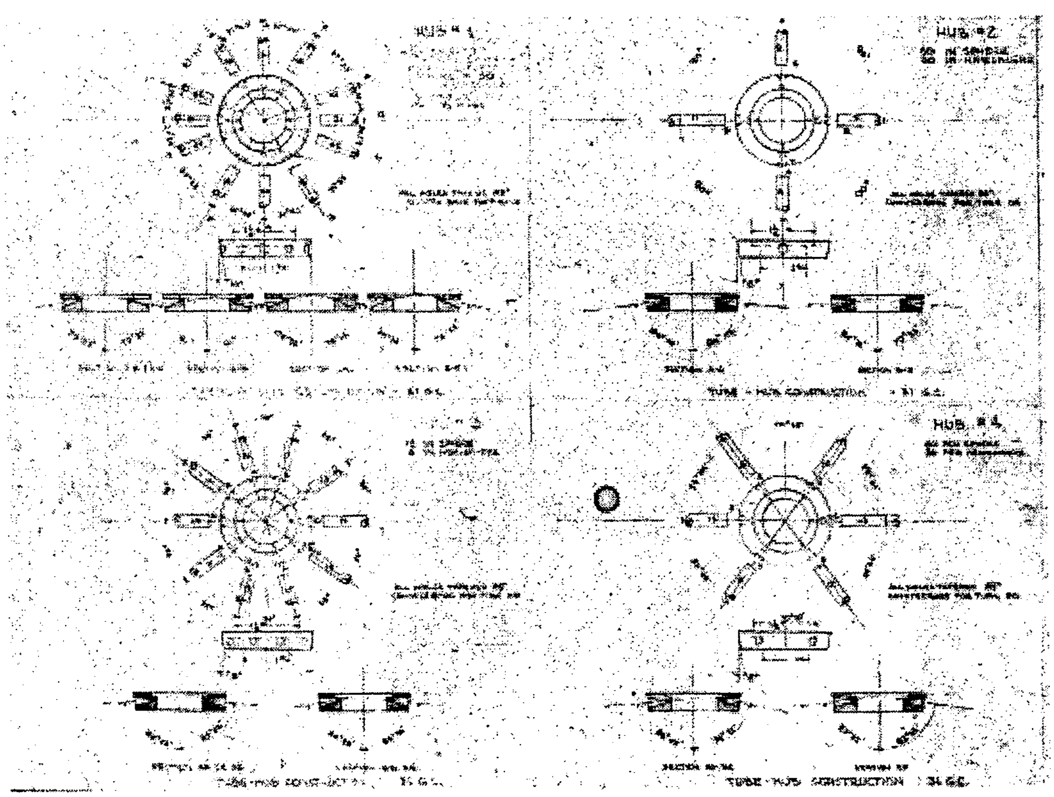


Fig.2.17a Casting the triangular fiberglass components, Summer 1949. Source: Mary Emma Harris, The Arts at BMC.

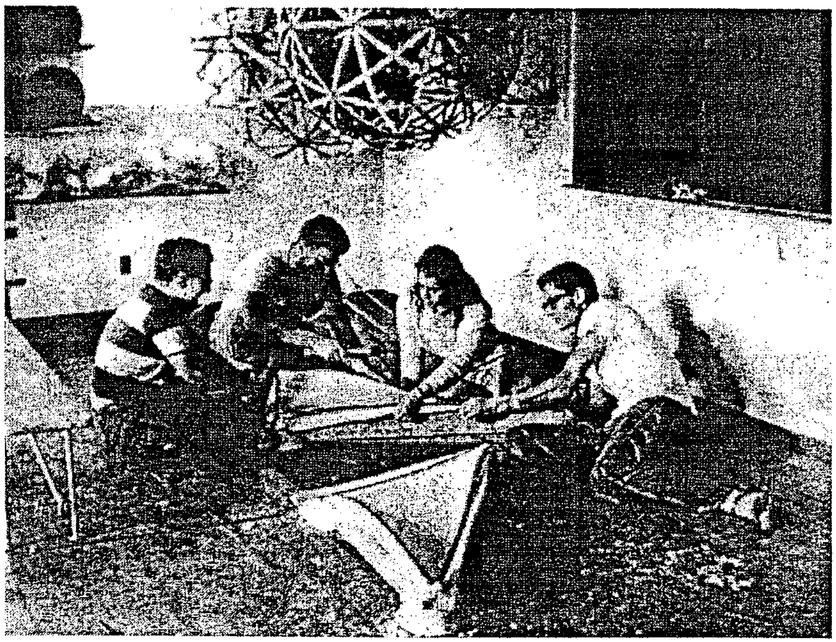
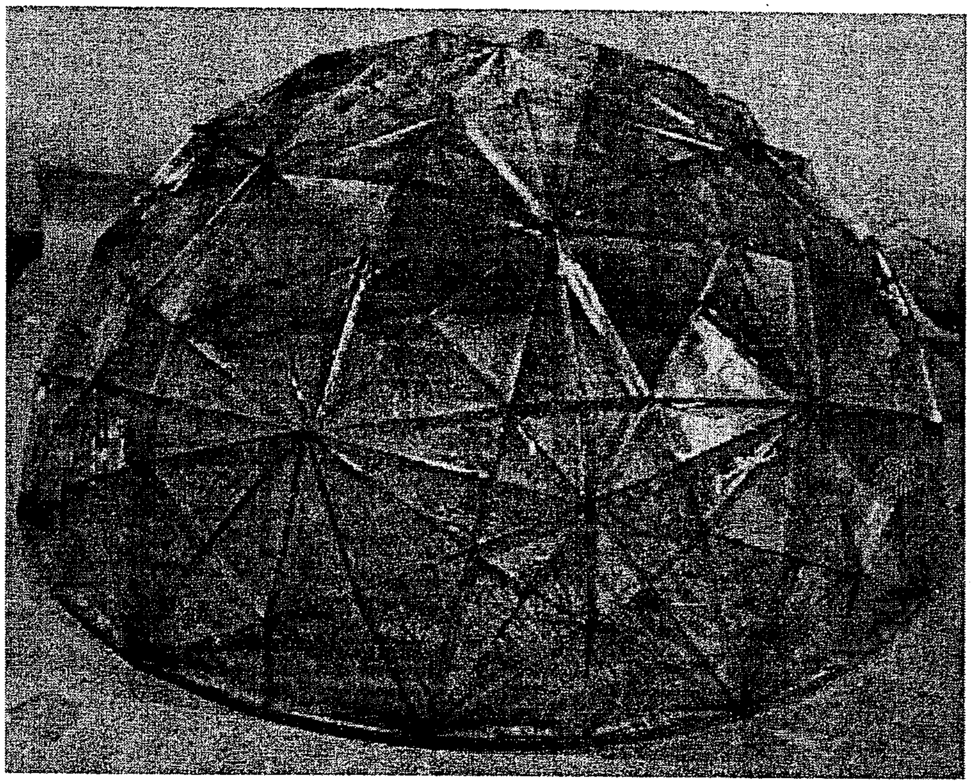


Fig.2.17b Photograph of fiberglass pan-type 3-GC geodesic dome, ca. 1959. Source: J. Ward. ed. The Artifacts of R. Buckminster Fuller, Vol.3, p.24.1.

Fig.2.17c Drawing for fiberglass pan-type 3-GC geodesic dome, ca, 1959. Source: J. Ward ed., The Artifacts of R. Buckminster Fuller, Vol.3, p.25.3.



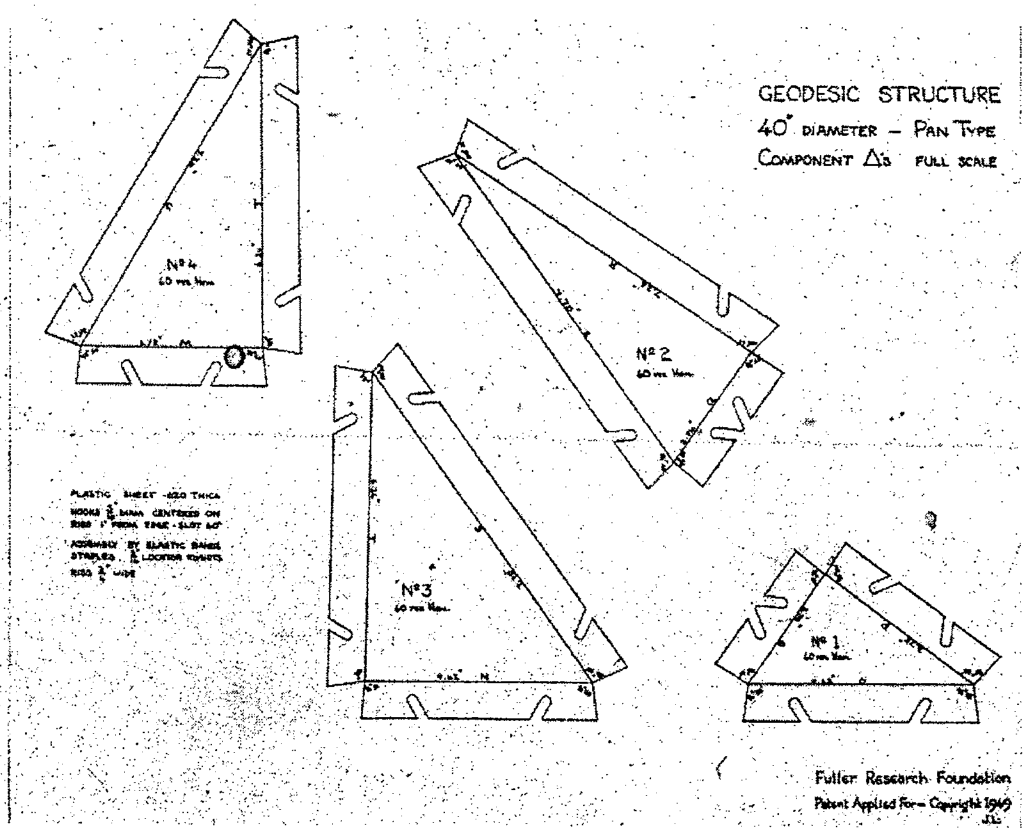
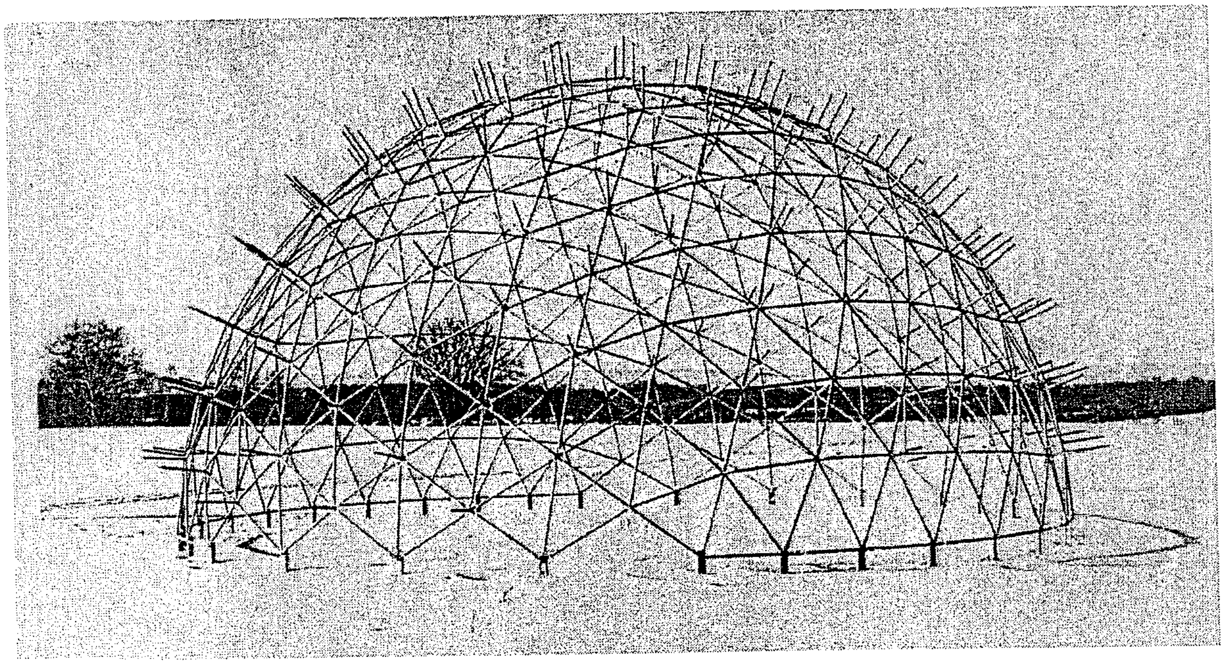


Fig.2.18a 49' experimental Dome of sprited tubular, by J. Lindsay (FRF-Montreal), ca. December 1950. <u>Source:</u> BFI-Photo #C3-12, C-3-5.



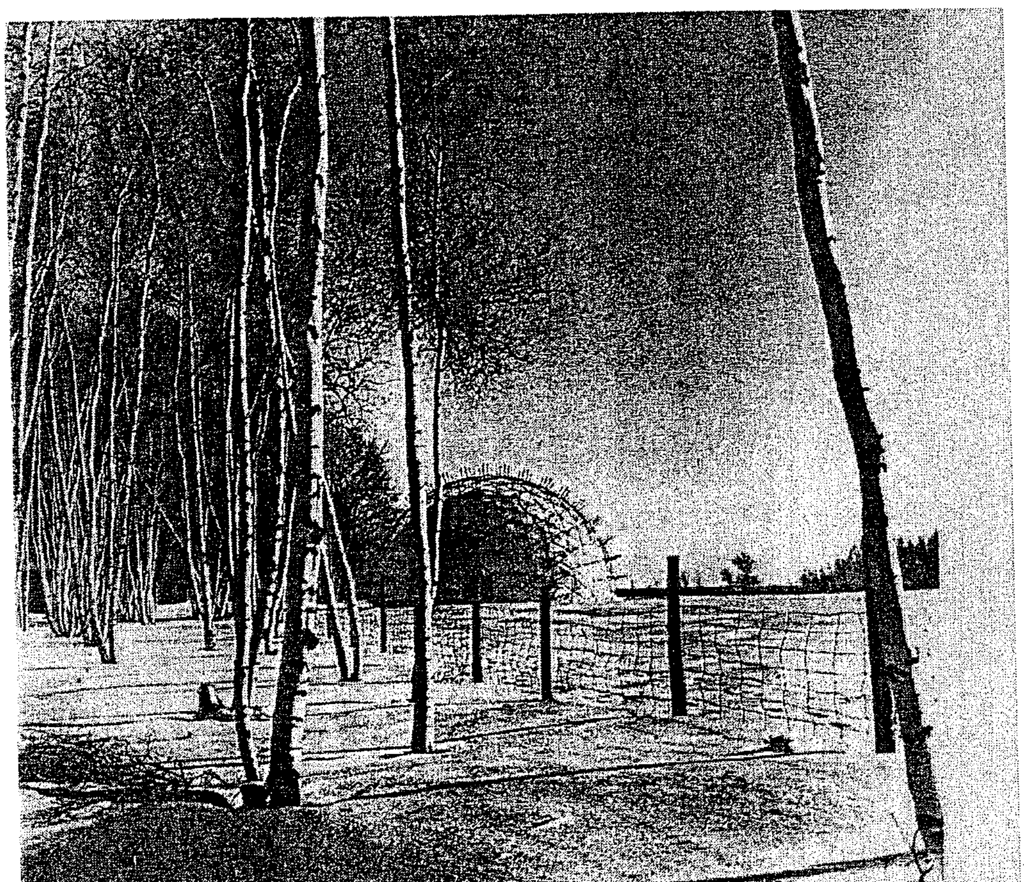


Fig.2.18b Hackney Farm Project by J. Lindsay. Source: "Dairy Farm, circa 1955," *Plastics Newsfront*, Vol.X, No.1, 1955.

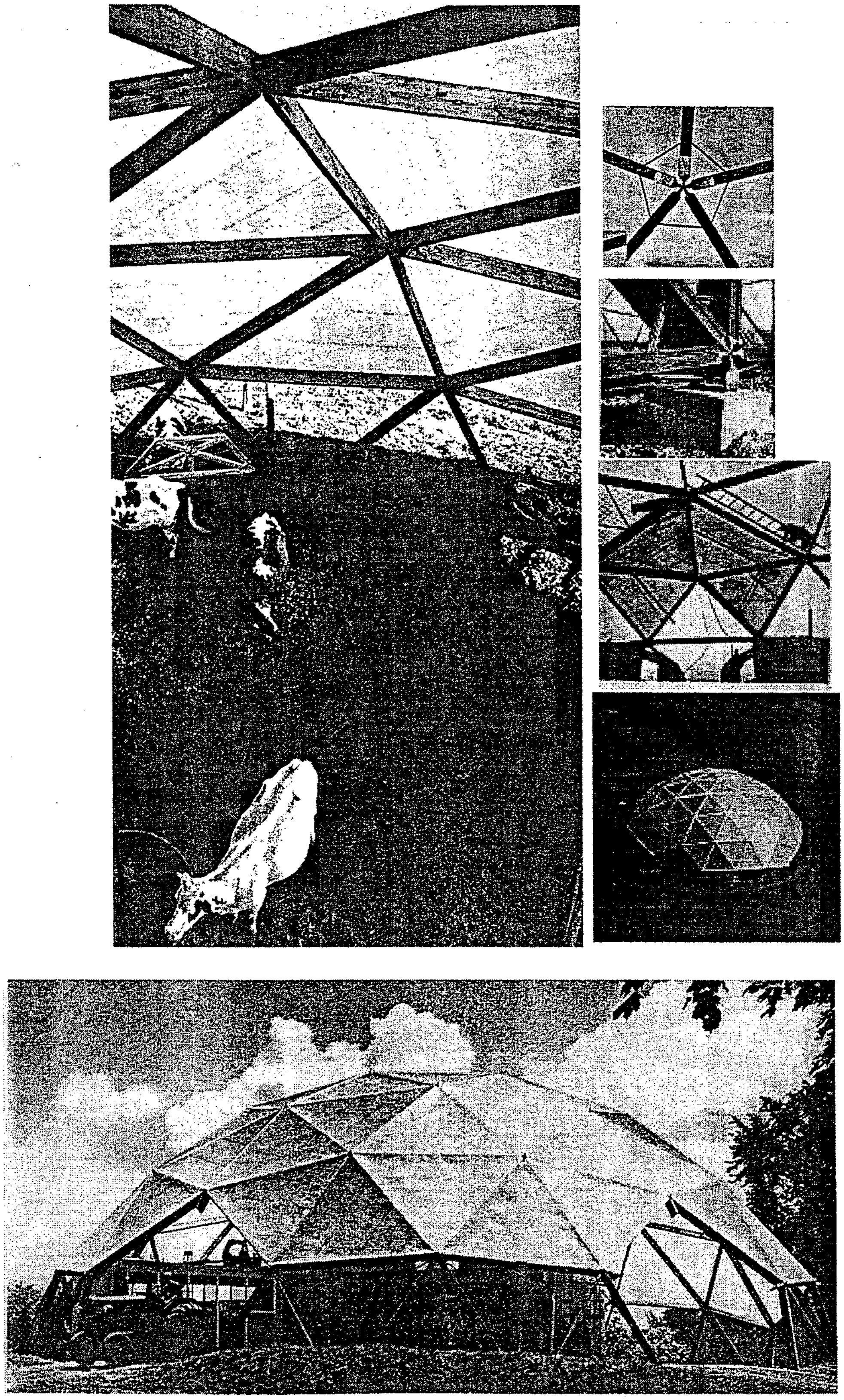


Fig.2.19a Extract from D. Stuart's Triacon Treatise, "A Report on the Triacon Gridding System for Spherical Surfaces," 4 June 1952. Source: BFI-EJA Green.

figure 2

edge patterns
a equals longest edge
h " shortest "

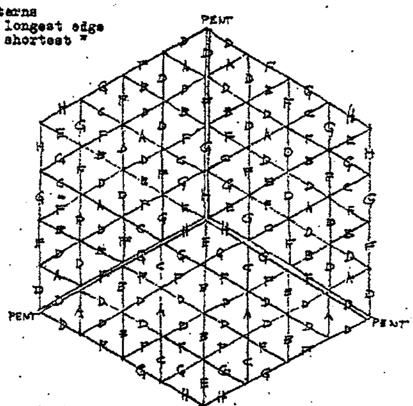
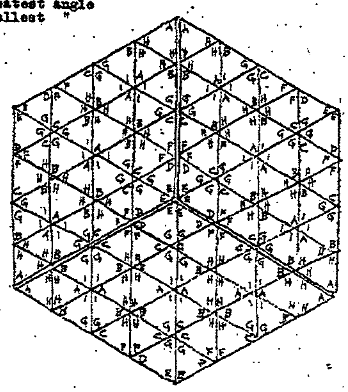
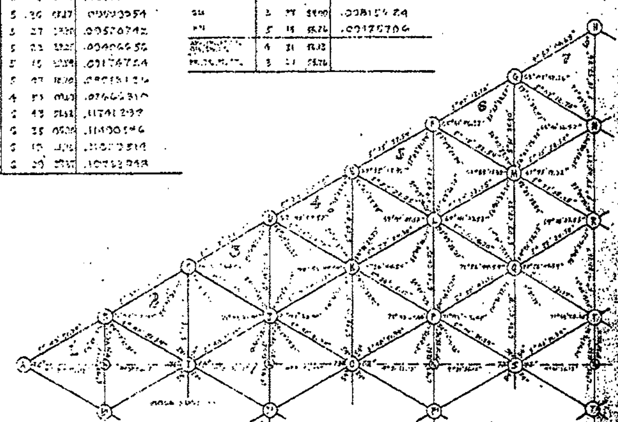


figure 3

a equals greatest angle
i " smallest "

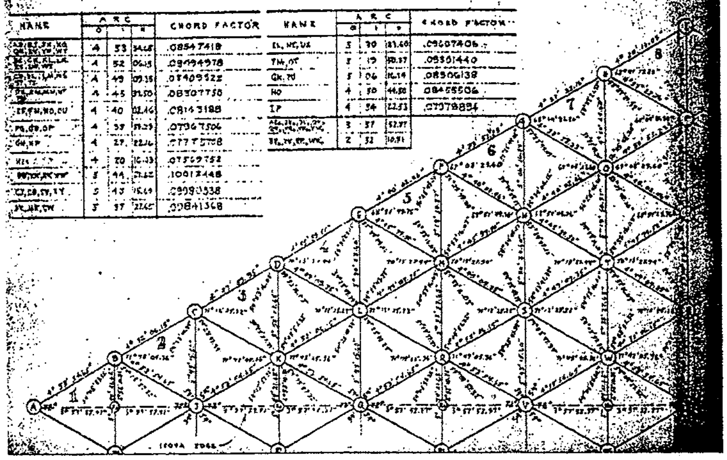




14 V TRIACON TRUSS*

NAME	ARC °	'	"	CHORD FACTOR
[illegible]	5	40	[illegible]	.09310850
[illegible]	5	36	[illegible]	[illegible]
[illegible]	5	27	[illegible]	.09570742
[illegible]	5	23	[illegible]	[illegible]
[illegible]	5	15	[illegible]	[illegible]
[illegible]	5	07	[illegible]	[illegible]
[illegible]	4	53	[illegible]	[illegible]
[illegible]	6	43	[illegible]	[illegible]
[illegible]	6	35	[illegible]	[illegible]
[illegible]	6	15	[illegible]	[illegible]
[illegible]	6	20	[illegible]	[illegible]

NAME	ARC °	'	"	CHORD FACTOR
[illegible]	5	57	05.19	.10352900
[illegible]	5	[illegible]	59.00	[illegible]
[illegible]	5	15	58.26	[illegible]
[illegible]	4	31	[illegible]	
[illegible]	3	[illegible]	[illegible]	



SKYBREAK CAROLINA CORPORATION

16 V TRIACON TRUSS*

NAME	ARC °	'	"	CHORD FACTOR
[illegible]	4	53	[illegible]	.08547418
[illegible]	4	52	06.15	.08494978
[illegible]	4	49	09.15	.08409522
[illegible]	4	45	31.50	.08307750
EF, FH, HO, CU	4	40	21.46	.08143188
FG, GO, OP	4	37	19.29	.07967506
GH, HP	4	27	22.16	.07775708
[illegible]	4	20	16.43	.07569752
[illegible]	5	44	[illegible]	.10013448
[illegible]	5	43	15.69	.09990538
[illegible]	5	37	[illegible]	.09841368

NAME	ARC °	'	"	CHORD FACTOR
[illegible]	5	30	31.40	.09607406
TH, OT	5	19	50.37	.09301440
GK, TO	5	06	16.14	.08906138
HO	4	50	44.50	.08455506
IP	4	34	22.53	.07978854
[illegible]	3	57	52.97	
[illegible]	2	32	10.91	

SKYBREAK CAROLINA CORPORATION

TRIACON TRUSS DATA* 4' MAX. ALT. Δ

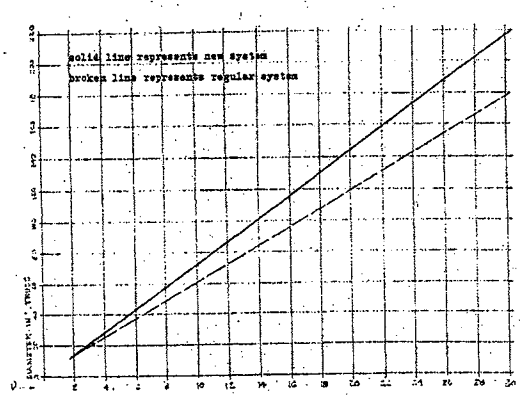
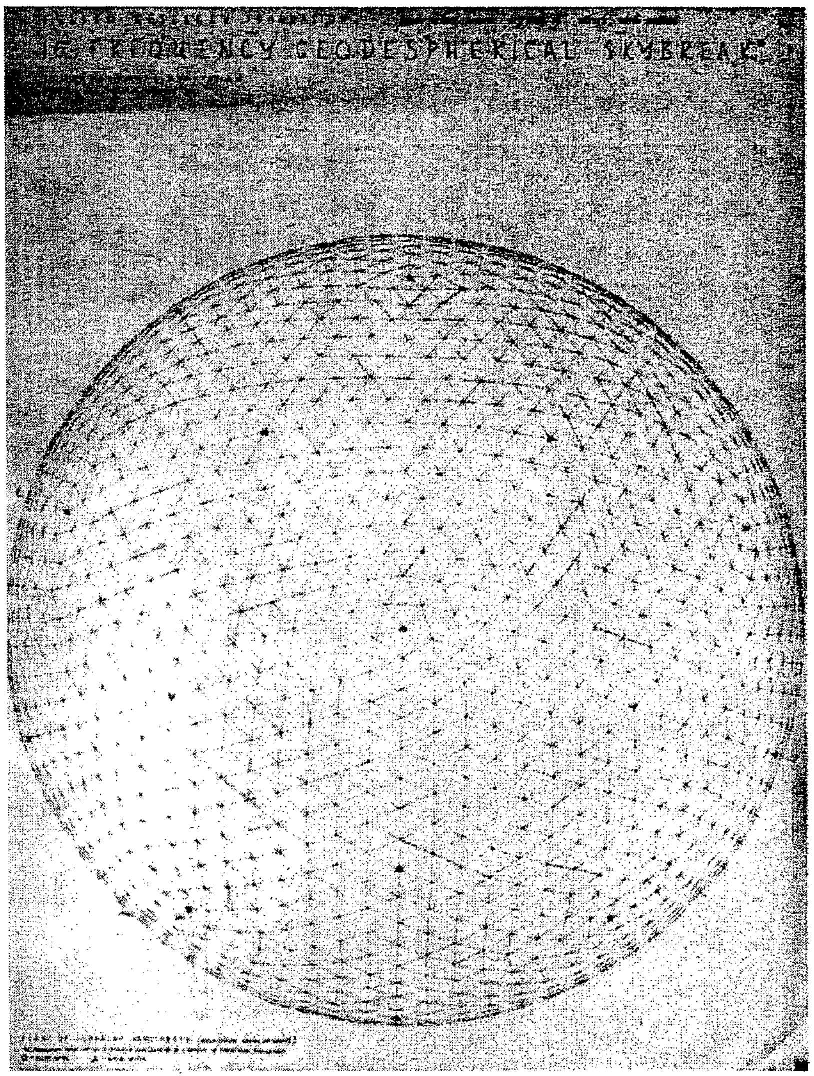


Fig.2.19b "16 frequency geodespherical Skybreak," ca. 1951. Source: J. Ward. ed. The Artifacts of R. Buckminster Fuller, Vol.3, p.78.



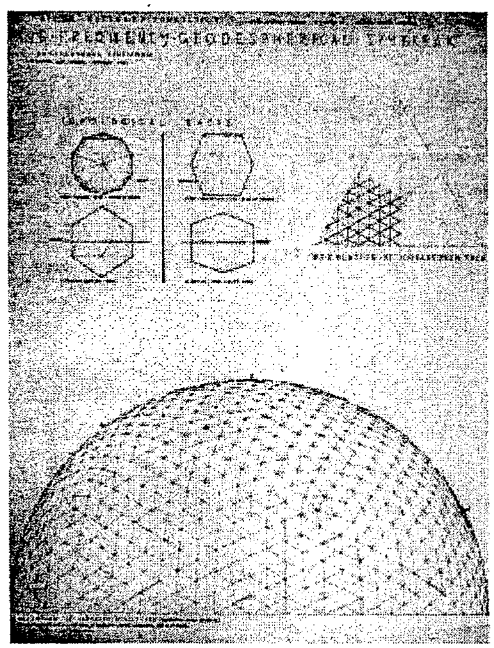


Fig.2.19c D. Stuart's Lesser circle studies. <u>Source:</u> BFI-CR135.

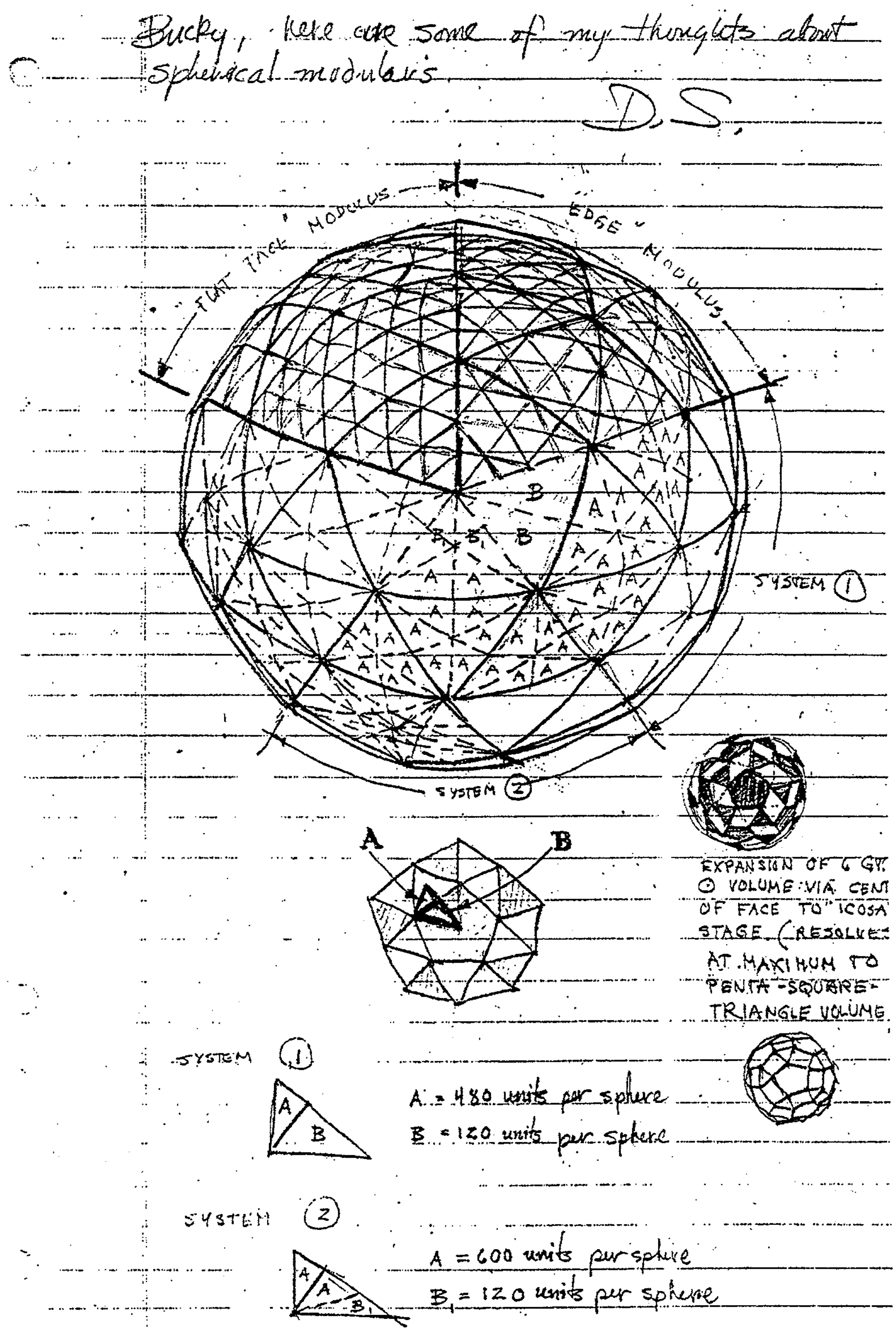


Fig.2.20 Comparative charts of Fuller's College initiated geodesic domes. Source: BFI-CR172.

COMPARATIVE CHART OF BEHAVIOR CHARACTERISTICS OF GEODESIC STRUCTURES

Date	Location	Mathematics	Frequency	Type of Construction	Materials	Diameter	Man-Hours Erection	Pounds	Volume	Pounds Per Vol.	Man-Hours Erection Per Vol.
Feb. '49	Pentagon Garden Washington, D.C.	Geodesic 3-Way Grid	0	31 Great Circle Triangular Necklace; Pneumatic Transparent Skin	Aluminum Tubing Aluminum Casting Vinyl Sheet	14'	1 1/2	50	686	.072	.0021
Dec. '50	Montreal Canada	"	8	Sprited Tubular	Aluminum; Orlon Fabric	48'	48	1,140	20,815	.055	.0023
June '51	Lawrence New York	"	16	Welded Triangular Grid Basket	12 Gage Steel Wire	20' 3/4 sphere	4	100	1,500	.066	.0026
July '51	Montreal Canada	"	2	Triangular Frame	Aluminum Tubing Orlon	18'	2/3	130	1,458	.089	.00046
Oct. '51	Laurentian Mountains Canada	"	Alternate 4	Triangular Frame 1/4" Plywood Sheathing	2" x 4" Pine	27'	36	2,500	2,460	1.016	.014
Jan. '52	North Carolina State College Raleigh, N.C.	"	16	Cocooned Triangulated Lattice	Carolina Pine Neoprene	30	240	1,000	6,750	.15	.036
May '52	Cornell University Ithaca, New York	"	8	Screen Covered Triangulated Lattices	Spruce Steel & Copper Wire	20 sphere	16	200	4,000	.05	.004
Nov. '52	Yale University New Haven Connecticut	"	8	Triangular Box	Kraft Paper Board	30	480	600	6,750	.09	.071
Jan. '53	North Carolina State College Raleigh, N.C.	" "	Alternate 4	Metal Strapped 1" x 2" Pine Prefab Double Skin Envelope	Pine Saran, Polyethylene Mylar, Vinyl	36	64	650	11,664	.054	.0053
Feb. '53	University of Minnesota Minneapolis, Minn.	" "	8	Accordian Truss	Oak, Steel, Glass Cotton, Duck, Polyethylene	36	12	550	11,644	.0473	.001
April '53	University of Oregon Eugene, Oregon	"	8	Hyperbolic Diamond Pan	Plywood Mylar	36	25	1,110	11,644	.09	.002
April '53	Dearborn Michigan	"	Alternate 4	Octet Truss	Aluminum Polyester Fiberglas Fiberglas	93	720	17,000	210,000	.0809	.0034
Aug. '53	Woods Hole Massachusetts	"	12	Hyperbolic Parabolic Diamonds	Douglas Fir & Mylar	54	180	6,000	39,366	.15	.004
Nov. '53	Princeton University Princeton, N.J.	"	6	Discontinous Compression	Aluminum Tubing Aircraft Steel Cable	40' sphere	120	1,000	32,000	.031	.0037
Dec. '53	University of Minneapolis, Minn.	"	8	Discontinous Compression	Polyester Fiberglas Aircraft Cable	40 2/3 sphere	36	1,000	23,500	.043	.0015
July '52	Beaurepaire Lake St. Louis Canada	"	4	Triangular Frame	Plywood, Masonite, Orlon, Saran	27'	36	500	2,460	2.03	.014

Fig.2.21 Three Houses of J. Rauma (MIT), billed by Fuller as "Geodesic skybreaks," ca. 1952.
Source: BFI-HEv4. [See also J. Ward, ed. The Artifacts of R. Buckminster Fuller, Vol.3, pp.83-85]

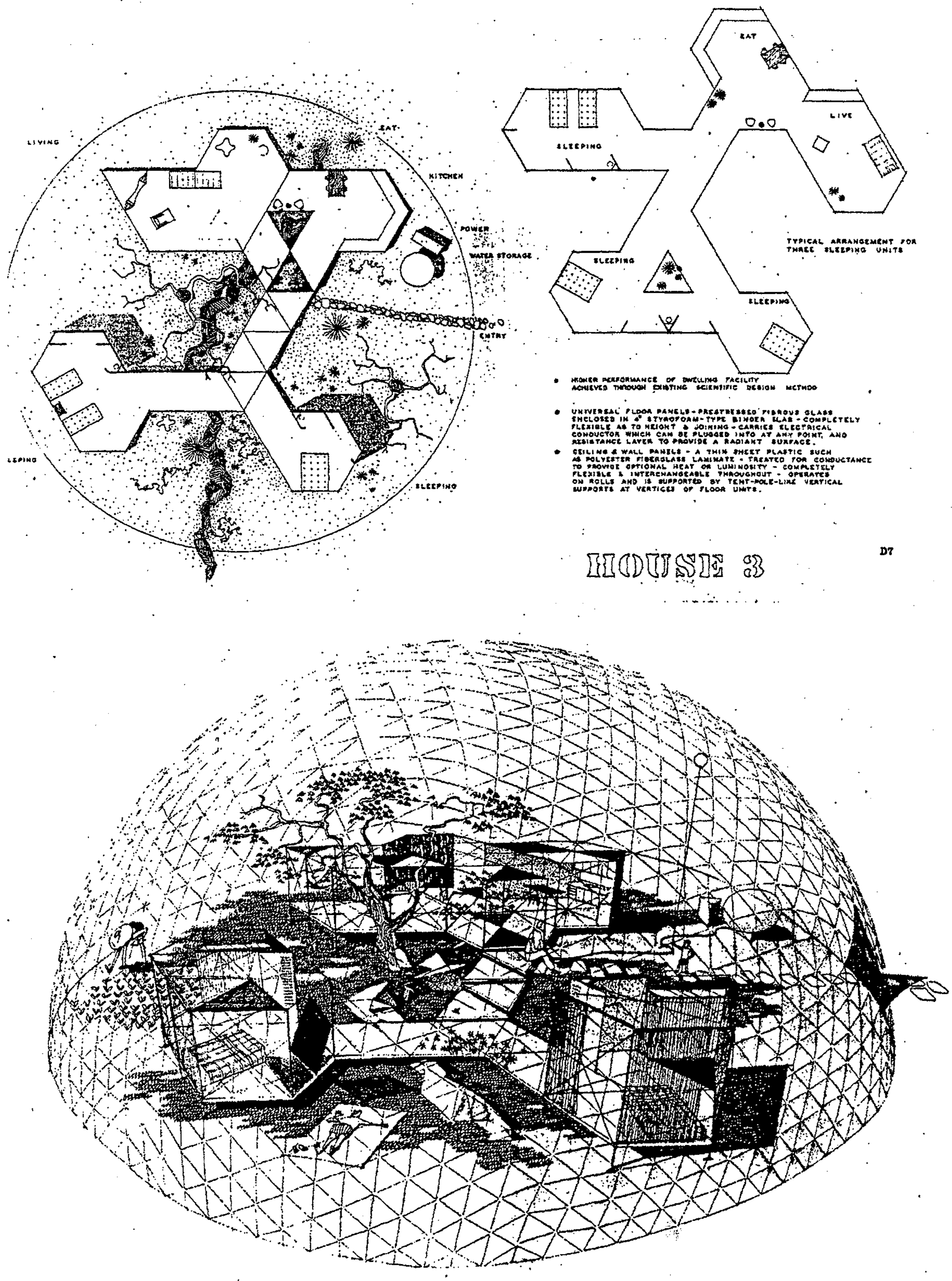
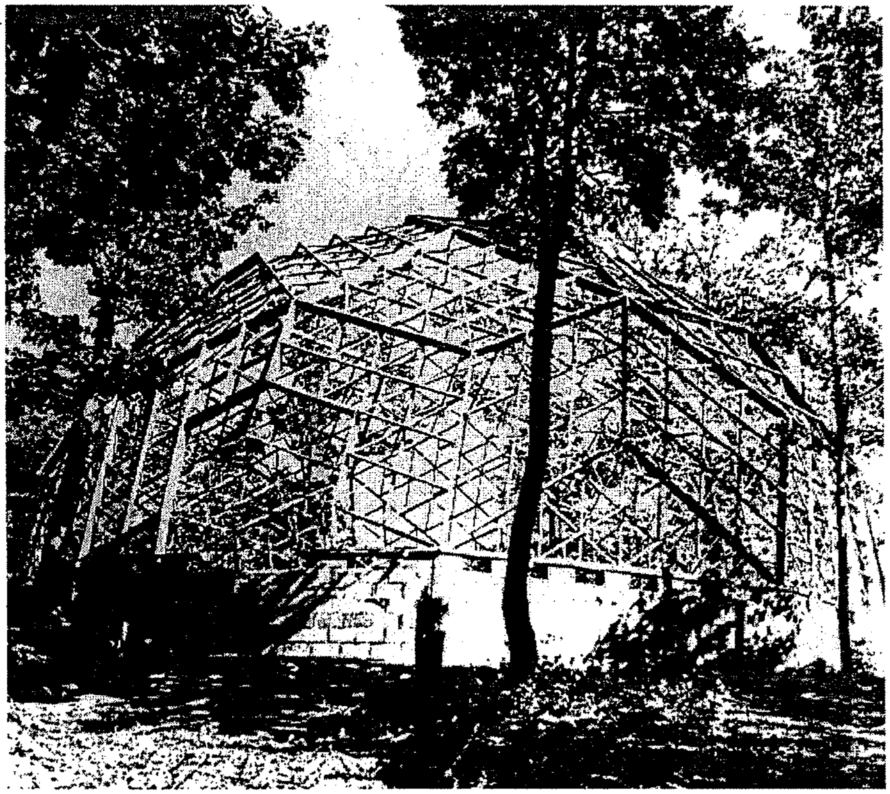


Fig.2.21b Woods Hole Dome. **1**: External view. Source: BFI-CR163; **2**: Internal view. Source: *Better Homes and Garden*, June 1957



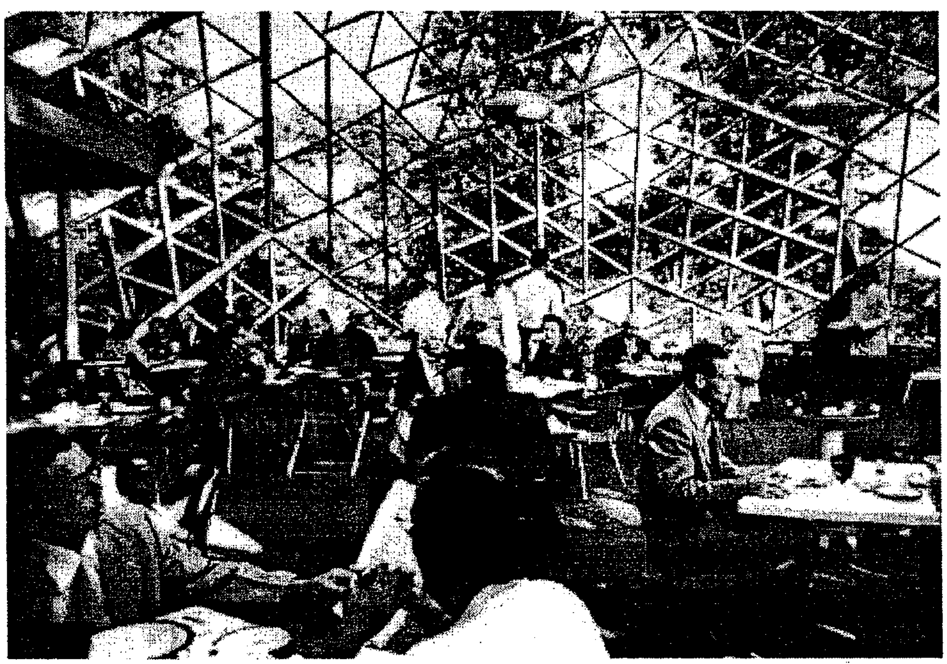


Fig.2.22a RBF's sketches of joints for Mendelsohn's House. <u>Source:</u> Ltr. 10/12/51 RBF to C. Eames, in BFI-CR141; Ltr. 8/15/51 RBF to C. Eames in BFI-CR141.

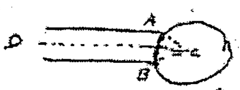
FULLER RESEARCH FOUNDATION
6 BURNS STREET
FOREST HILLS, N. Y.
BOULEVARD 8-2639

August 15 1951

Dear Charles:–

There is an alternative method which requires a little more jigging of the wood cutting operations.

Inasmuch as the reason for the plug (or core) in the Keiser ~~joint~~ connector was to insure that axis of thrust of the struts would be focused to common center rather than tending to turbine



the same result may be obtained by mitreing the ends of

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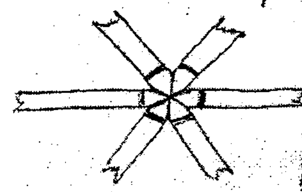
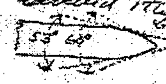
the struts at 57° terminals (which allows of enough slop in wood construction to adjust to the 53°–57° minimum max. ∠ of extreme ranges of spherical excess occurring in the pattern.) – and then seizing the ends together with a much smaller diameter (2"–3") caps of possible standard manufacture – or by § cut offs of 2" or 2½" pipe. Have found several such 2" to 3" range circular pan caps of stamping or die cast – which may or may not save cost on casting & pattern.



I think this is neater. And that if the terminals were slightly bevelled it would be a delux fitting job.



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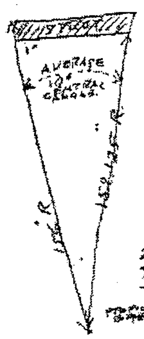
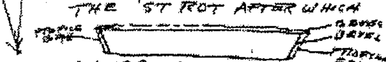
This means then that if we are working on a 46' ~~radius~~ diameter ~~we would want~~ and are using 1"x4" i.e. 7/8" x 3 5/8" standard mill stock of (good clear material of clear approx strength stock) that we would have 2 radii to figure the chords for – (at inside and outside of strut) called-out in inches as in figure at left.



13' = 156" = outside radius
12'8¼ = 152¼" = inside "

so by multiplying our respective chord factors (16 types in 8 classes) times those 2 radii in each case we have the dimensions of the TRUNCATED ISOSCELES TRIANGLE PROFILE OF THE STRUT AFTER WHICH



THE TERMINAL EDGES WOULD HAVE TO BE BEVELED, AS I THINK

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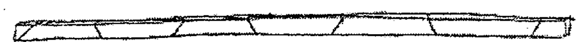
IT WOULD PAY TO CUT THE MILL STOCK 1"x4" IN COMPLEMENTARY



SEGMENTS – (BELIEVE WHEN PRODUCTION ACCELERATES THAT VERY FAVORABLE PRICES MAY BE OBTAINED FOR THESE SHORT LENGTHS.) AND THEN TO ARRANGE A BEVELING JIG CUT OR PLANING OR MOLDING OPERATION.

I like all this better than what I have suggested earlier – BUT Please feel free to make your own suggestion.

Bucky.

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Fig.2.22b "Turbine joint" of Skybreak Carolina by D. Stuart, ca. 12 April 1952. <u>Source:</u> BFI-CR139.

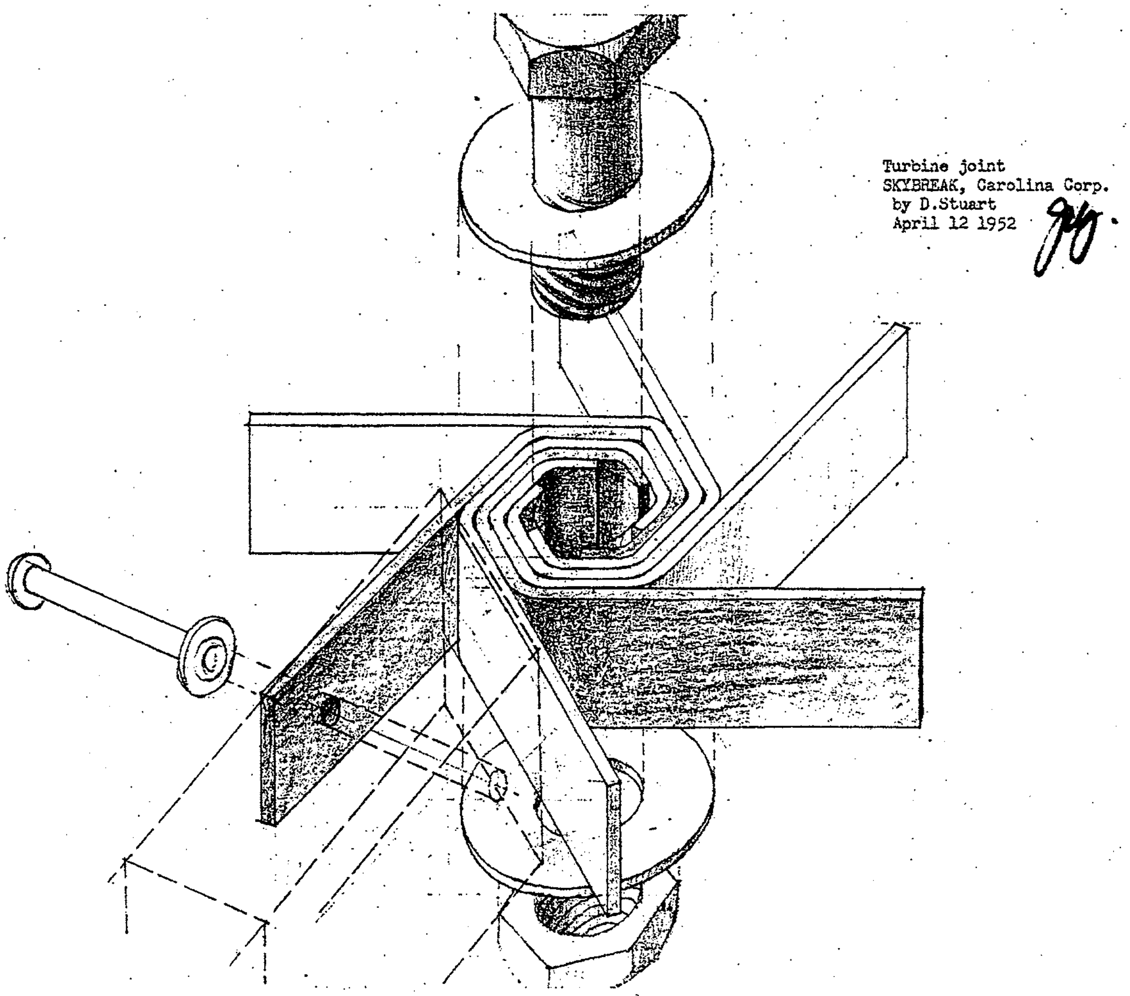
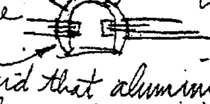
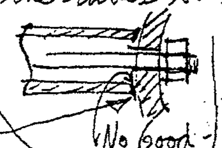


Fig.2.22c Working sketches for early radome joint details, by John Williams, 2/2/53. Source: BFI-[?].

I feel that the many piece joint casting would go togeather alot faster and would not involve extra redundant members. as could happen with pre-assembled octas of sheet aluminum. I talked today with a professor in the foundry of the metal processing lab at MIT about a cast joint. As I expected the problem of "draft" caused by the casting being more than a hemisphere

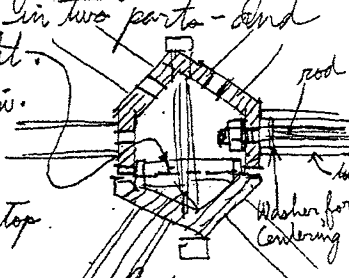


would cause alot of trouble. Also he said that aluminum castings would never develop the strength of the rods and tubing connected to them, tho die and "permanent mold" castings would be better than sand castings. He suggested flat faces on the casting where the tubes meet the casting — so we get back to the good old rhombic dodecahedron. This also eliminates a problem of special finishing the ends of the tubes so it will have good contact with the joint.



It is much easier to cut the end of a tube off square (flat) than to bevel it.
He suggested aluminium forgings for really high strength and I'll see a man about this tomorrow. This rhombic dodeca joint:

that has the "scalloped" bottom edge would not be good for casting or forging so the thing would be made in two parts - and modified so the edge is straight.
- Note drawing is just a crude approximation.



The tower would be 3 colums of octas, trussed togeather periodically with sections of octet truss and an octet truss on the top as a platform. A heavier tower could be made of columns of dymaxions with $\frac{1}{2}$ octas on the square faces — which is really 3 cols. of octas "tangent" to a column of tetras in the center. Will send you more word as things get worked out. Will build wire model of tower — am keeping busy - sincerely John Williams

Will send Wayne Univ. stuff to you in Detroit as soon as possible.

Fig.2.22d Fuller/Collaborators' joints (T.C. Howard & Synergetics Inc.) Joints. Source: John Borrego, *Space Grid Structures*, pp.84-87.

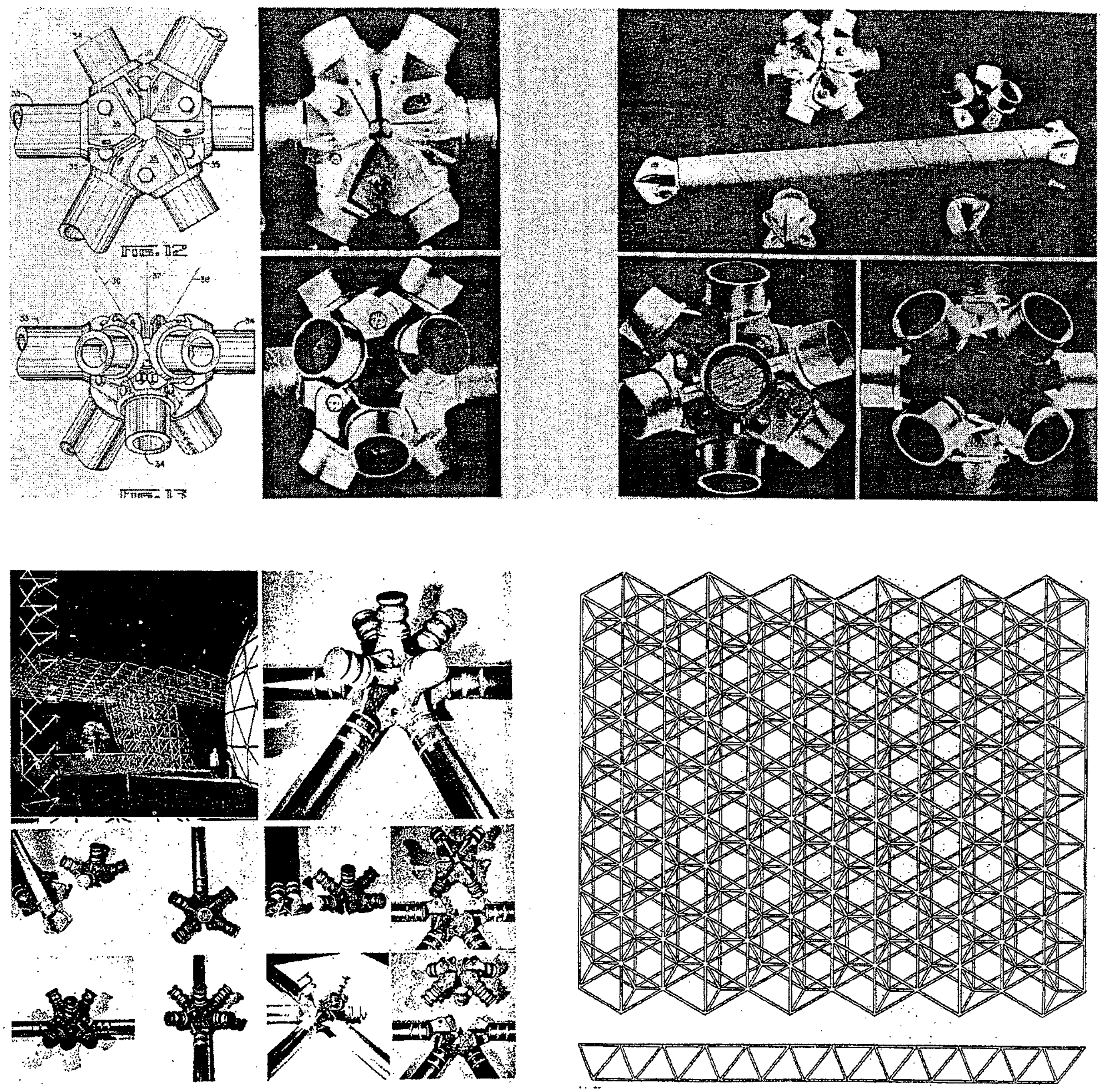
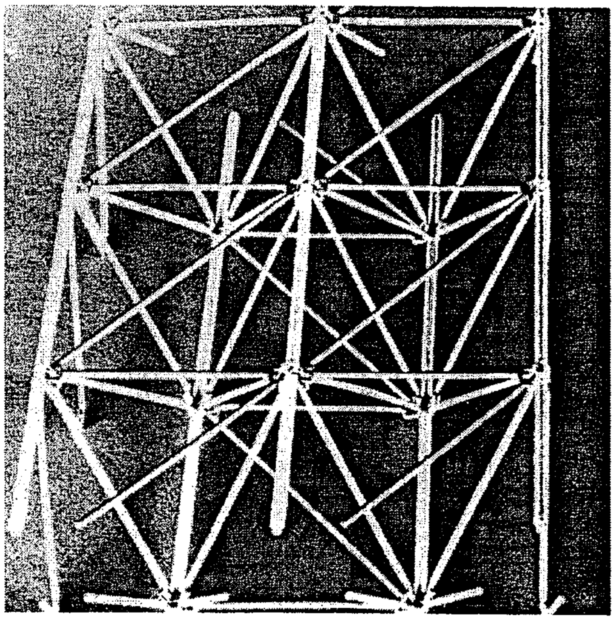
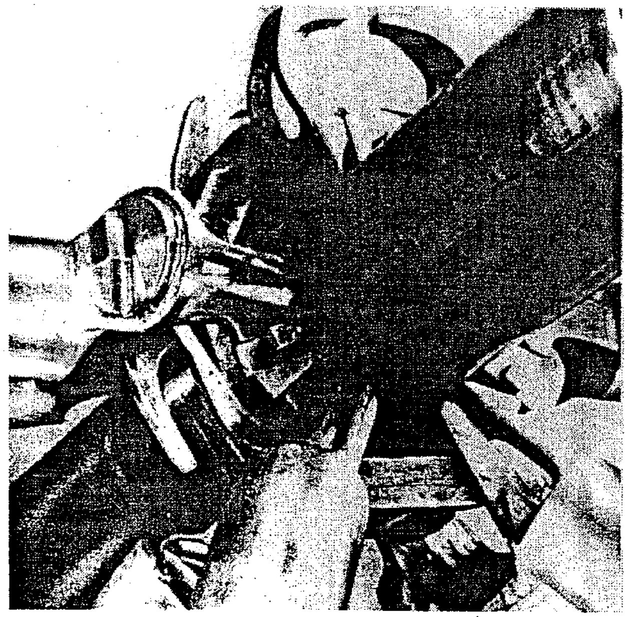
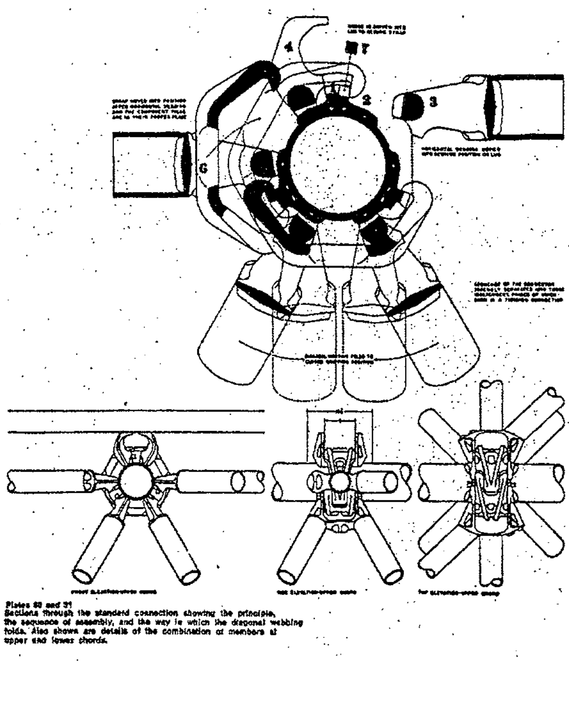


Fig.2.22e Tetrahedral system of space structure & joint for large hangar, K. Wachsmann Joint.
Source: John Borrego, *Space Grid Structures*, pp.34-35.







Plates [illegible] and [illegible]
Sections through the standard connection showing the principle, the sequence of assembly, and the way in which the diagonal webbing folds. Also shown are details of the combination of members at upper and lower chords.

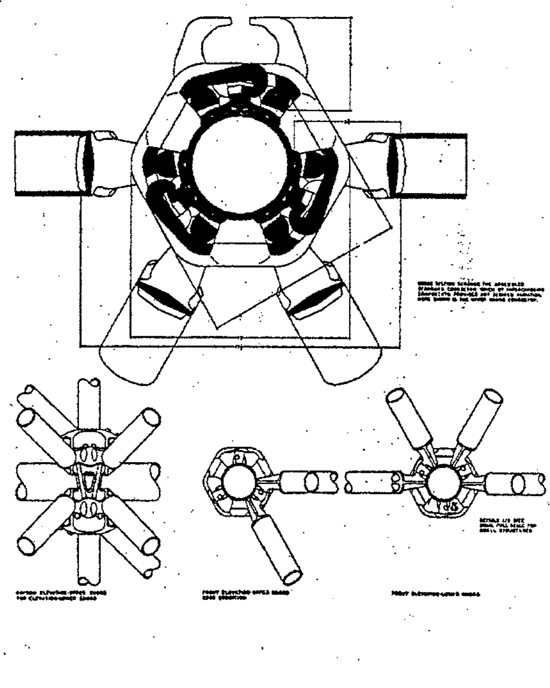
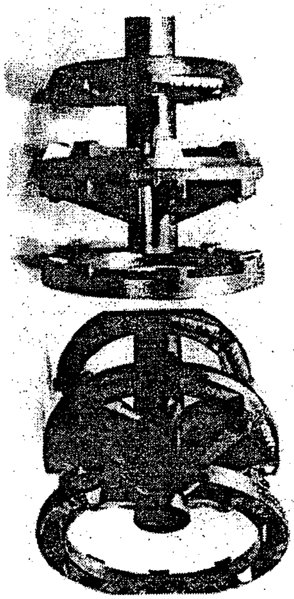
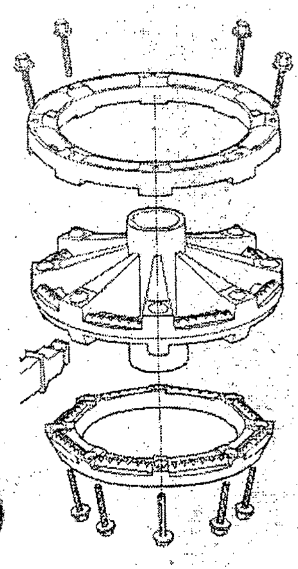
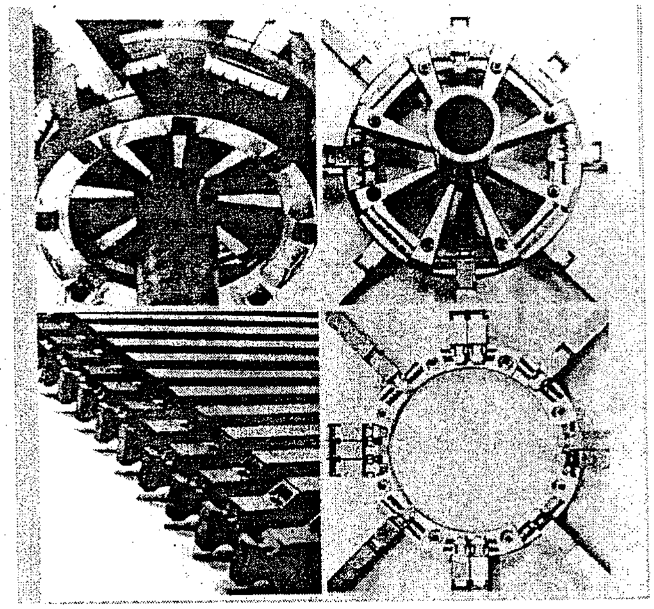


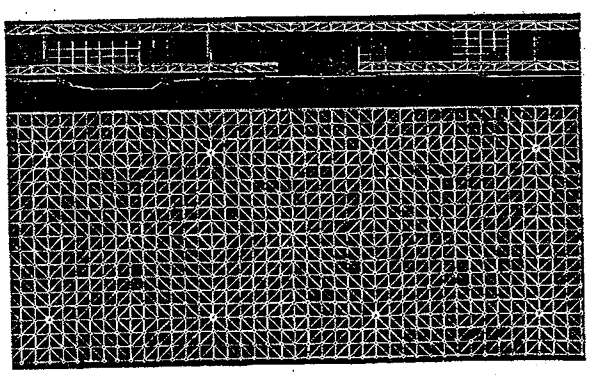
Plate [illegible]

Fig.2.22f Space Frame & joint developed at L' Ecole Polytechnique de 'Université de Lausanne, ca. 1959, K. Wachsmann Joint. <u>Source:</u> John Borrego, *Space Grid Structures*, pp.38-41.









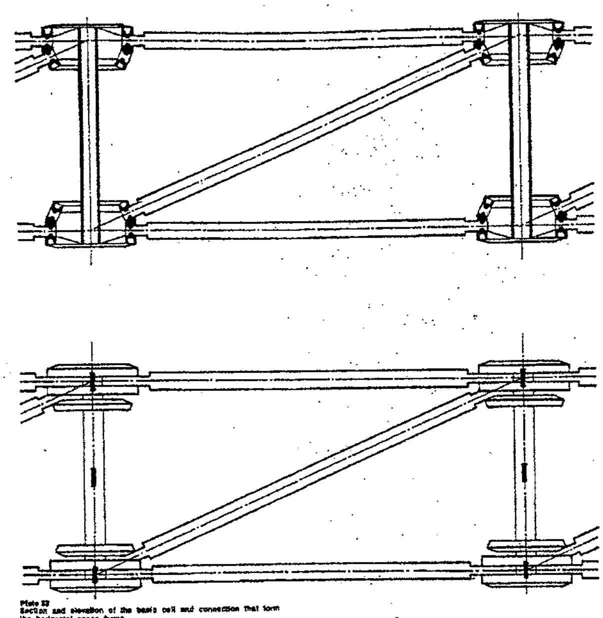


Plate 32
Section and elevation of the basic cell and connection that form the horizontal space frame.

Fig.2.22g Fuller's comparative sketch of his geodesic tetrahedral system versus Wachsmann's Airforce Hangar, undated. Source: BFI-CR137.

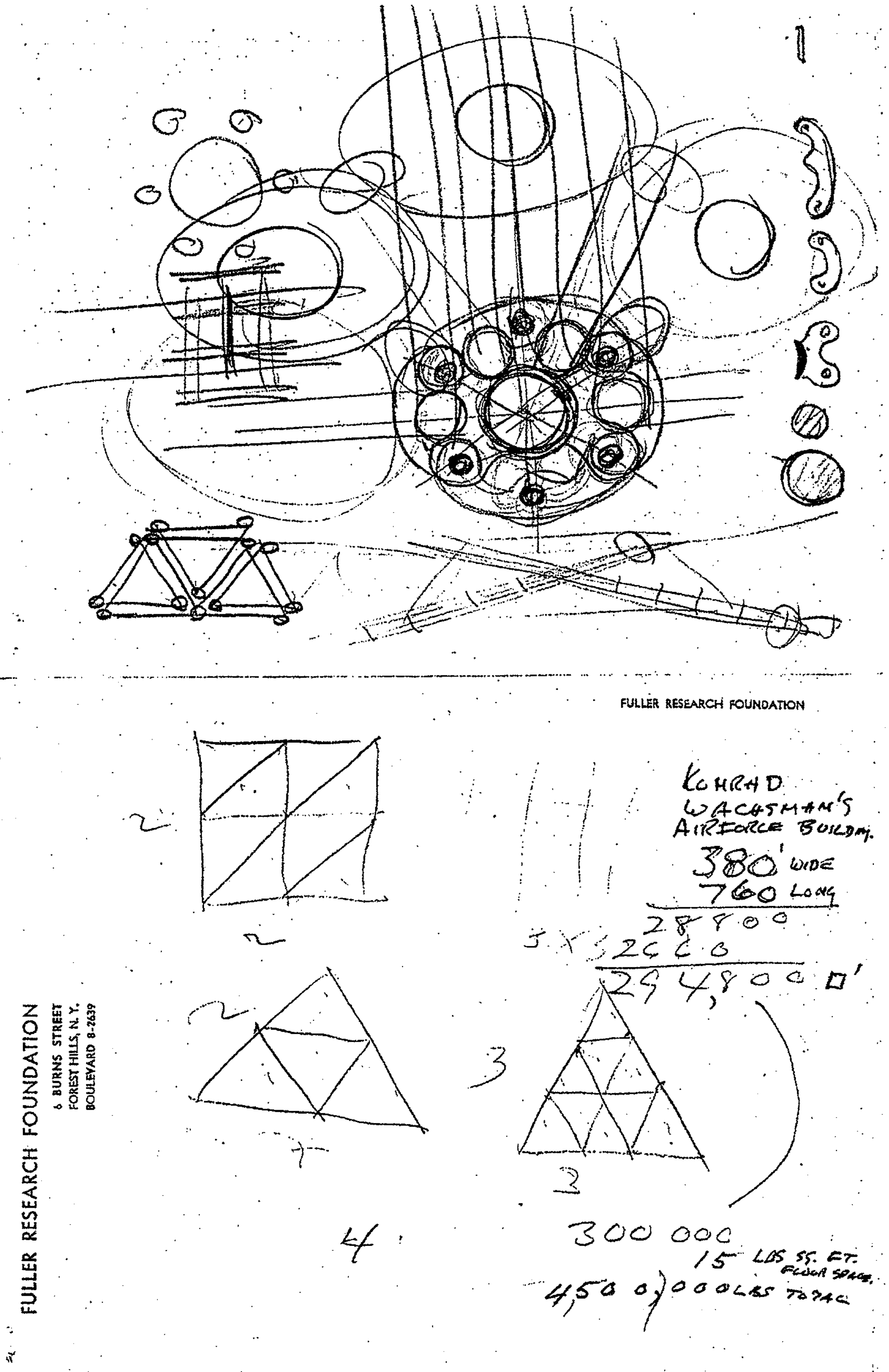
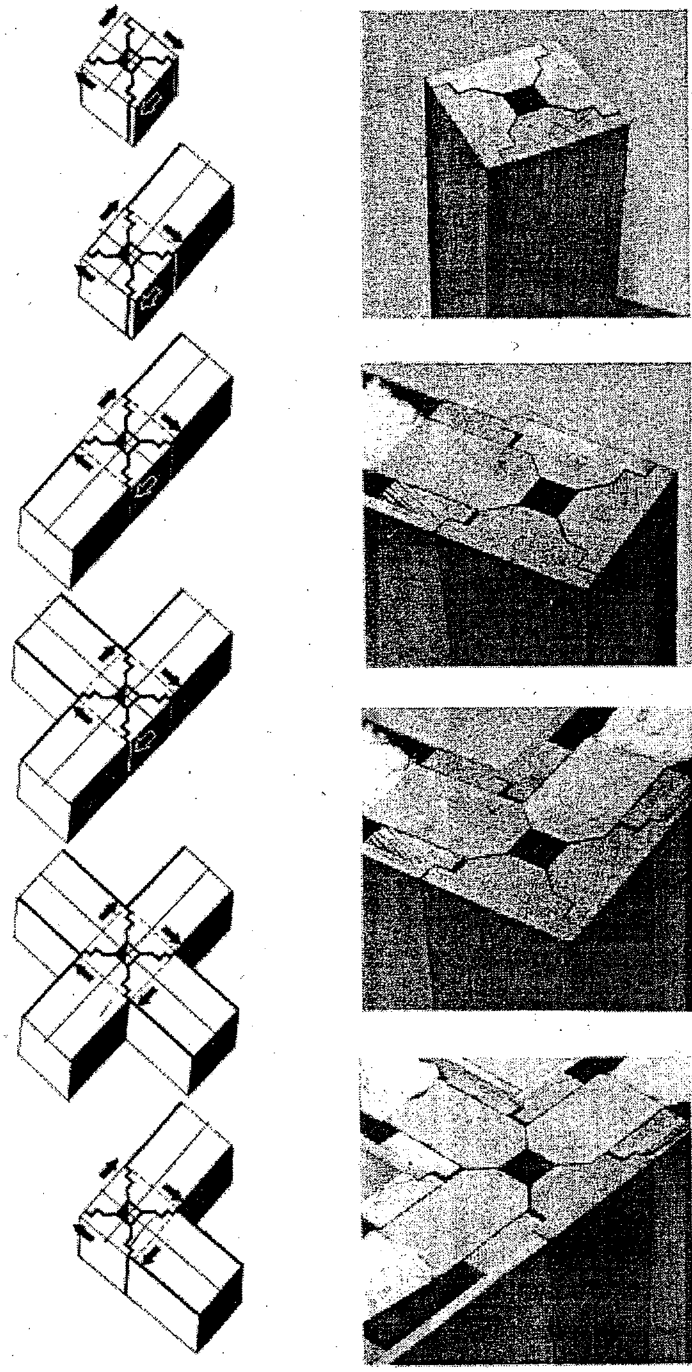


Fig.2.22h General Panel System, ca.1942. Source: K. Wachsmann, *The Turning Point*, p.141.



206 The standard section, identical vertically and horizontally, used in the General Panel System

Fig.2.23 "Experimental Tensegrity structure," at Beech Aircraft, Wichita-Kans., ca.1944. Source: BFI-Photo #T-14-2.

Fig.2.24a Extracts from Graham Bell's journal on tetrahedral structure, August 1902. Source: Robert V. Bruce, *Bell. Alexander Graham Bell, and the Conquest of Solitude.*

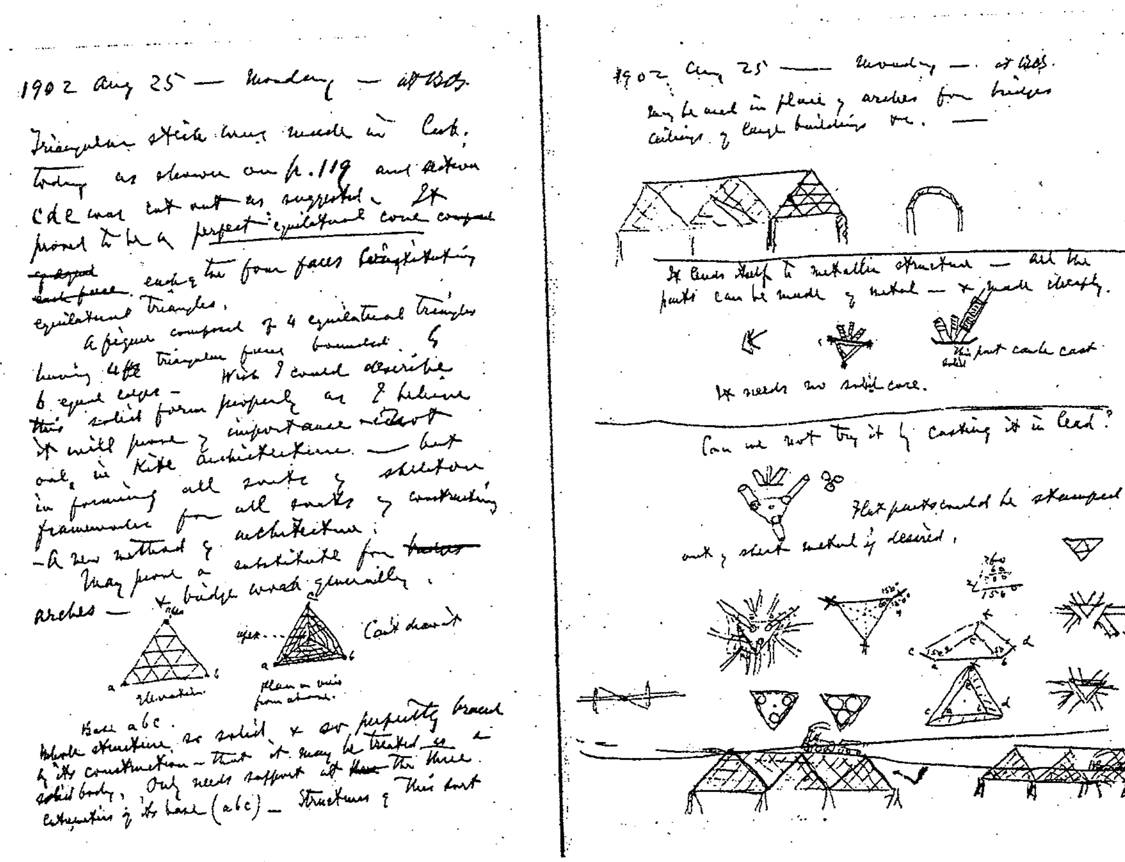


Fig.2.24b Bell's experimental tetrahedral structures. John Borrego, *Space Grid Structures*, pp.38-41. pp.80-81

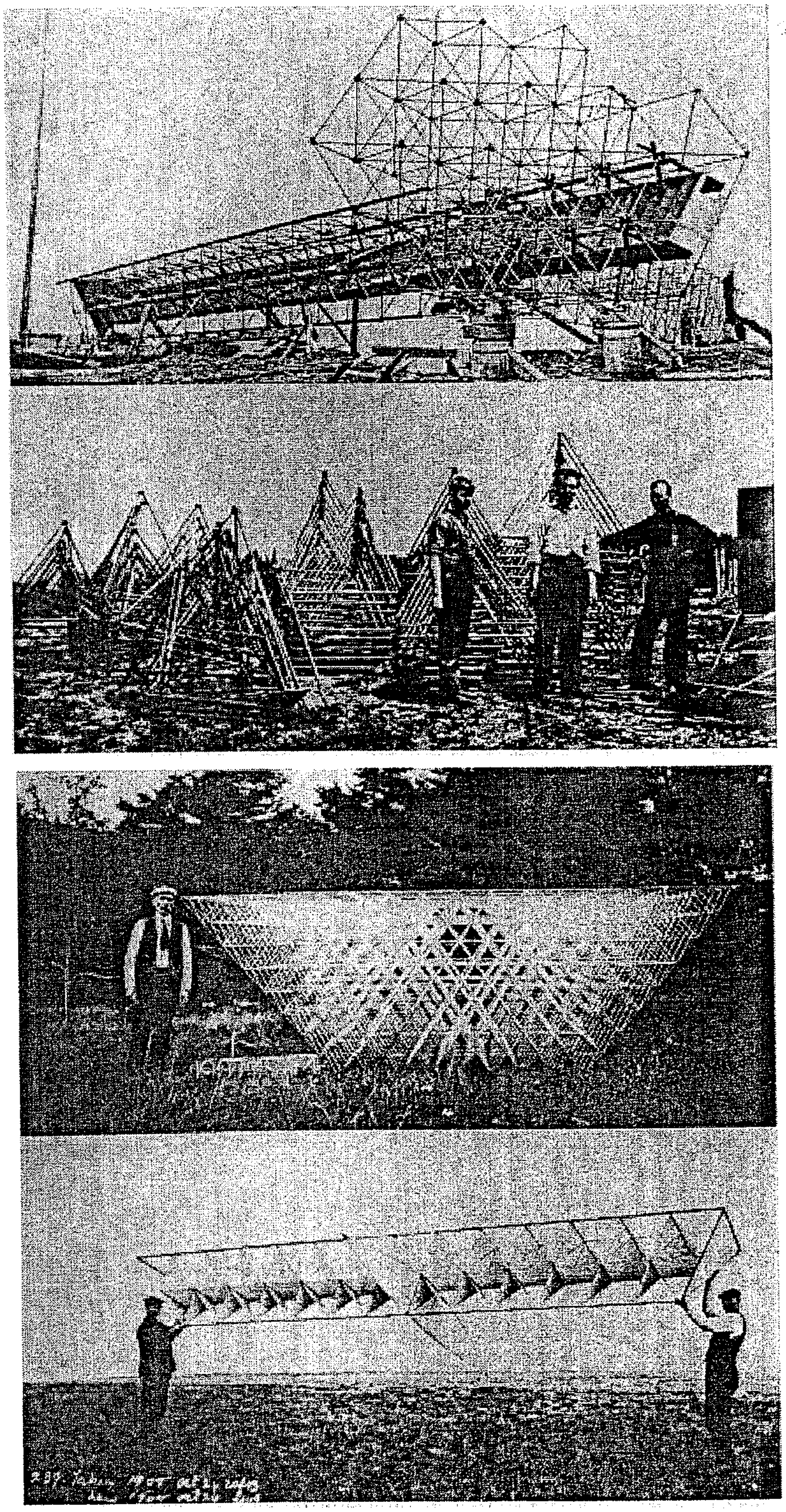


Fig.2.24c Graham Bell's 70' Tetrahedral Tower to demonstrate tetrahedral principles applied to large structures. [Patent Application, May 15, 1906]. <u>Source:</u> Dorothy H. Eber, *Genius at work, Images of Alexander Graham Bell.*

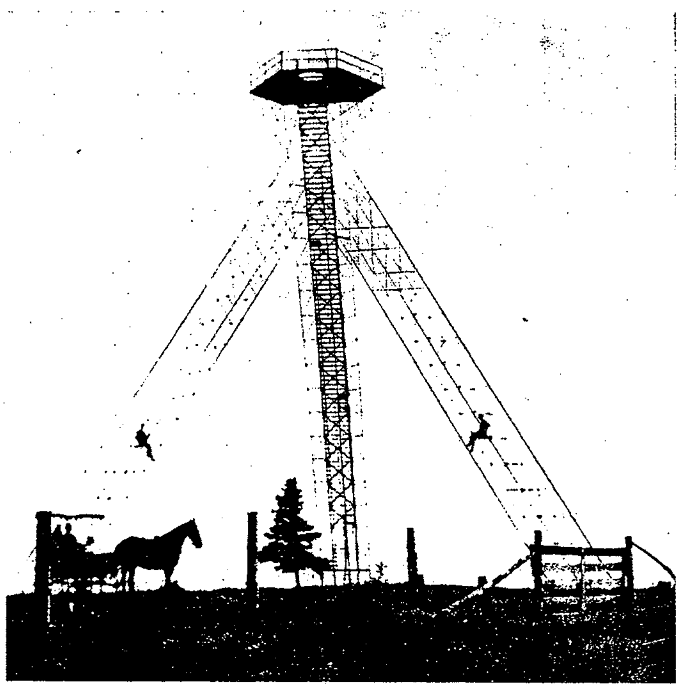
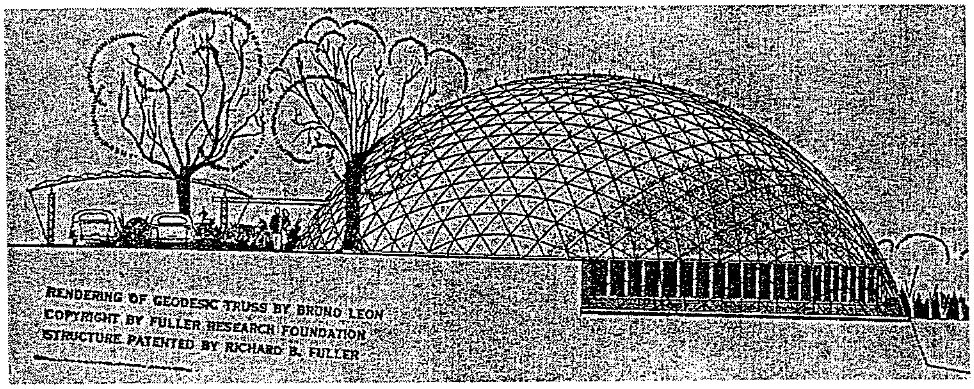


Fig.2.25 Brewer House, J.W. Fitzgibbon. Source: "Tensile Integrity," *Student publication NCSC*, Spring '51, Vol.1, No. 2, p.39.



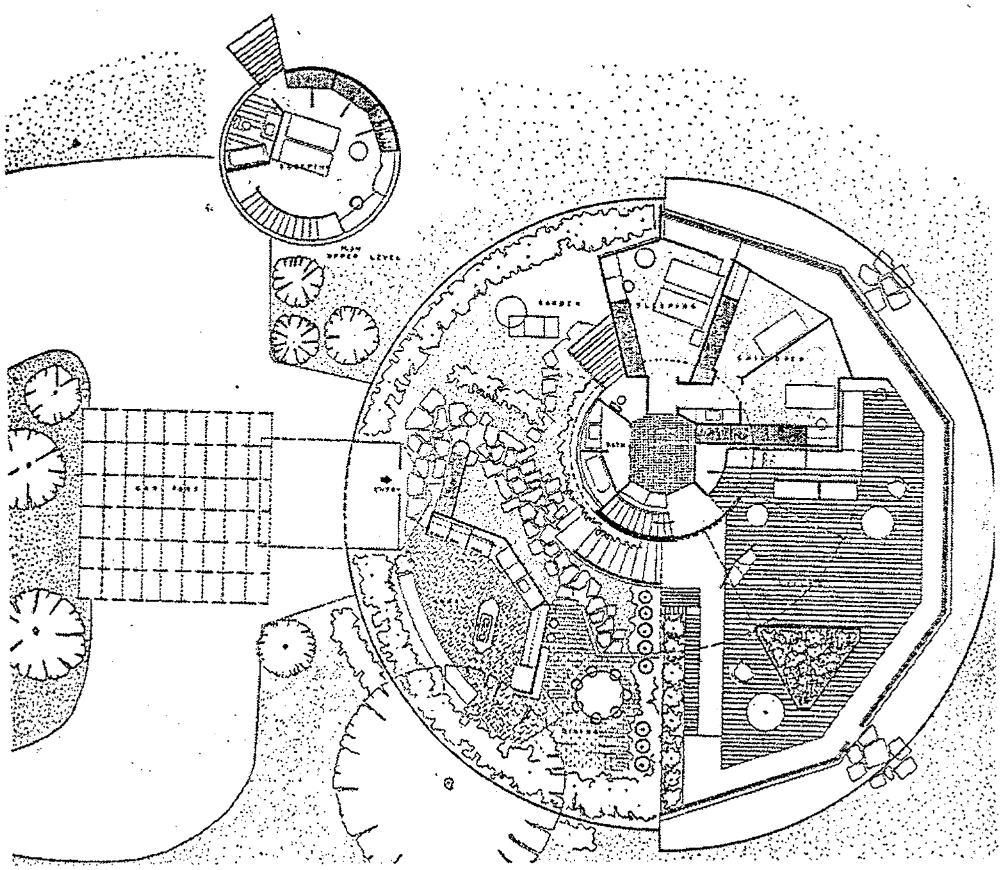
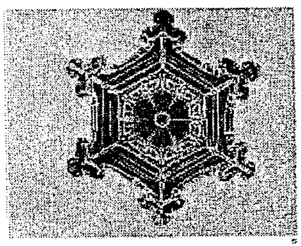


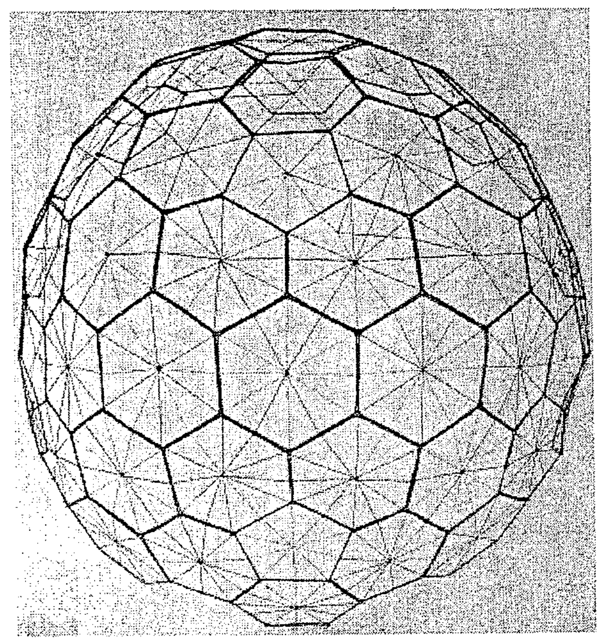
Fig.2.26a Illustration from G. Kepes "Vision and Value" series. Source: G. Kepes, ed., Module, Proportion, Symmetry, Rhythm, p.83.

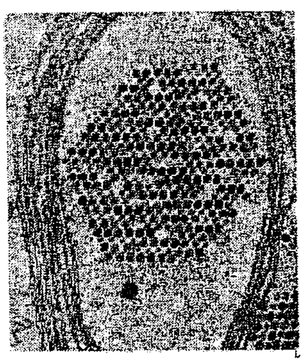


b. Crystal of virus. Magnification: [illegible] X. Electron micrograph. Courtesy Dr. C. Morgan, Department of Microbiology, Columbia University.

c. Pattern from Hokusai's [illegible] of 18[illegible], a book for the [illegible] trade.

d. R. Buckminster Fuller, Structure Study.





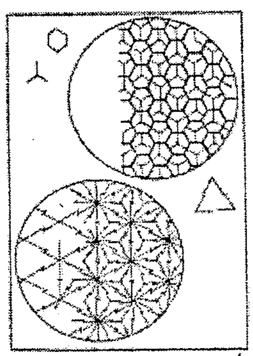


Fig.2.26b Illustration from G. Kepes "Vision and Value" series. Source: G. Kepes, ed., Module, Proportion, Symmetry, Rhythm, p.87.

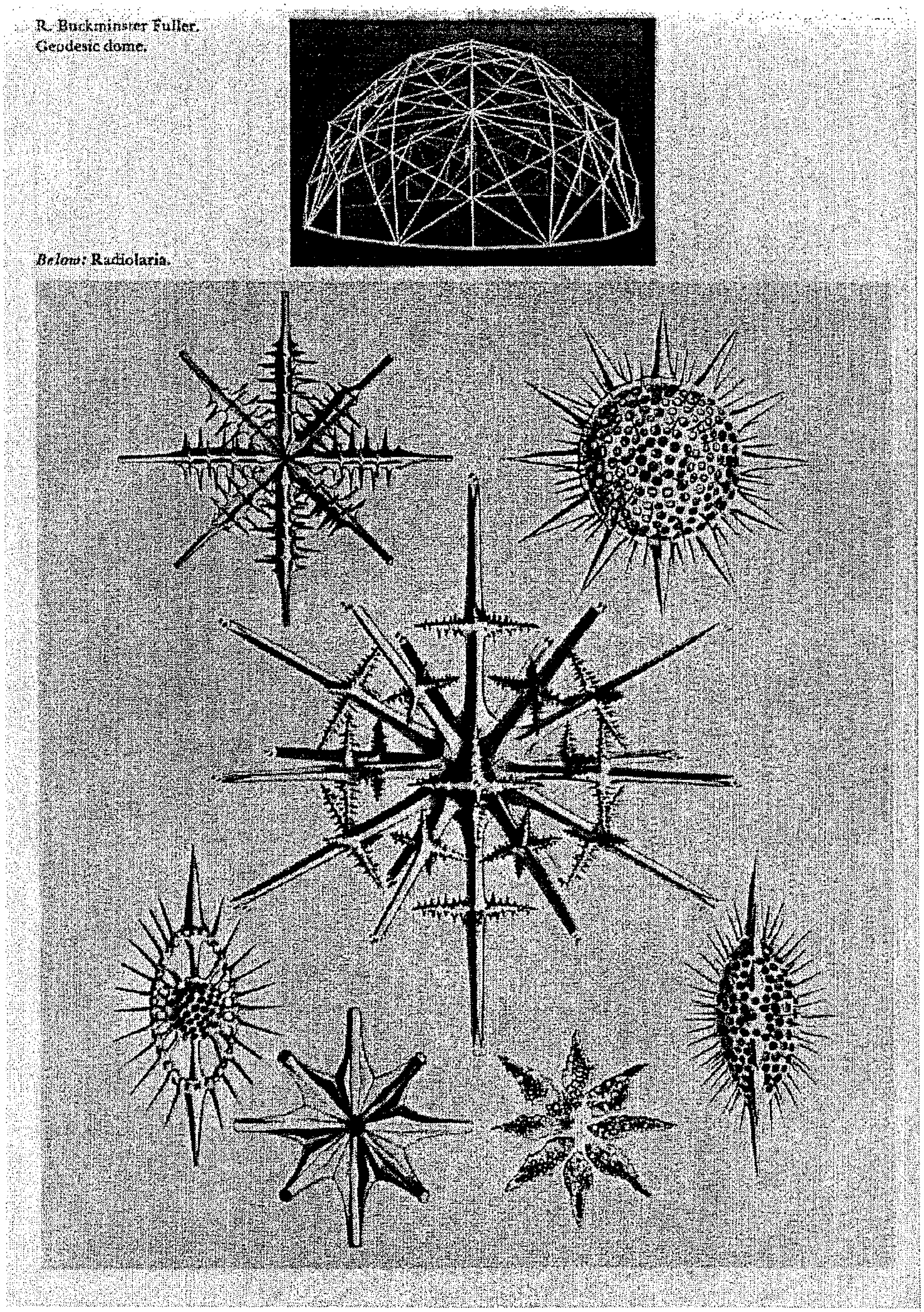


Fig.2.27a Walter Bauersfeld's Carl Zeiss Dome at Jena, ca. 1924. Source: Joachim Krausse, "The Miracle of Jena," *World Architecture*, November 1992, p.46.

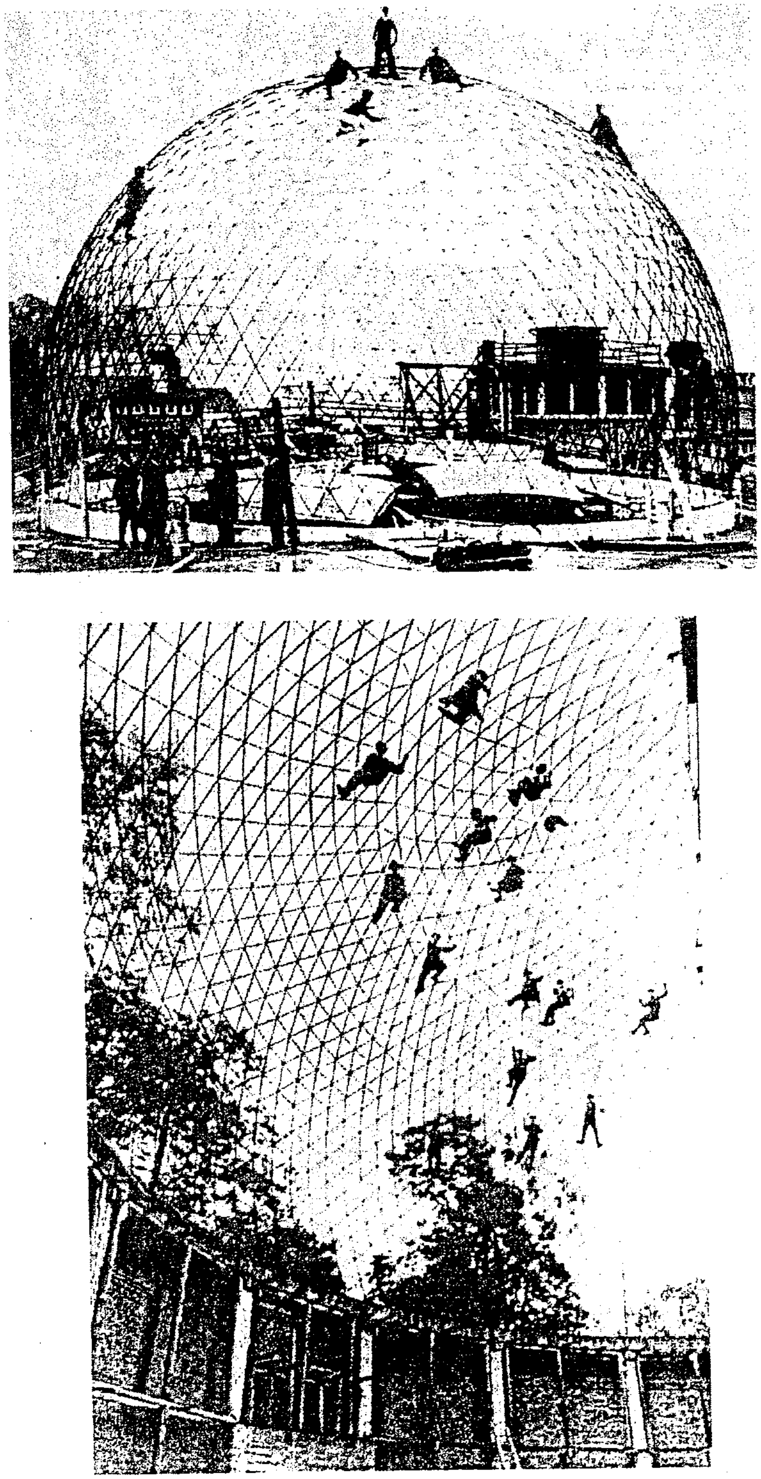
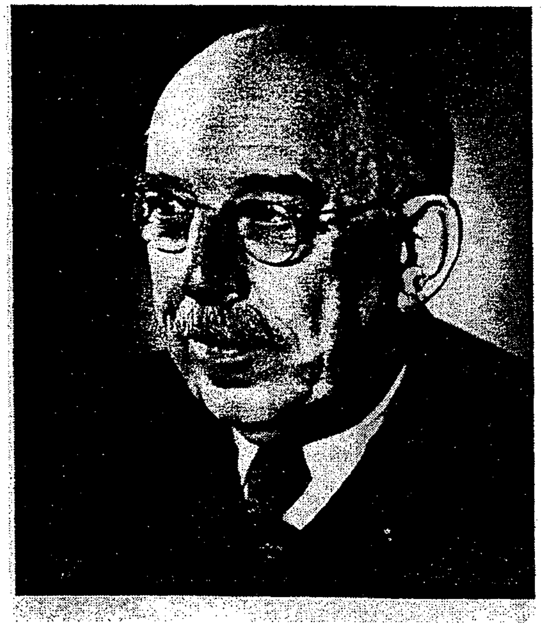


Fig.2.27b Walter Bauersfeld (1879-1960), Director & Chief Engineer of the Optical Works, Carl Zeiss-Jena. Source: Henry C. King, *Geared to the Stars. The Evolution of Planetarium, Orreries and Astronomical Clocks*, p.343.

Fig.2.27c Project machine for planetarium. Carl Zeiss-Jena. Source: Henry C. King, *Geared to the Stars. The Evolution of Planetarium, Orreries and Astronomical Clocks*, p.346.



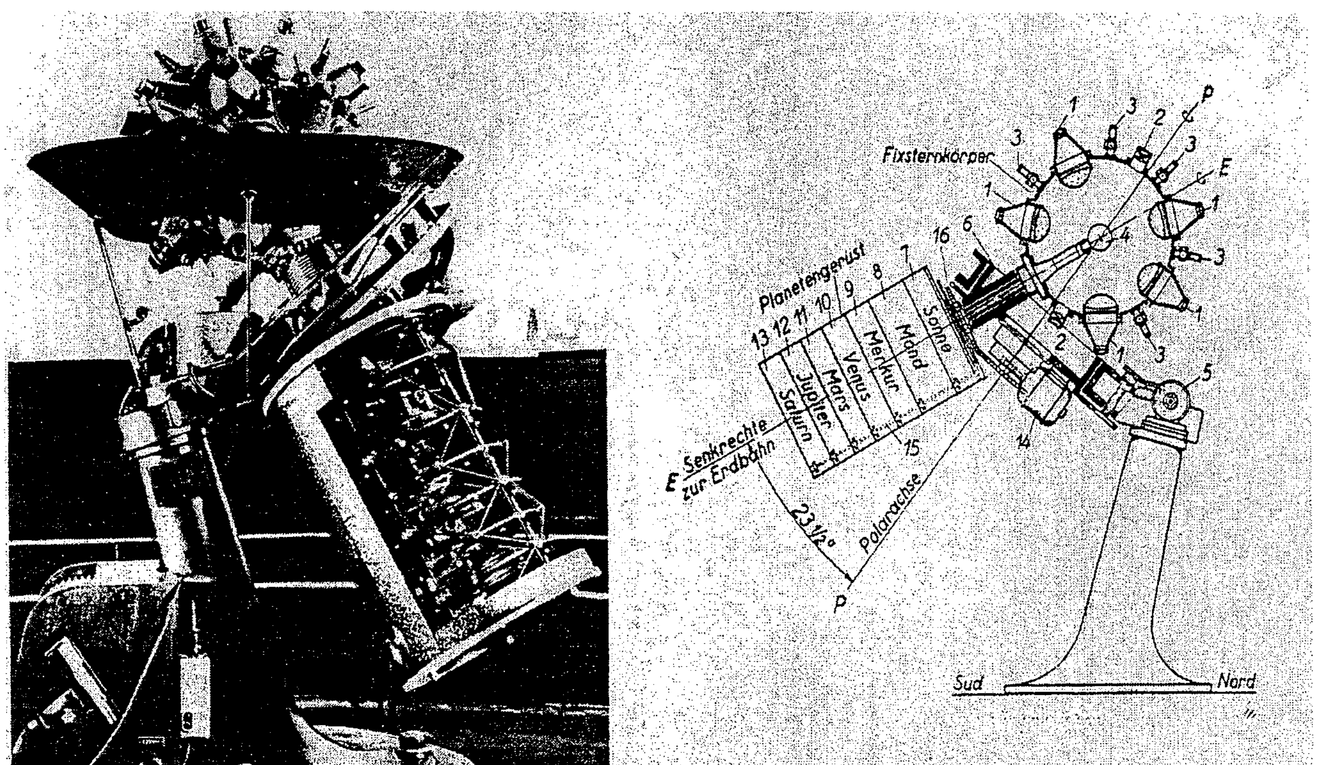


Figure 21.5 The first Zeiss planetarium instrument as set up in

Fig.2.27d Patent for the Zeiss Dome, 9 November 1922. Source: Tony Rothman, *Science á la Mode (Physical Fashions & Fictions)*

DEUTSCHES REICH

AUSGEGEBEN AM 19. JUNI 1925

REICHSPATENTAMT

PATENTSCHRIFT

№ 415395

KLASSE 37a GRUPPE 2

(Z 13458 V/37a)

Firma Carl Zeiss in Jena.

Verfahren zur Herstellung von Kuppeln und ähnlichen gekrümmten Flächen aus Eisenbeton.

Patentiert im Deutschen Reiche vom 8. November 1922 ab.

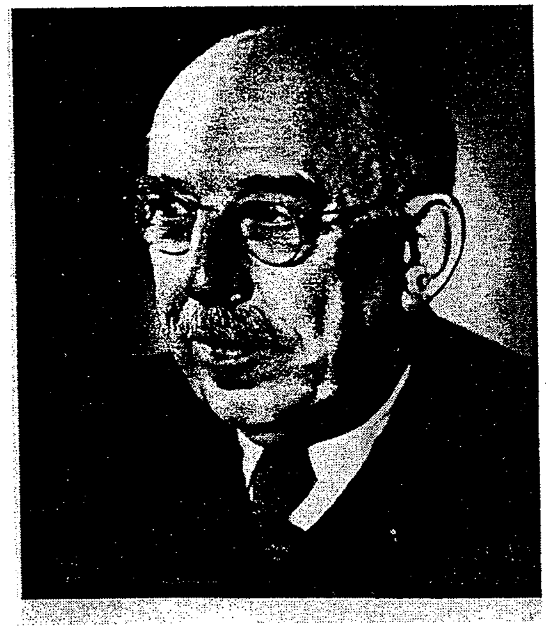
Die vorliegende Erfindung betrifft ein Verfahren zur Herstellung von Kuppeln und ähnlichen gekrümmten Flächen aus Eisenbeton, das sich durch besondere Wohlfeilheit auszeichnet. Das neue Verfahren besteht darin, daß ein sich selbst und einen Teil des Gesamteigengewichts tragendes, in der Dachhaut liegendes räumliches Netzwerk aus Eisenstäben aufgebaut und unter Verwendung leichter, unmittelbar an das Eisenwerk angehängter Schalungen, beispielsweise durch das Spritzverfahren, mit dem zur Erreichung der vollen Tragfähigkeit erforderlichen Betonmantel umhüllt wird. Man braucht nur einen kleinen Teil der Schalung auszuführen und nacheinander an alle Stellen der gekrümmten Fläche zu bringen. Dabei ist diese Teilschalung so an dem Eisengerippe zu verteilen, daß die Eisenstäbe keine wesentlichen Biegungsspannungen bei der Herstellung des Betonmantels erfahren. Durch die Verwendung des bekannten Spritzverfahrens werden neben der Erhöhung der Betonfestigkeit die sonst unvermeidlichen Erschütterungen und Belastungen des Traggerippes und der Schalung bei der Herstellung des Betonmantels vermieden. Bei der Anwendung des neuen Verfahrens erhält daher das Netzwerk auch während der Ausführung des Baues keine nennenswerten Biegungsbeanspruchungen; infolgedessen ist auch bei großen Spannweiten der Aufwand von Eisen verhältnismäßig sehr gering. Ferner wird bei dem neuen Verfahren eine kostspielige Unterrüstung vermieden, an deren Stelle die erwähnten Schalungen treten, und es fallen auch die Ausrüstungsspannungen so gut wie vollständig weg, denen sonst bei der Bemessung der Stärke der Einzelteile Rechnung getragen werden muß.

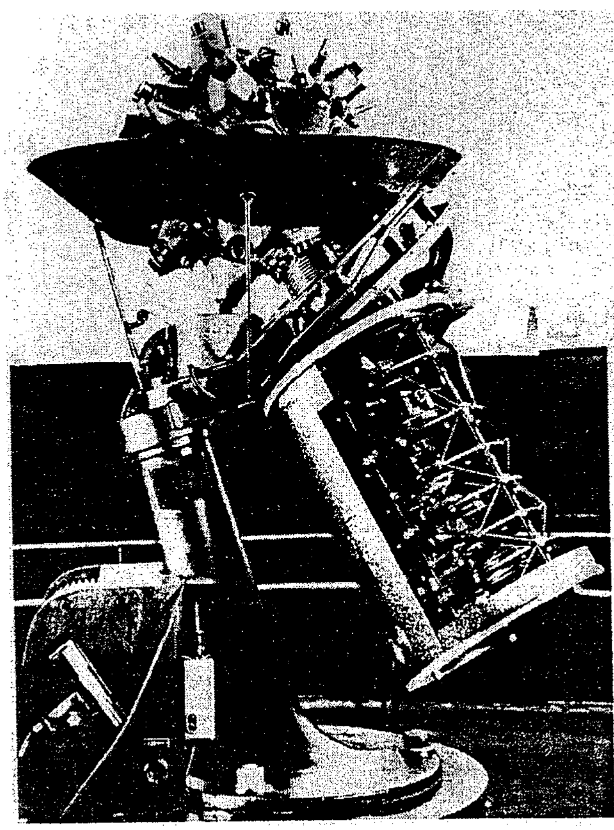
PATENT-ANSPRUCH:

Verfahren zur Herstellung von Kuppeln und ähnlichen gekrümmten Flächen aus Eisenbeton, dadurch gekennzeichnet, daß ein sich selbst und einen Teil des Gesamteigengewichts tragendes, in der Dachhaut liegendes räumliches Netzwerk aus Eisenstäben aufgebaut und unter Verwendung leichter, unmittelbar an das Eisenwerk angehängter und entsprechend dem Fortgang der Arbeiten zu verschiebender Schalungen durch das Spritzverfahren mit dem zur Erreichung der vollen Tragfähigkeit erforderlichen Betonmantel umhüllt wird.

Fig.2.27b Walter Bauersfeld (1879-1960), Director & Chief Engineer of the Optical Works, Carl Zeiss-Jena. Source: Henry C. King, *Geared to the Stars. The Evolution of Planetarium, Orreries and Astronomical Clocks*, p.343.

Fig.2.27c Project machine for planetarium. Carl Zeiss-Jena. Source: Henry C. King, *Geared to the Stars. The Evolution of Planetarium, Orreries and Astronomical Clocks*, p.346.





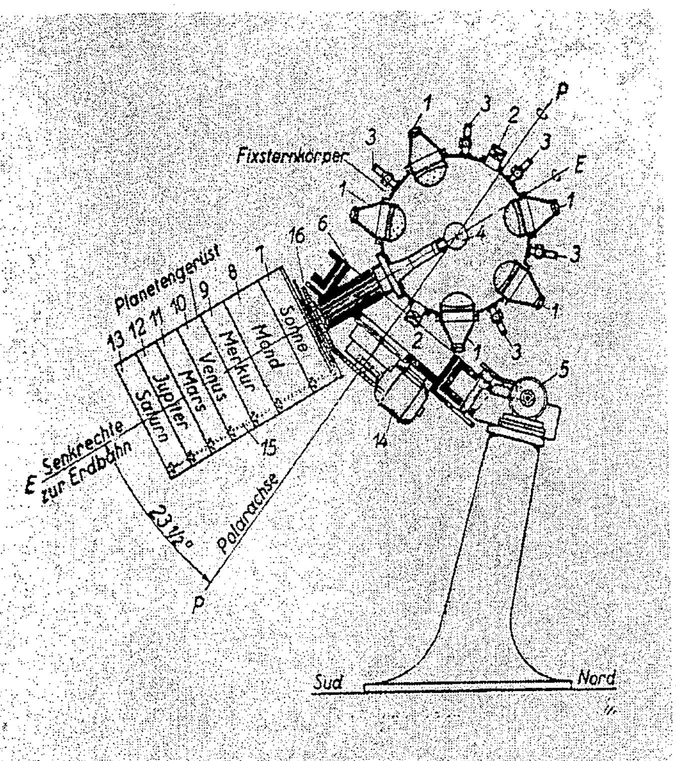


Figure 21.5 The first Zeiss planetarium instrument as set up in

Fig.2.27d Patent for the Zeiss Dome, 9 November 1922. Source: Tony Rothman, *Science á la Mode (Physical Fashions & Fictions)*

DEUTSCHES REICH

Nr. 28/26

AUSGEGEBEN AM 19. JUNI 1925

REICHSPATENTAMT

PATENTSCHRIFT

№ 415395

KLASSE 37a GRUPPE 2

(Z 13458 V/37a)

Firma Carl Zeiss in Jena.

Verfahren zur Herstellung von Kuppeln und ähnlichen gekrümmten Flächen aus Eisenbeton.

Patentiert im Deutschen Reiche vom 9. November 1922 ab.

Die vorliegende Erfindung betrifft ein Verfahren zur Herstellung von Kuppeln und ähnlichen gekrümmten Flächen aus Eisenbeton, das sich durch besondere Wohlfeilheit auszeichnet. Das neue Verfahren besteht darin, daß ein sich selbst und einen Teil des Gesamteigengewichts tragendes, in der Dachhaut liegendes räumliches Netzwerk aus Eisenstäben aufgebaut und unter Verwendung leichter, unmittelbar an das Eisenwerk angehängter Schalungen, beispielsweise durch das Spritzverfahren, mit dem zur Erreichung der vollen Tragfähigkeit erforderlichen Betonmantel umhüllt wird. Man braucht nur einen kleinen Teil der Schalung auszuführen und nacheinander an alle Stellen der gekrümmten Fläche zu bringen. Dabei ist diese Teilschalung so an dem Eisengerippe zu verteilen, daß die Eisenstäbe keine wesentlichen Biegungsspannungen bei der Herstellung des Betonmantels erfahren. Durch die Verwendung des bekannten Spritzverfahrens werden neben der Erhöhung der Betonfestigkeit die sonst unvermeidlichen Erschütterungen und Belastungen des Traggerippes und der Schalung bei der Herstellung des Betonmantels vermieden. Bei der Anwendung des neuen Verfahrens erhält daher das Netzwerk auch während der Ausführung des Baues keine nennenswerten Biegungsbeanspruchungen; infolgedessen ist auch bei großen Spannweiten der Aufwand von Eisen verhältnismäßig sehr gering. Ferner wird bei dem neuen Verfahren eine kostspielige Unterrüstung vermieden, an deren Stelle die erwähnten Schalungen treten, und es fallen auch die Ausrüstungsspannungen so gut wie vollständig weg, denen sonst bei der Bemessung der Stärke der Einzelteile Rechnung getragen werden muß.

Patent-Anspruch:

Verfahren zur Herstellung von Kuppeln und ähnlichen gekrümmten Flächen aus Eisenbeton, dadurch gekennzeichnet, daß ein sich selbst und einen Teil des Gesamteigengewichts tragendes, in der Dachhaut liegendes räumliches Netzwerk aus Eisenstäben aufgebaut und unter Verwendung leichter, unmittelbar an das Eisenwerk angehängter und entsprechend dem Fortgang der Arbeiten zu verschiebender Schalungen durch das Spritzverfahren mit dem zur Erreichung der vollen Tragfähigkeit erforderlichen Betonmantel umhüllt wird.

Fig.2.27e Comparison of Walter Bauersfeld's Carl Zeiss Dome-Jena patent & Fuller's 1954 patent.
Source: Joachim Krausse, "The Miracle of Jena," *World Architecture*, November 1992, p.53.

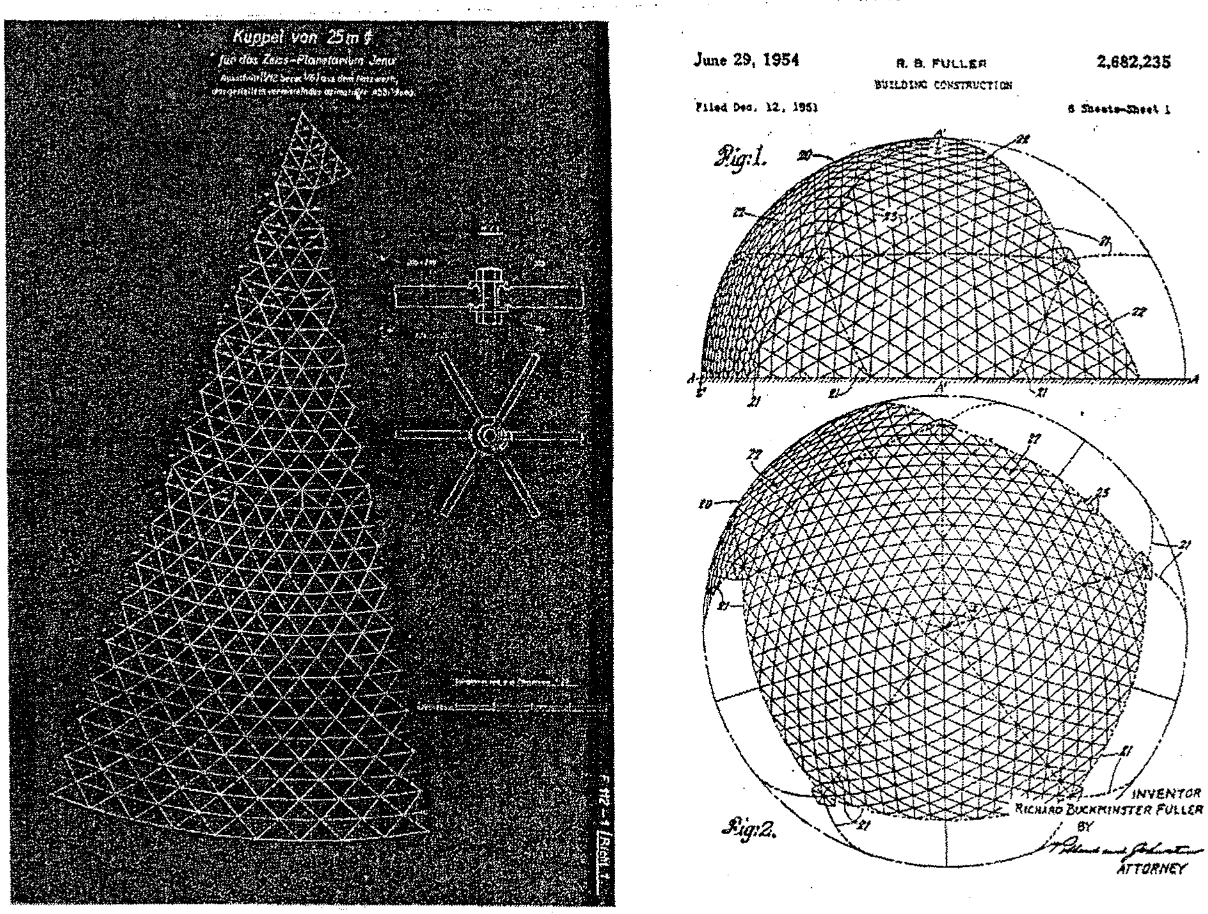


Fig.2.27f Interior of Barnes Willis' R-110 airship & the Wellington bomber. Source: "Artist or Engineer?" *Journal of the Society of Industrial Artist*, [?date] p.7.

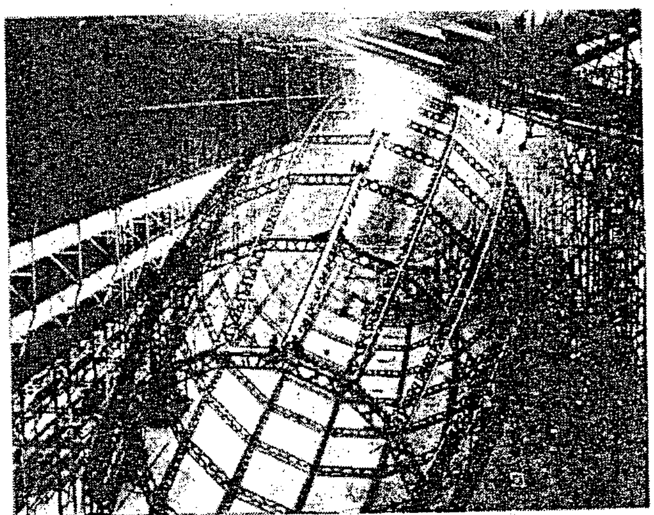
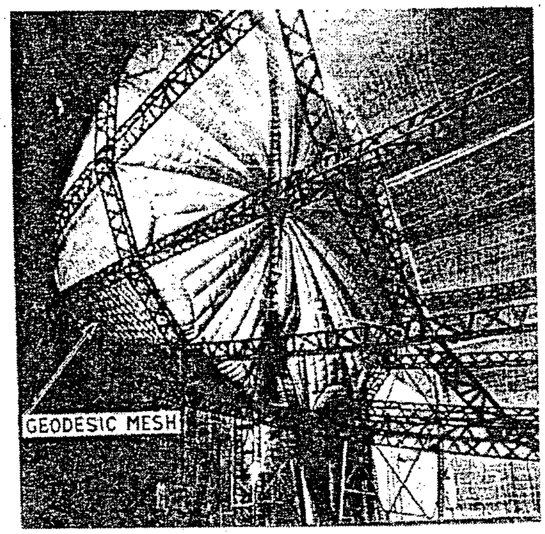


Figure 1. *Hull structure of the airship R.100*



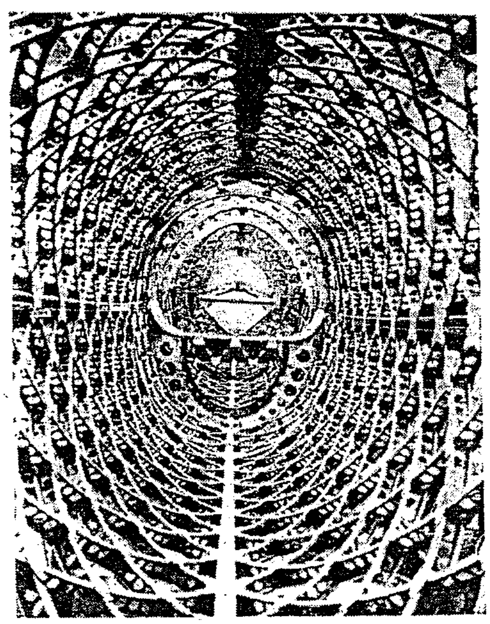


Fig.2.27g Structural experimentations of Robert Le Ricolais. Source: "Contribution to Space Structures," *Student Publication NCSC*, Vol.3, No.3, Spr. 1953, pp.1-15.

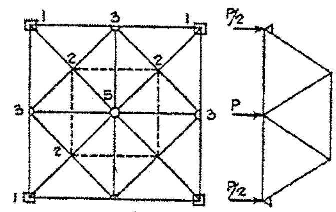


Figure 15

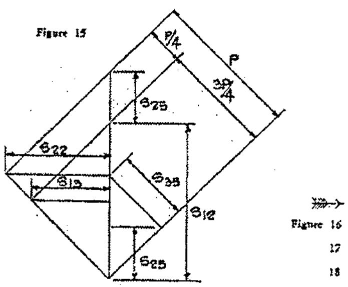


Figure 16

17

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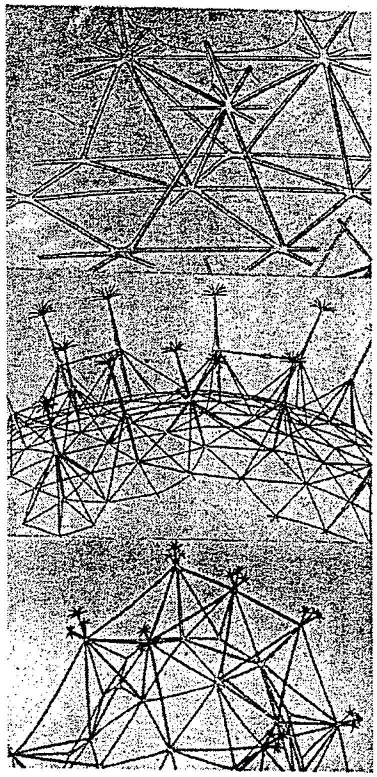
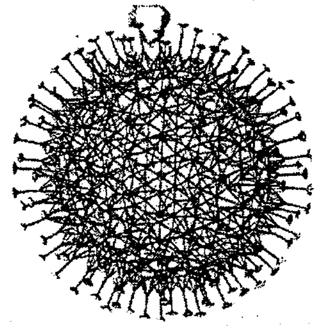
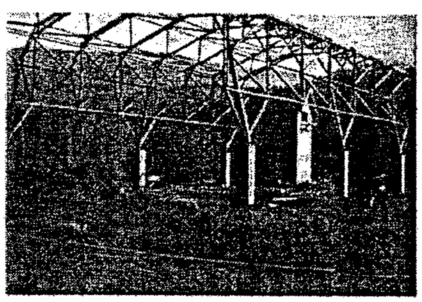




FORMES IMAGINÉES FORMES CONCRÈTES

PAR ROBERT LE RICOLAIS



R. LE RICOLAIS

Figure 20

Thus far limited budgets have restricted these experiments to timber but the system appears adaptable to other materials as well. The use of steel should be advantageous, since the continuity at the connections could be obtained through welded joints. Caution should be noted regarding secondary moments involved in that particular instance, and the structure should be calculated as a rigid frame.

This solution based on the property of paraboloids of revolution intersected by parallel vertical planes results in a minimum number of bars of different length, together with an unique type of joint. In the near future, when synthetic materials will be available for roofing purposes, propositions of this kind may be worthy of closer investigations.

As a final comment, we will caution designers against considering 3 dimensional networks as capable of solving all problems with unequalled efficiency. Extrapolation in the possibilities of new systems or new materials are always full of risks and dangers. It is certainly true that this technique belongs to a scale exceeding our present need in building, and presently the restrictions lie in the increased labor involved in the connections. In this respect, we will conclude in saying that the choice of a correct modulus for cell unit is likely to decide the economic factor in function of the type of building wanted. This somewhat common place assertion is particularly important in 3 dimensional design.

R. Le Ricolais
Paris, France
December, 1952

Figure 19

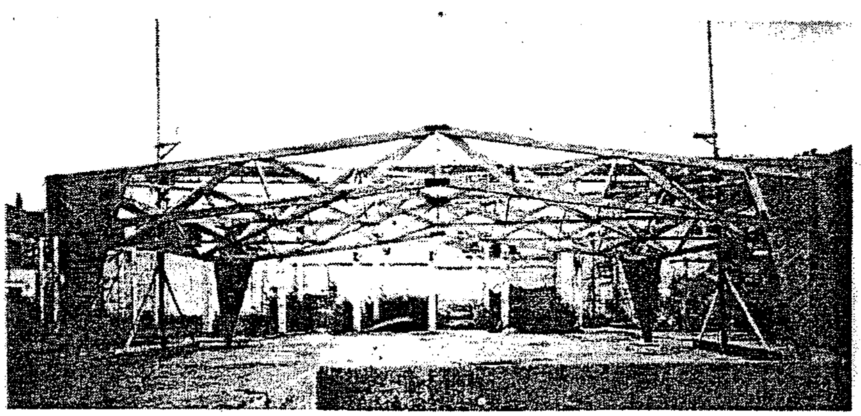
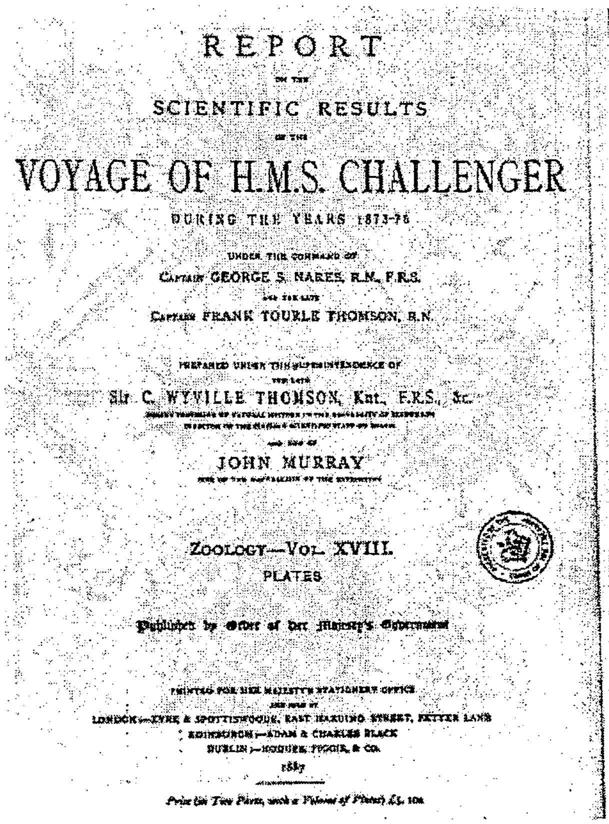


Fig.2.27h Zoological plates. Source: Voyage of *H.M.S. Challenger* [ca.1887].


REPORT
ON THE
SCIENTIFIC RESULTS
OF THE
VOYAGE OF H.M.S. CHALLENGER
DURING THE YEARS 1873-76
UNDER THE COMMAND OF
CAPTAIN GEORGE S. NARES, R.N., F.R.S.
AND THE LATE
CAPTAIN FRANK TOURLE THOMSON, R.N.
PREPARED UNDER THE SUPERINTENDENCE OF
THE LATE
SIR C. WYVILLE THOMSON, Knt., F.R.S., &c.
AND NOW OF
JOHN MURRAY
ZOOLOGY—VOL. XVIII.
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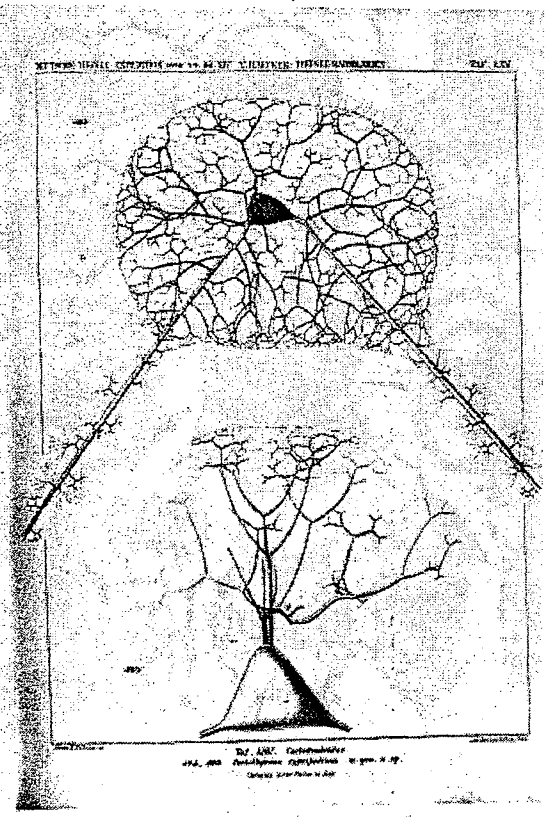
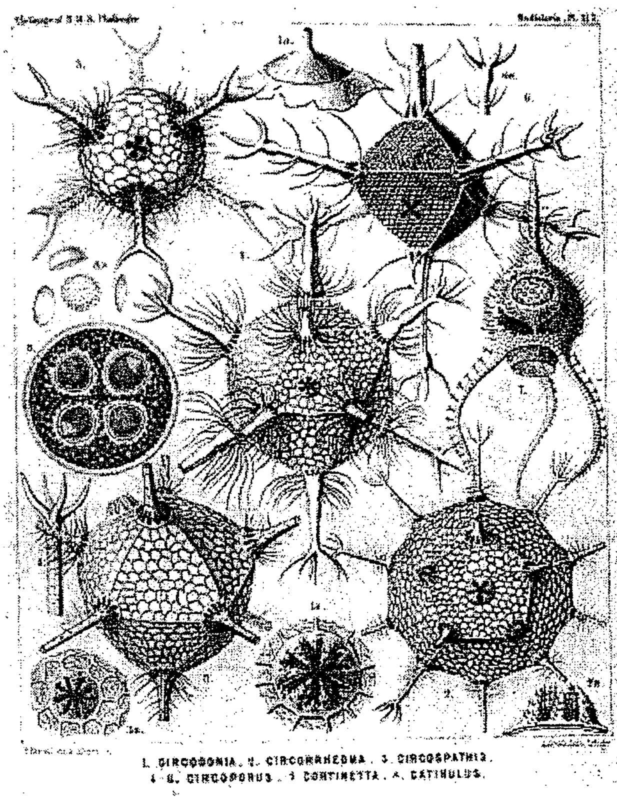




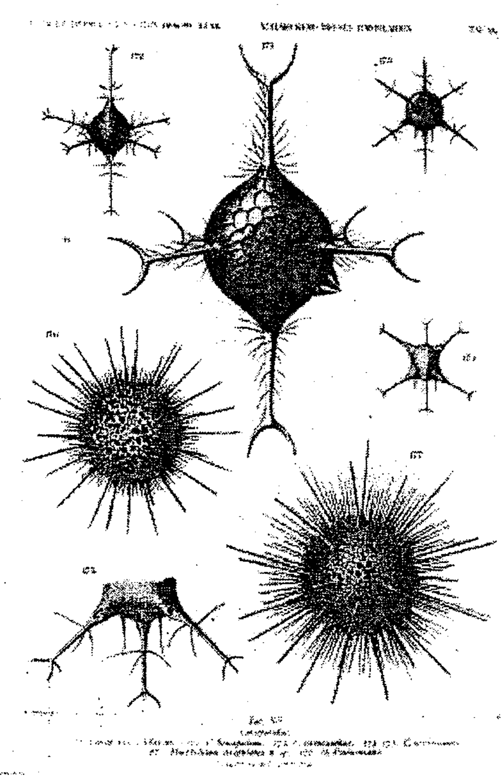
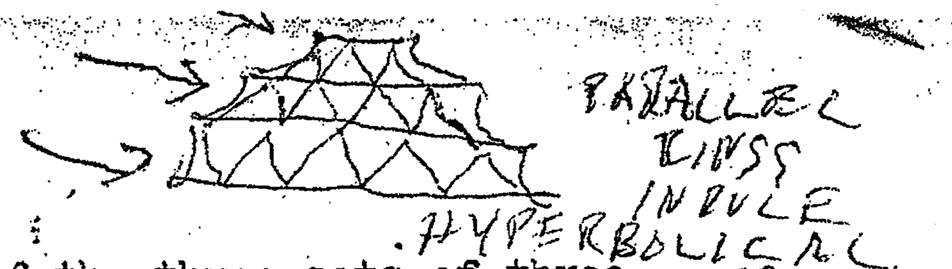


Fig.2.27i Fuller's sketch of a later Zeiss dome, with explanation: "Parallel rings induce hyperbolical para(boliod) interlacing (therefore) induce Jap(anese) lantern foldability". Source: Ltr. 9/12/59 RBF to D. Robertson in BFI-CR256



that one of the three sets of three-
ystem are in parallel, the third side
een voided for the system. Two sides
y unstable. This is why the Jena or
y useful as tension systems when com-
pressional means of keeping them from
the mast acts as the spreader. In Jena
regate acts as the compressional

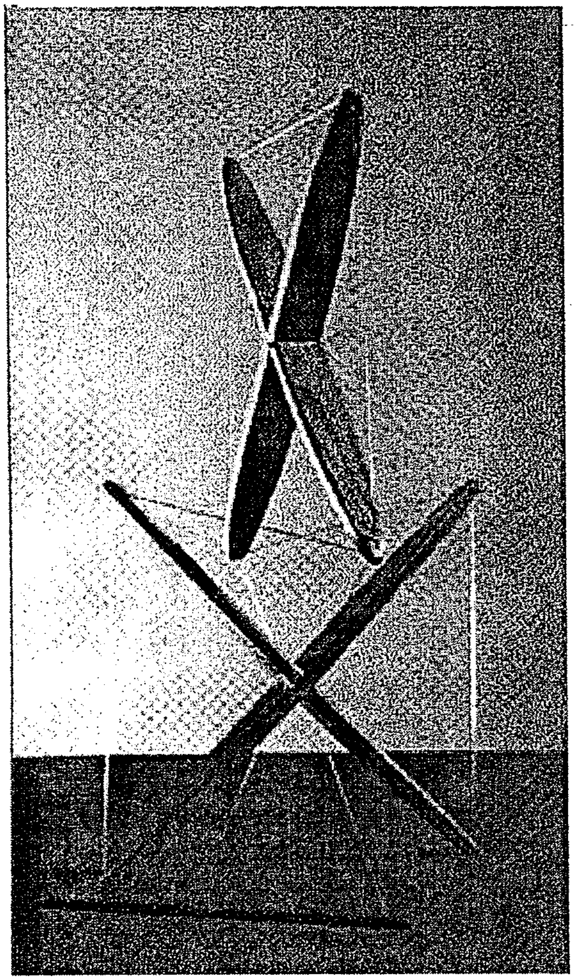
Fig.2.28a Kenneth Snelson installing "Floating compression" aluminum sculpture, New York World's Fair. Source: "Artist Designs 30-Legged Giant For Utility Exhibition at Fair," *The New York Times*, 28 January 1964.

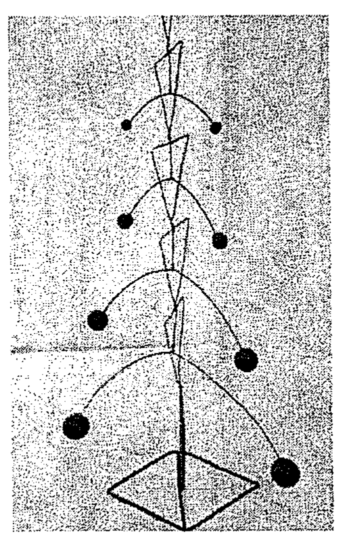
Fig.2.28b Kenneth Snelson's "Plywood X-Piece (#3)," ca. June 1949. Source: Ltr. ca. Nov.1990 to R. Motro , retrieved from Kirby Urner's "Synergetics on the Web" [http://www.teleport.com/~pdx4d/snelson.html] August 6 1996.

The New York Times

SCULPTURE IN ALUMINUM: "Floating compression," fashioned from aluminum tubing, is inspected by its sculptor, Kenneth Snelson. Structure will be shown in the Electric Power and Light Company exhibit at World's Fair.

Artist Designs 30-Legged Giant For Utility Exhibition at Fair





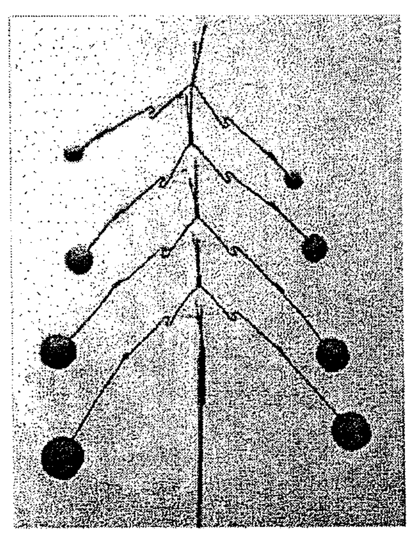
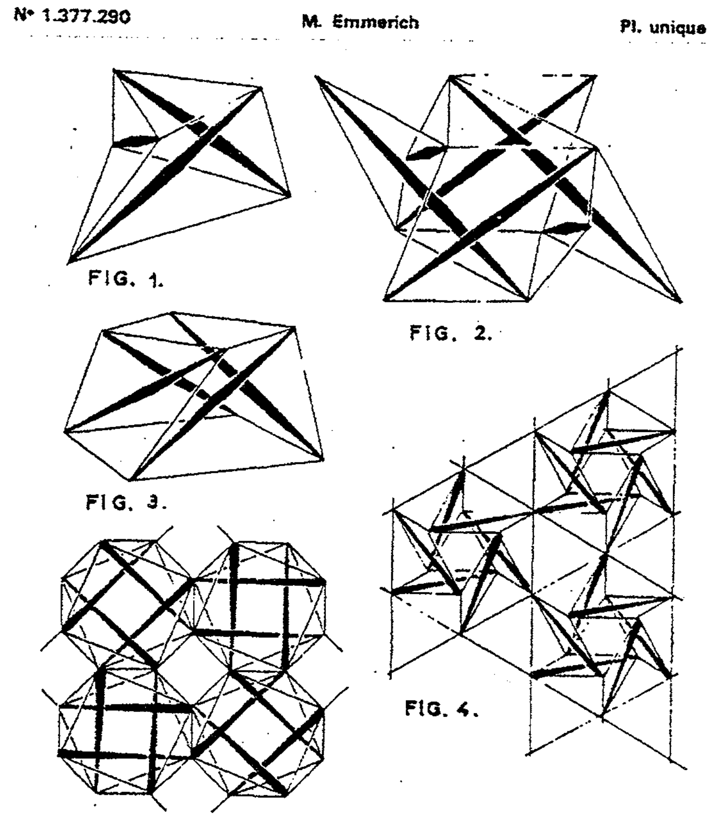


Fig.2.28c "Tensegrity" patents. **1**: D. G. Emmerich's patent. **2**: Snelson's U.S. Patent #3,169,611 entitled "Continuous Tension, Discontinuous Compression Structures." <u>Sources</u>: "Snelson on the Tensegrity Invention," *International Journal of Space Structures*, Vol.11 No.1 &2, 1996:233-239 & 43-48.



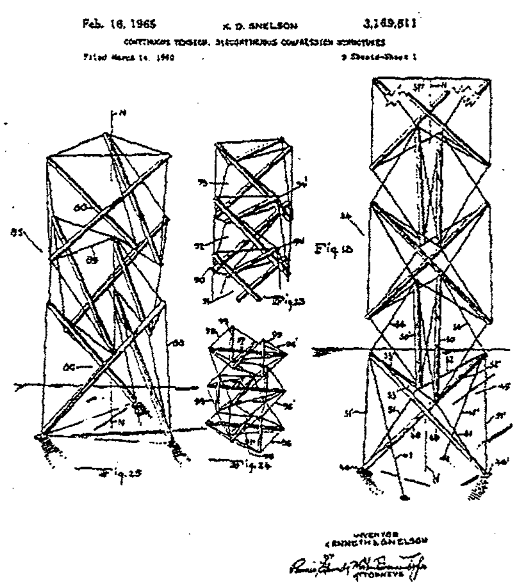
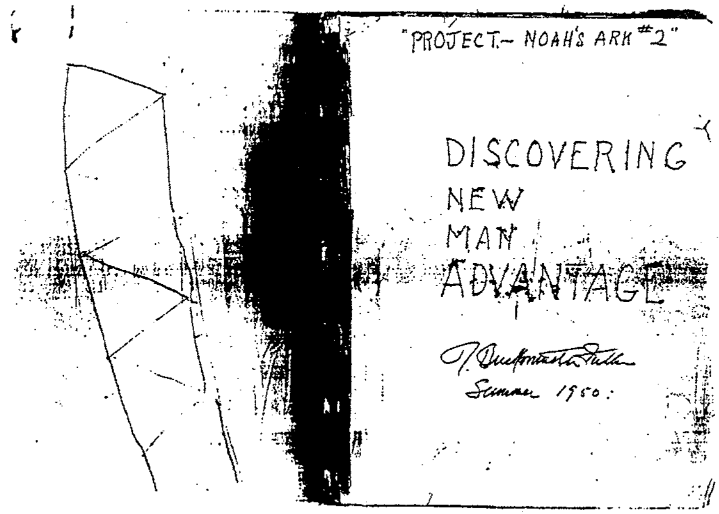


Fig.2.29a Three-way Geodesic grid. Source: R. B. Fuller, "Project - Noah's Ark 2," ca. August 1950, BFI-MSS.



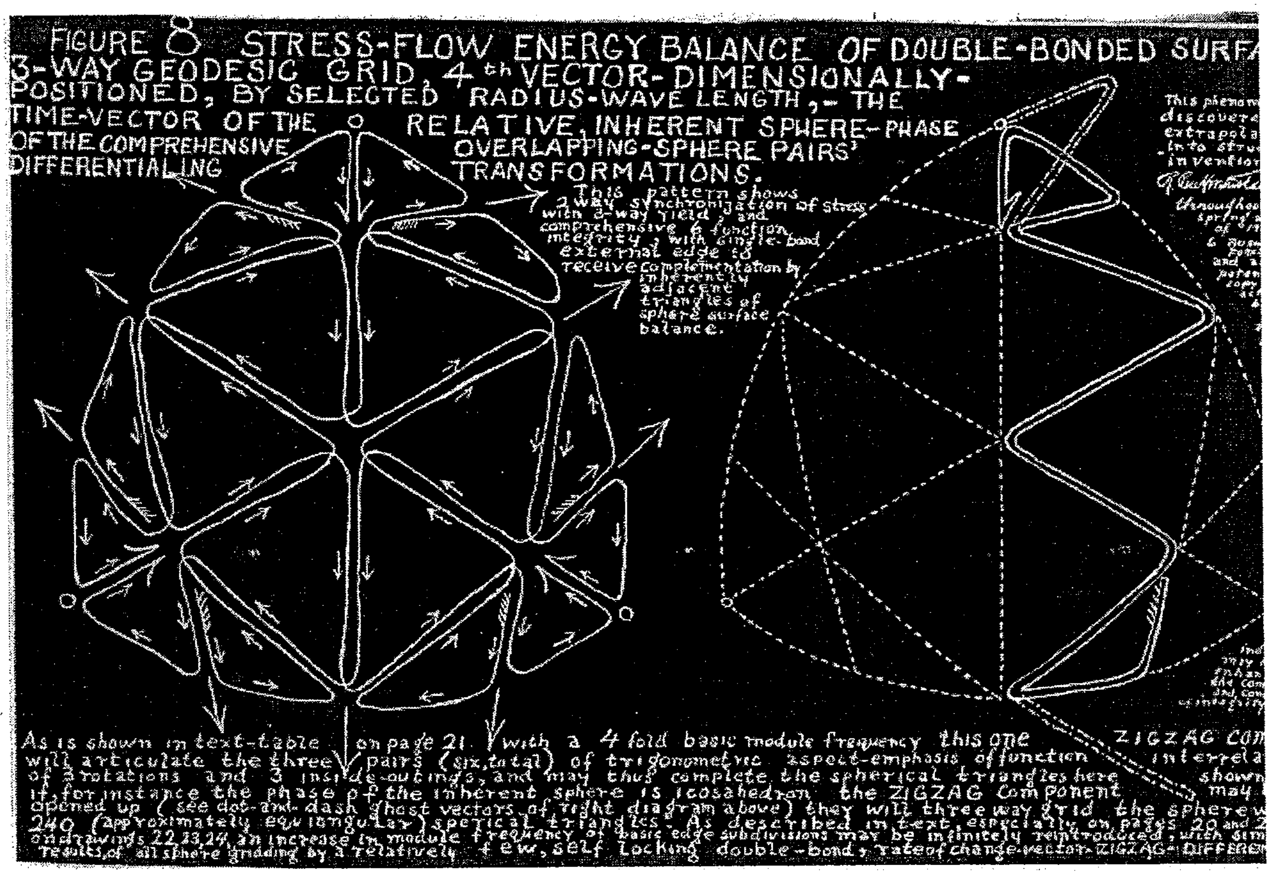
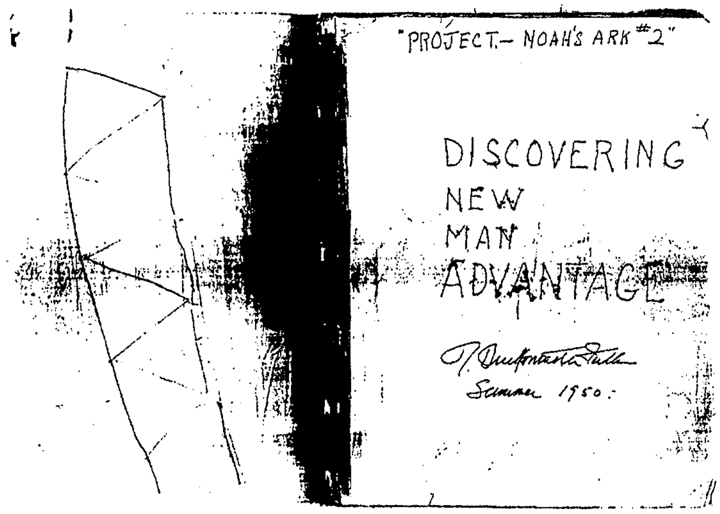
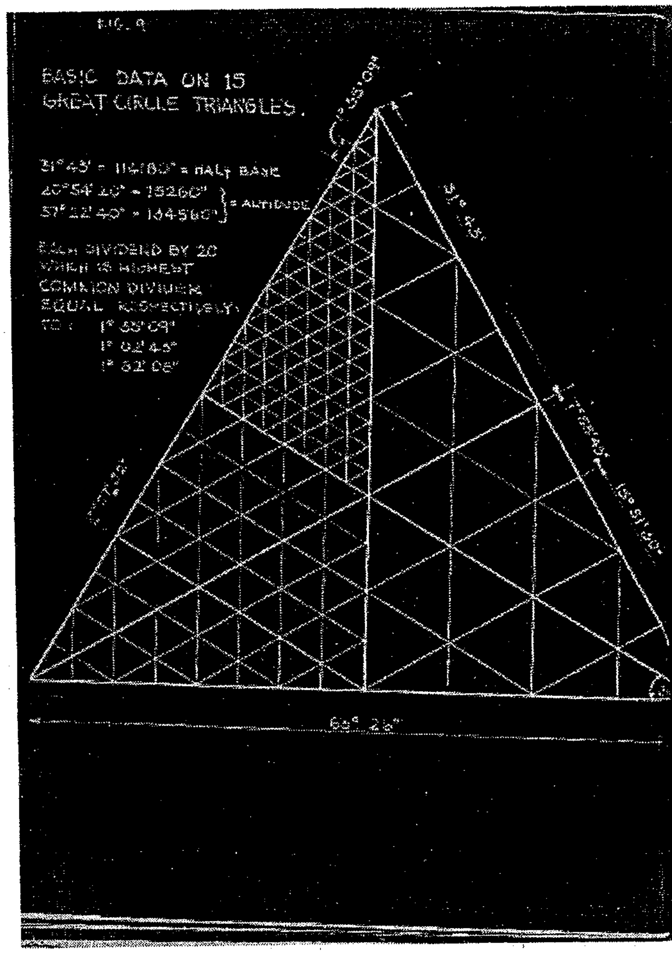


Fig.2.29b Basic Data on 15-Great Circle Triangles. Source: R.B. Fuller, "Project - Noah's Ark 2," ca. August 1950. BFI-MSS.





11

[illegible] refering to our model and its articulatable triangle, we see three phases of its expanding surface development, of its proportion of the whole spherical surface as in figures 8a,b,c,d, and particularly refering to a,b,c looking successively the triangle as one face of the spherical icosahedron, then of the octahedron, and then of the tetrahedron, it is to be noted that as the spherical equiangular triangles are all subdivided primarily into the 6 identical (3 insideout, 3 outsideout) right triangles, and inasmuch as in each case the angle at the midedge great circle intersection is always 90 degrees of surface vertex angle and, inasmuch as the three great circles crossing at the center of gravity of the surface of the basic equiangle triangle is always productive of 6, 60 degree surface vertex angles, and that this is true all throughout the expansive transformations at 180 degree angle phase et al, that the two angles of each of the six primary triangles subdividing the basic equiangular triangle are CONSTANT angles, therefore the third angle of the progressive sets of primary subdivision into right spherical triangles reflects the transformative variable, uniquely, as throughout energetic geometry the angles remain the basic constants and the relative magnitudes of edges vary, and in the transformation interactions we seek to identify the variable in angles which specifically identify rate of transformative change and establish the basic curves of reference. In the 8a,b,c,d figures the third, or basic vertex (of surface) angle, of the three equiangles of the basic triangles, primary right triangles angle, under consideration read progressively 36 degrees, 45 degrees, 60 degrees, and 90 degrees. These four readings may be compared to the plane right triangle [illegible] lesser angle of 30 degrees for a 30-60 right triangle, in the flat or zero inflection phase of transformations. As figures 8 a,b,c, and d (?) represent the complete hierarchy and order of sequence of the spherical subdivisions in-to identical equiangular triangles of 20 faces, 8 faces, 4 faces, and 2 faces respectively, and 2 faces is the insideoutin inflection phase, which reads thereafter inside out 4 faces, insideout 8 faces, and inside-out 20 faces, we see that the maxima minima inside out-ing is the zone of infinity faces, in which the flat triangle is the readable value, and therefore 30 degrees equals zero, and the rate of change for the overall transformation sequence of phases is [illegible] 0-6-15-30-60-30-15-6-0 as half a wave cycle and the other half reverses back to 0, again. *As the edge length of our basic steel triangle were [illegible] and the rod-radii lengths varied this rate of change referes to the pulsative [illegible]

So relatively slight is the angular distortion at the icosahedron stage (6 degrees) that the internal threeway griding of the icosa's 6 primary subdivisions reduces the overall variable topological component limits to the minimum obtainable in the structural aspect of the comprehensive INDUSTRIAL LOGISTICS problem; and the ability to continually further subdivide with always less variation of the size and shape [illegible] remembered, than was resultant to the last previous subdivision, back to the first such sub-division as provided by our 3way griding generated by the uniform boundary scale subdivision.

It is clearly evidenced that in the icosa's combination with the 6way great circle grid an advantage of maximum degree from an industrial logistics viewpoint is arrived at which may be applied to structural enclosure problems of high variable stress from the smallest to ones so large as never heretofore to be considered being previously impractical of conception and without the bounds of imagining such for instance as is now practical in the threeway grid icosa-geodesic of for instance the enclosure of a whole city within one sky control with a myriad of new and hitherto uncontemplated integrating energy balance gains.

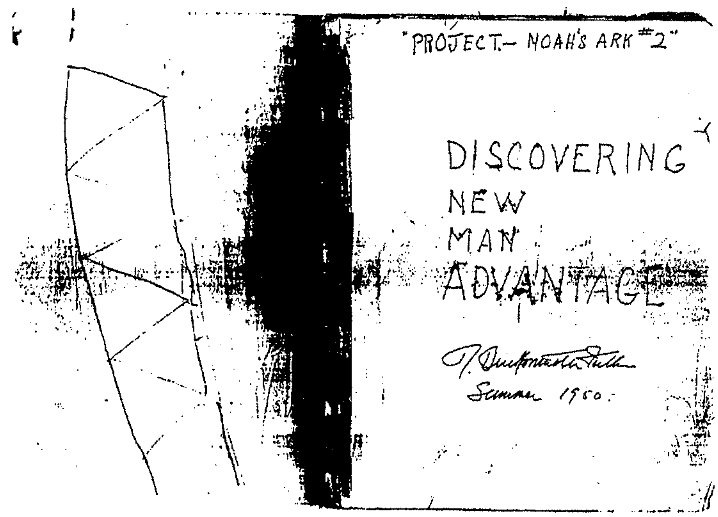
In respect to any given industrial materials, available through priority expediency, in respect to any given structural enclosure task, the tactical factors of design realization consist in the specific amount of the uniform boundary arc subdivision of the basic icosa's spherical triangle, and will be determined by the span and interstice sizes desirable for optimum employment of the physical properties of the expediently available chemical elements of the latters compounding, alloying, and strength treating, and the industrial fabricating dimensional standards and other factors of realization previously outlined. For instance the skinning in of structures is dependent upon the

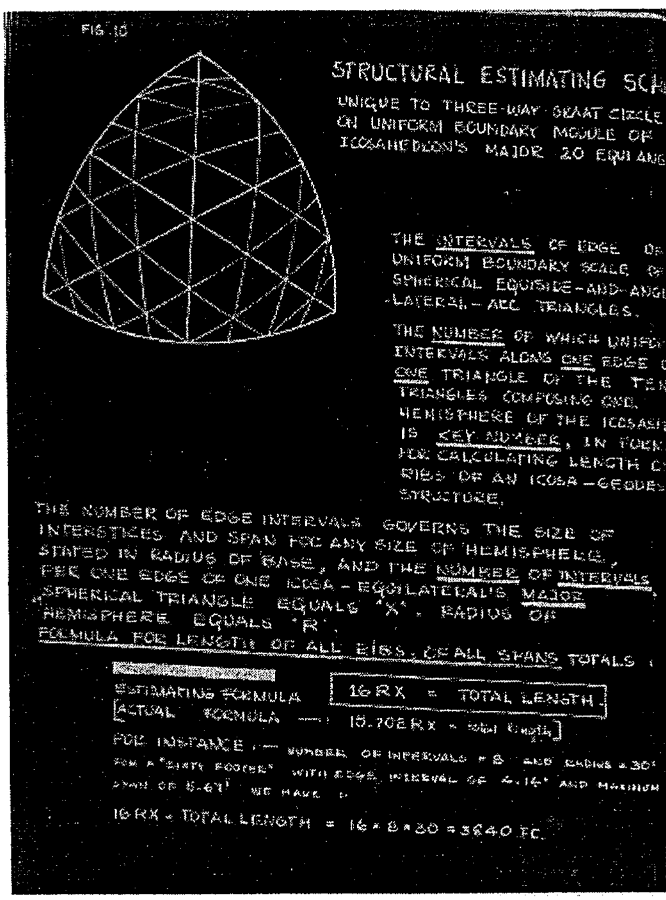
(to next page)

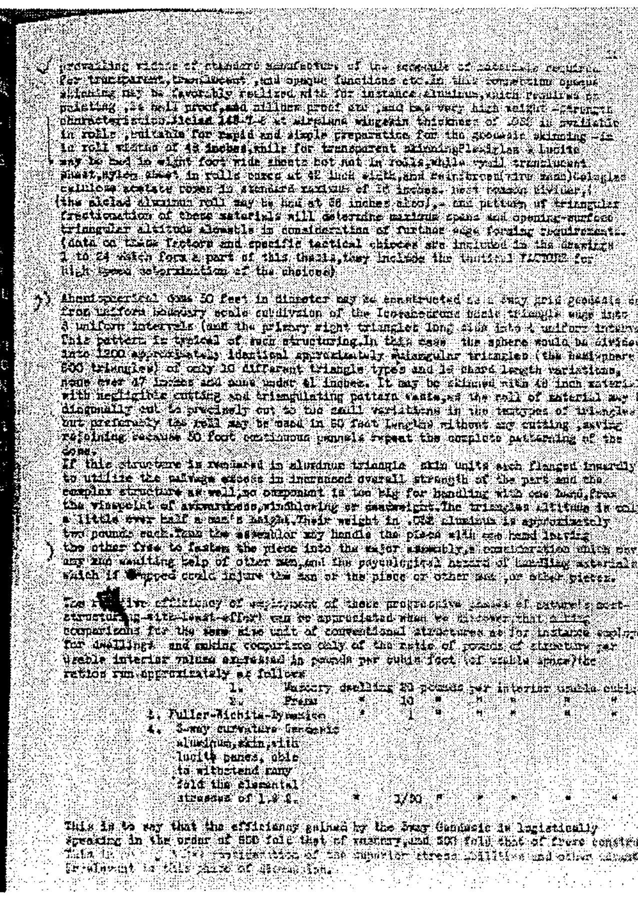
foot note

* while the nuances of the 0 end of the pulsating cycle above referred to are matter for treatment elsewhere it must be noted that after the icosa 6 phase the dymaxion spherical 6 degrees [illegible] than the dymaxion sequence [illegible] 0 complete the [illegible]

Fig.2.29c Structural Estimating Scheme. Source: R.B. Fuller, "Project - Noah's Ark 2," ca . August 1950, BFI-MSS.







prevailing widths of standard manufacture of the [illegible] of materials required for transparent, translucent, and opaque functions etc. In this connection opaque skinning may be favorably realized with for instance aluminum, which requires no painting, is hail proof, and mildew proof etc., and has very high weight-strength characteristics. Alclad [illegible] at airplane wingskin thickness of .032 is available in rolls, suitable for rapid and simple preparation for the geodesic skinning - in roll widths of 48 inches, while for transparent skinning Plexiglas & lucite may be had in eight foot wide sheets but not in rolls, while [illegible] translucent sheet, nylon sheet in rolls comes at 42 inch width, and reinforced (wire mesh) [illegible] cellulose acetate comes in standard maximum of 36 inches. [illegible] (the alclad aluminum roll may be had at 66 inches also), - the pattern of triangular fractionation of these materials will determine maximum spans and opening-surface triangular altitude allowable in consideration of further edge forming requirements. (data on these factors and specific tactical choices are included in the drawings 1 to 24 which form a part of this thesis, they include the [illegible] FACTORS for high speed determination of the choices)

A hemispherical dome 50 feet in diameter may be constructed as a 3way grid geodesic [illegible] from uniform boundary scale subdivision of the Icosahedrons basic triangle edge into 8 uniform intervals (and the primary right triangles long side into 4 uniform intervals). This pattern is typical of such structuring. In this case the sphere would be divided into 1200 approximately identical approximately equiangular triangles (the hemisphere 600 triangles) of only 10 different triangle types and 14 chord length variations, none over 47 inches and none under 41 inches. It may be skinned with 48 inch material with negligible cutting and triangulating pattern waste, as the roll of material may be diagonally cut to precisely cut to the small variations in the [illegible] of triangles, but preferably the roll may be used in 50 foot lengths without any cutting, saving rejoining because 50 foot continuous pannels repeat the complete patterning of the dome.

If this structure is rendered in aluminum triangle skin units each flanged inwardly to utilize the salvage excess in increased overall strength of the part and the complex structure as well, no component is too big for handling with one hand, from the viewpoint of awkwardness, windblowing or deadweight. The triangles altitude is only a little over half a man's height. Their weight in .032 aluminum is approximately two pounds each. Thus the assembler may handle the piece with one hand leaving the other free to fasten the piece into the major assembly, a consideration which [illegible] any man waiting help of other men, and the psychological hazard of handling materials which if dropped could injure the man or the piece or other men, or other pieces.

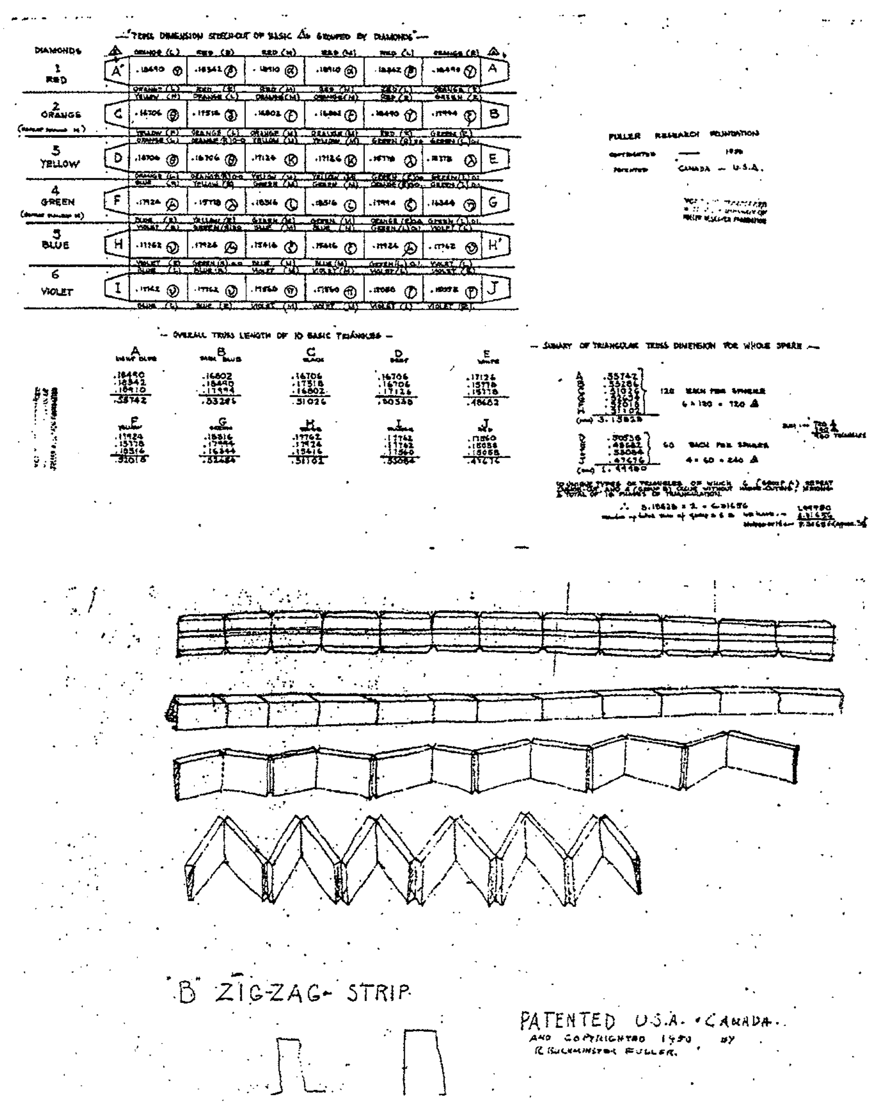
The [illegible] efficiency of employment of these progressive phases of nature's [illegible] structuring-with-least-effort) can be appreciated when we discover that [illegible] comparisons for the same size unit of conventional structures as for instance employed for dwellings and making comparison only of the ratio of pounds of structure per usable interior volume expressed in pounds per cubic foot (of usable space) the ratios run approximately as follows

1.	Masonry dwelling	20	pounds per interior usable cubic [illegible]
2.	Frame	10	" " " " "
3.	Fuller-Wichita-Dymaxion	1	" " " " "
4.	3-way curvature Geodesic aluminum, skin, with lucite panes, able to withstand many fold the elemental stresses of 1, & 2.	1/30	" " " " "

This is to say that the efficiency gained by the 3way Geodesic is logistically speaking in the order of 600 fold that of masonry, and 300 fold that of frame construction [illegible] realization of the superior stress [illegible] and other [illegible] [illegible] in this phase of [illegible].

Fig.2.30a "Zig-zag" schema for "trussed geodesic". Source: J. Ward., ed., The Artifacts of R. Buckminster Fuller, Vol.3, p.48.1-2.

Fig.2.30b Strip patterns for "Zig-zag" schema. Source: J. Ward., ed., The Artifacts of R. Buckminster Fuller, Vol.3, p.49.1.



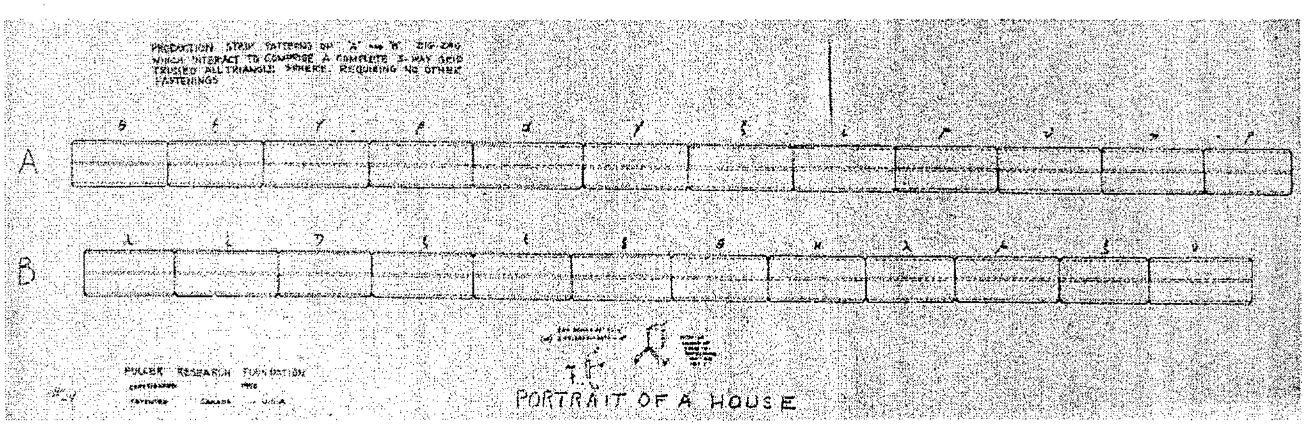


Fig.2.30c "High-speed expanding, skinned & trussed 3-way geodesic structure," Source: J. Ward., ed., The Artifacts of R. Buckminster Fuller, Vol.3, p.46.2

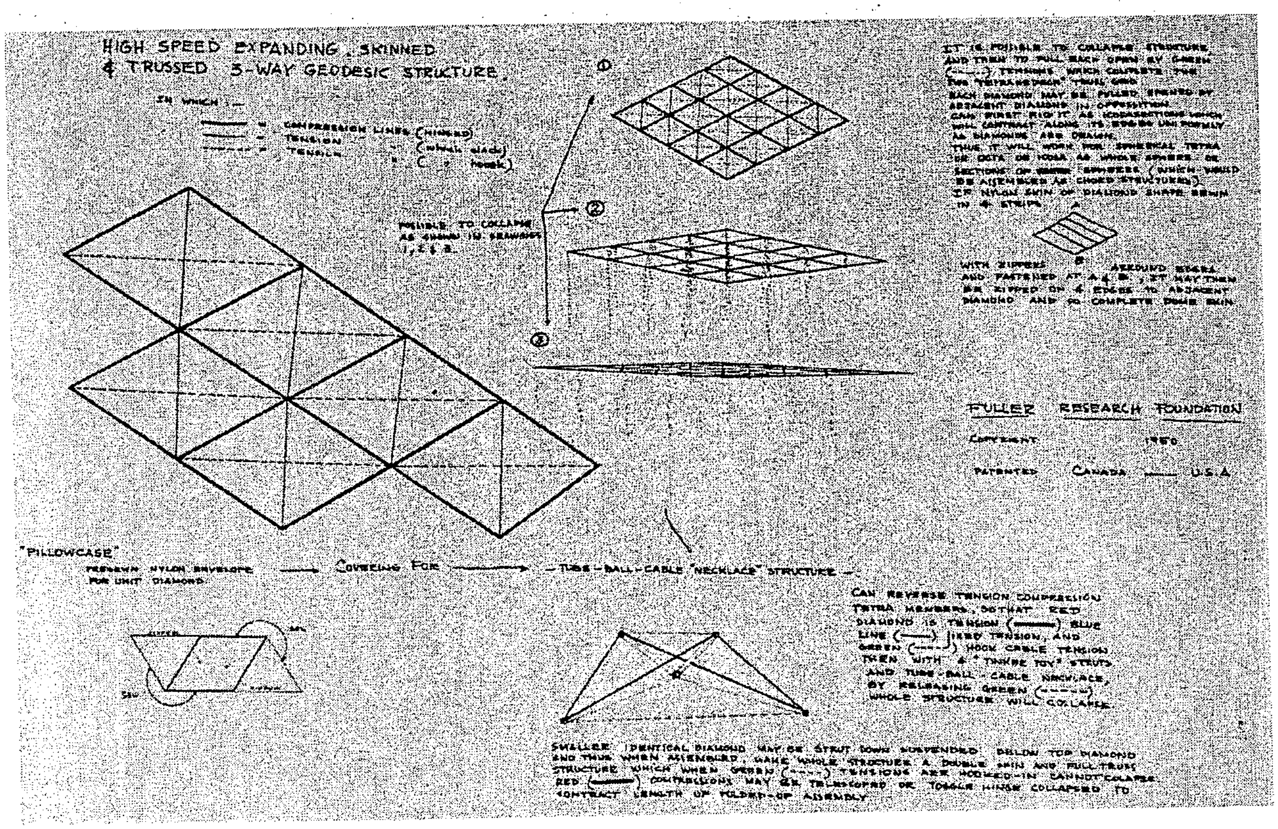
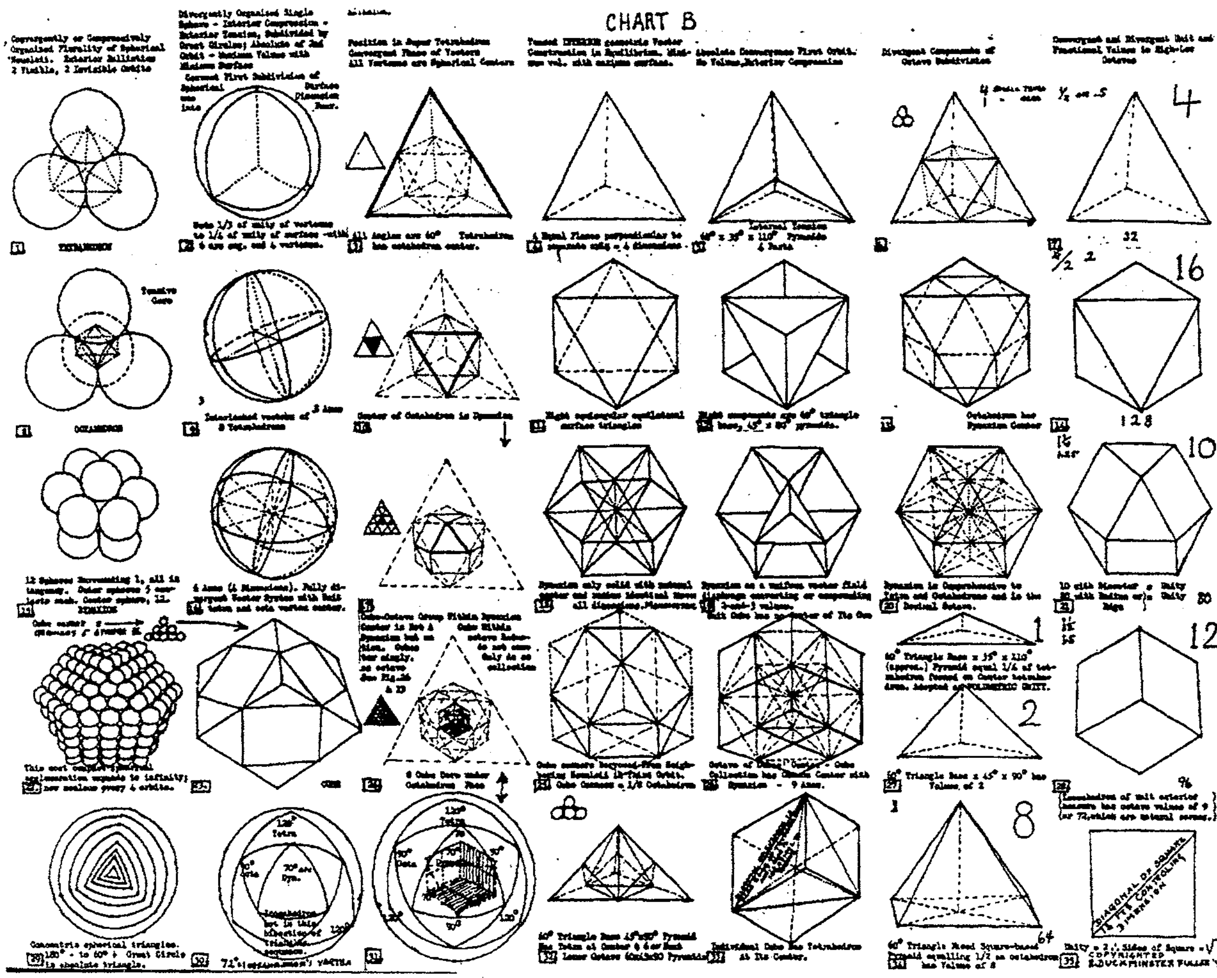
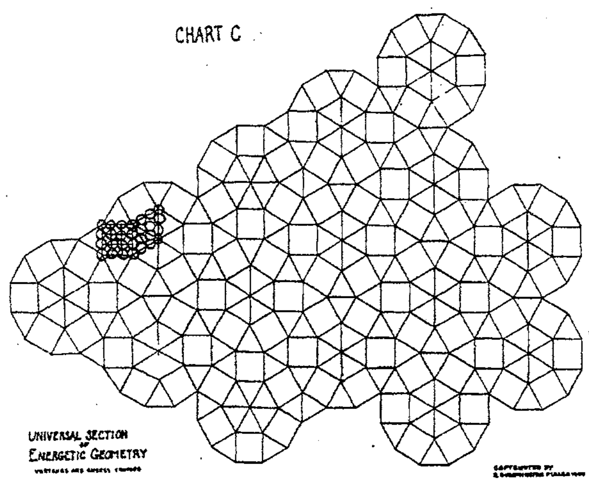


Fig.2.31 Extracts from Fuller's self-published "Energetic Geometry," [1944].. Source: BFI-EJA Blue Trunk.





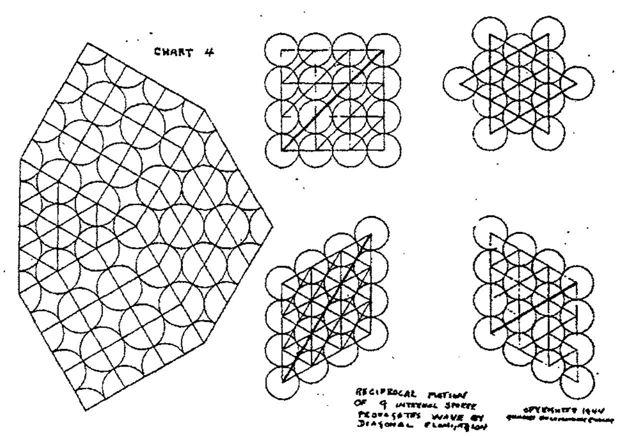
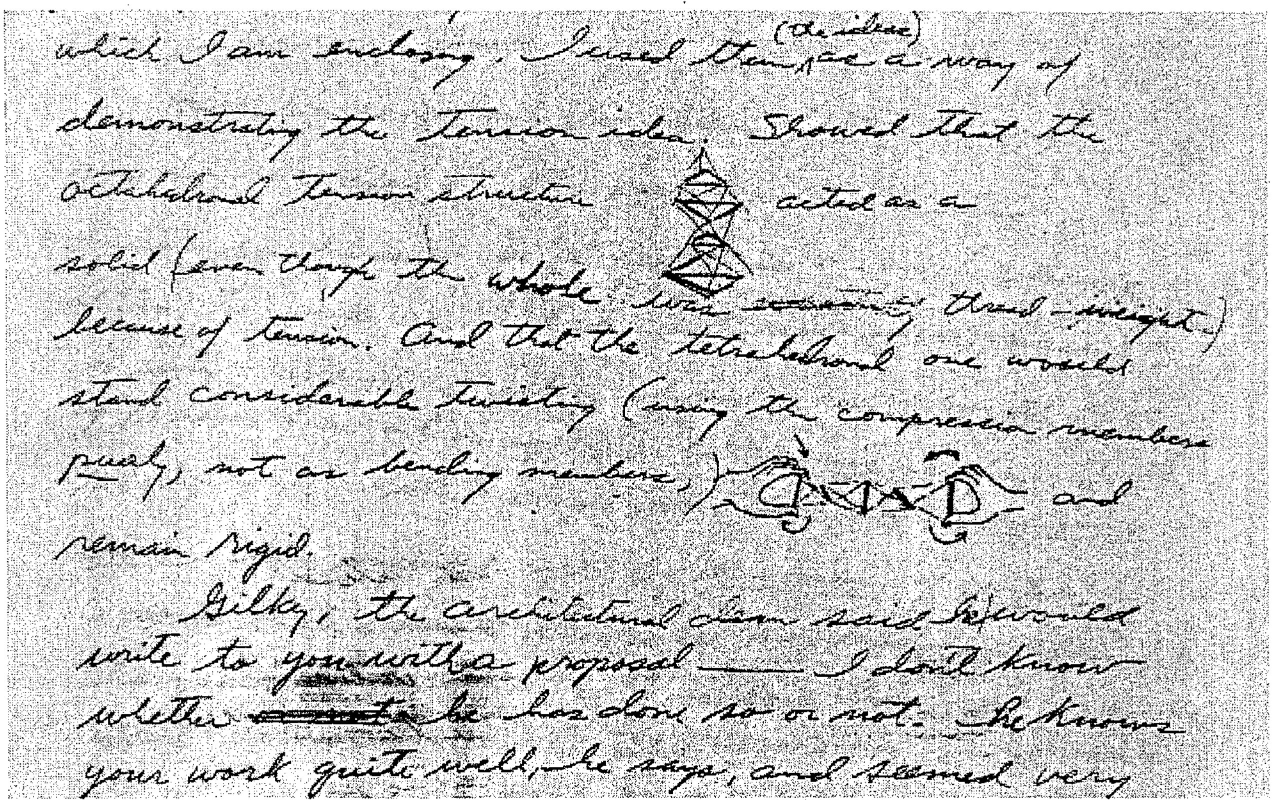


Fig.2.32a Snelson's drawings and models of his experimentations, ca. February 1949. Source: Ltr. 2/20/49 K. Snelson to RBF in BFI-"Snelson's Letter."


which I am enclosing. I used them (the ideas) as a way of demonstrating the tension idea. Showed that the octahedral tension structure acted as a solid (even though the whole was ~~...~~ thread-weight) because of tension. And that the tetrahedral one would stand considerable twisting (using the compression members purely, not as bending members) and remain rigid.

Gilky, the architectural dean said he would write to you with a proposal — I don't know whether ~~...~~ he has done so or not. He knows your work quite well, he says, and seemed very

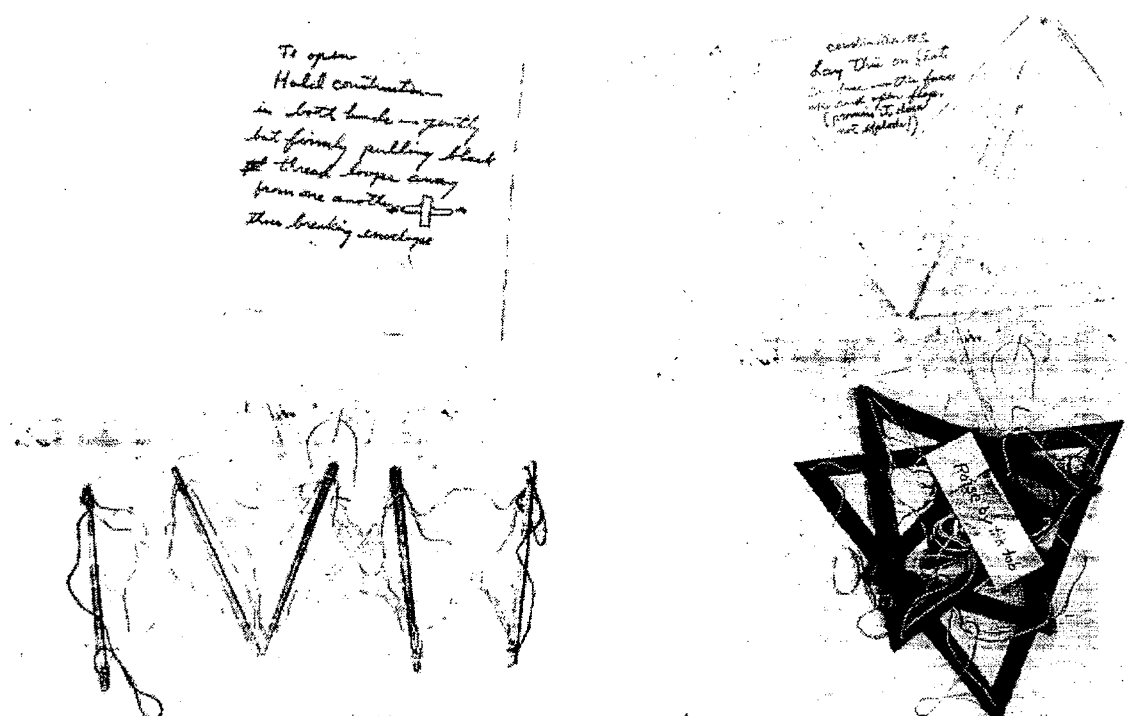


Fig.2.32b Fuller's sketch and note of his investigations with magnets, as he had demonstrated to Snelson. Source: BFI-EJA Blue.

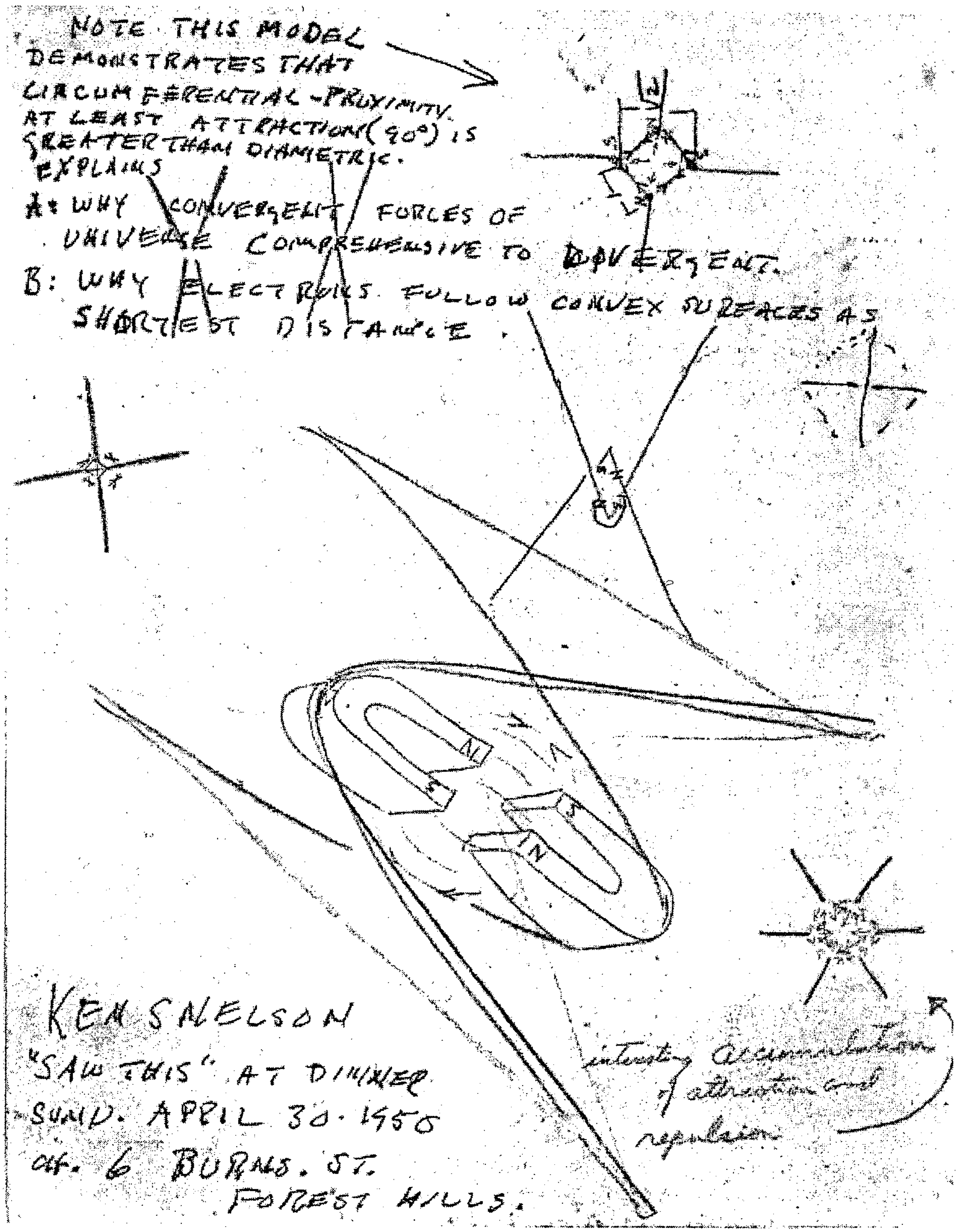
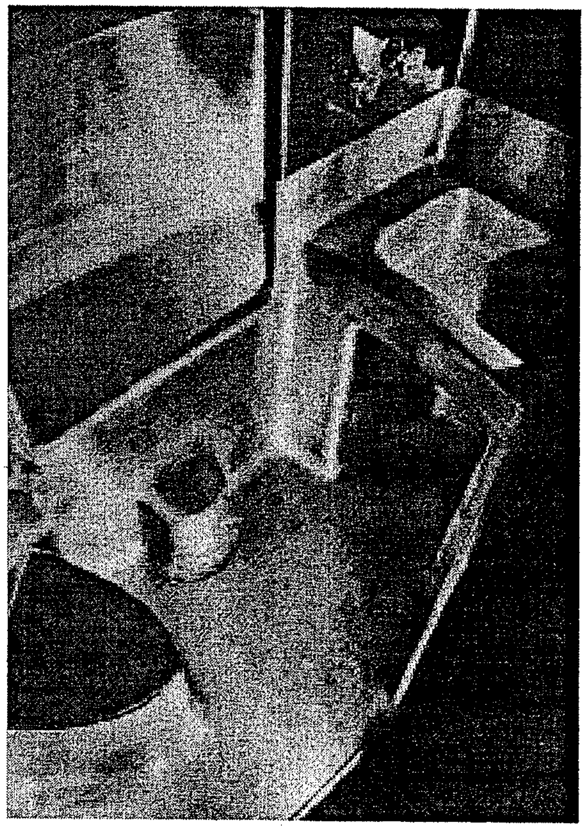


Fig.2.33 Phelps-Dodge Dymaxion copper bathroom. Source: R.W. Marks, The Dymaxion World of Buckminster Fuller, p.90.



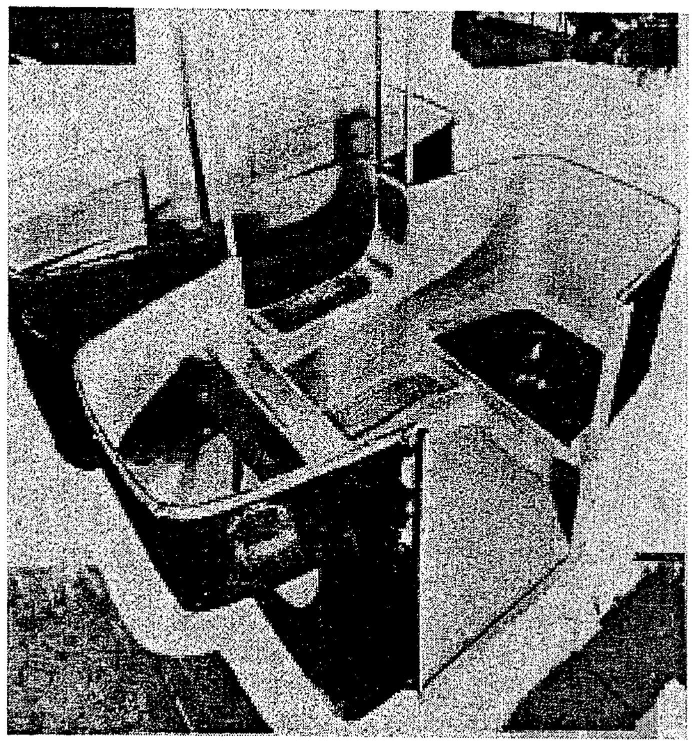


Fig.2.34 BMC Suppine Dome, after the collapse. Source: M.E. Harris, "Art as Experiment: Form The Arts at BMC," *The American Poetry Review*, May/June 1987.

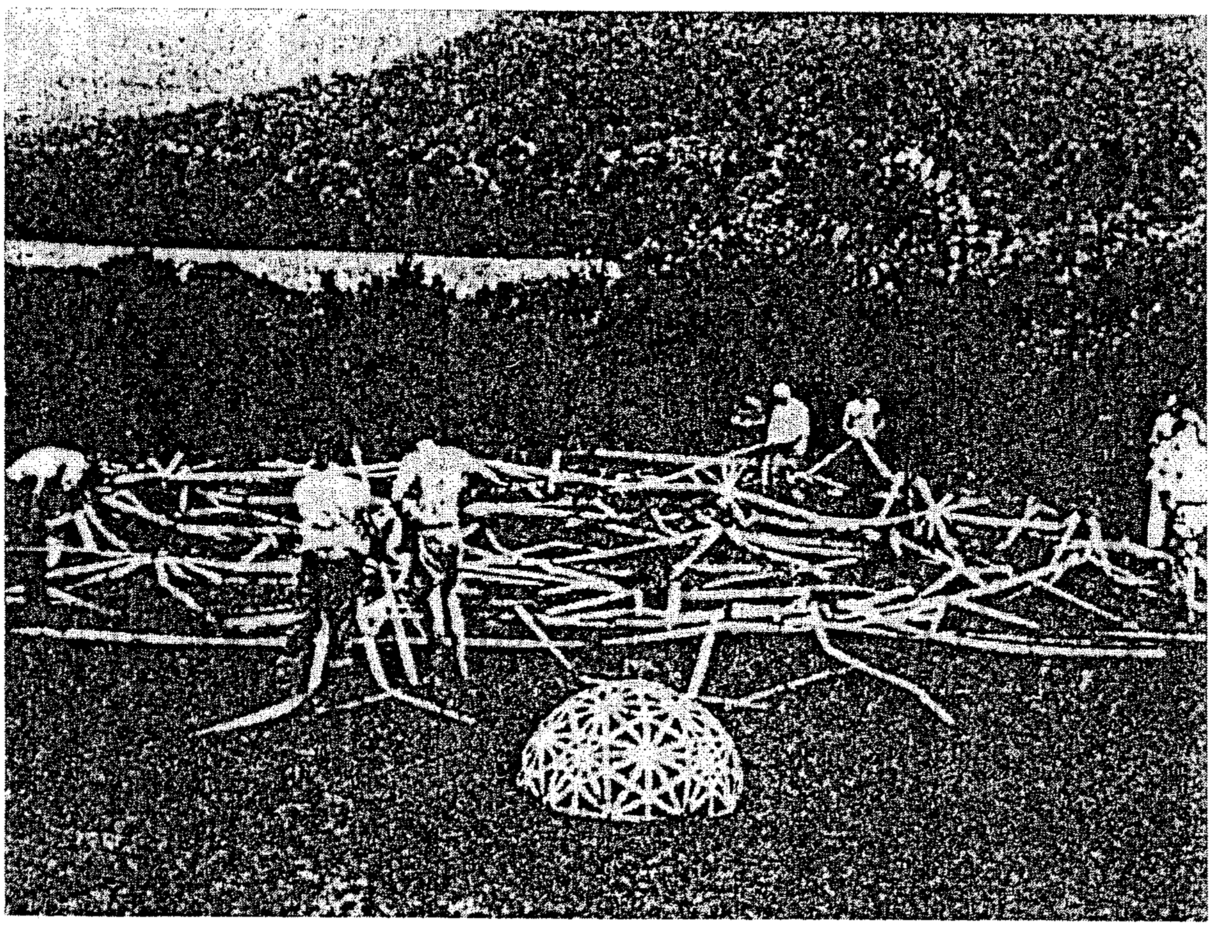


Fig.2.35 Fuller's first 14-segment map, assembled into a cube-octahedron, given to D. Parks.
Source: ANY 17 (Architecture-New York), back cover page.

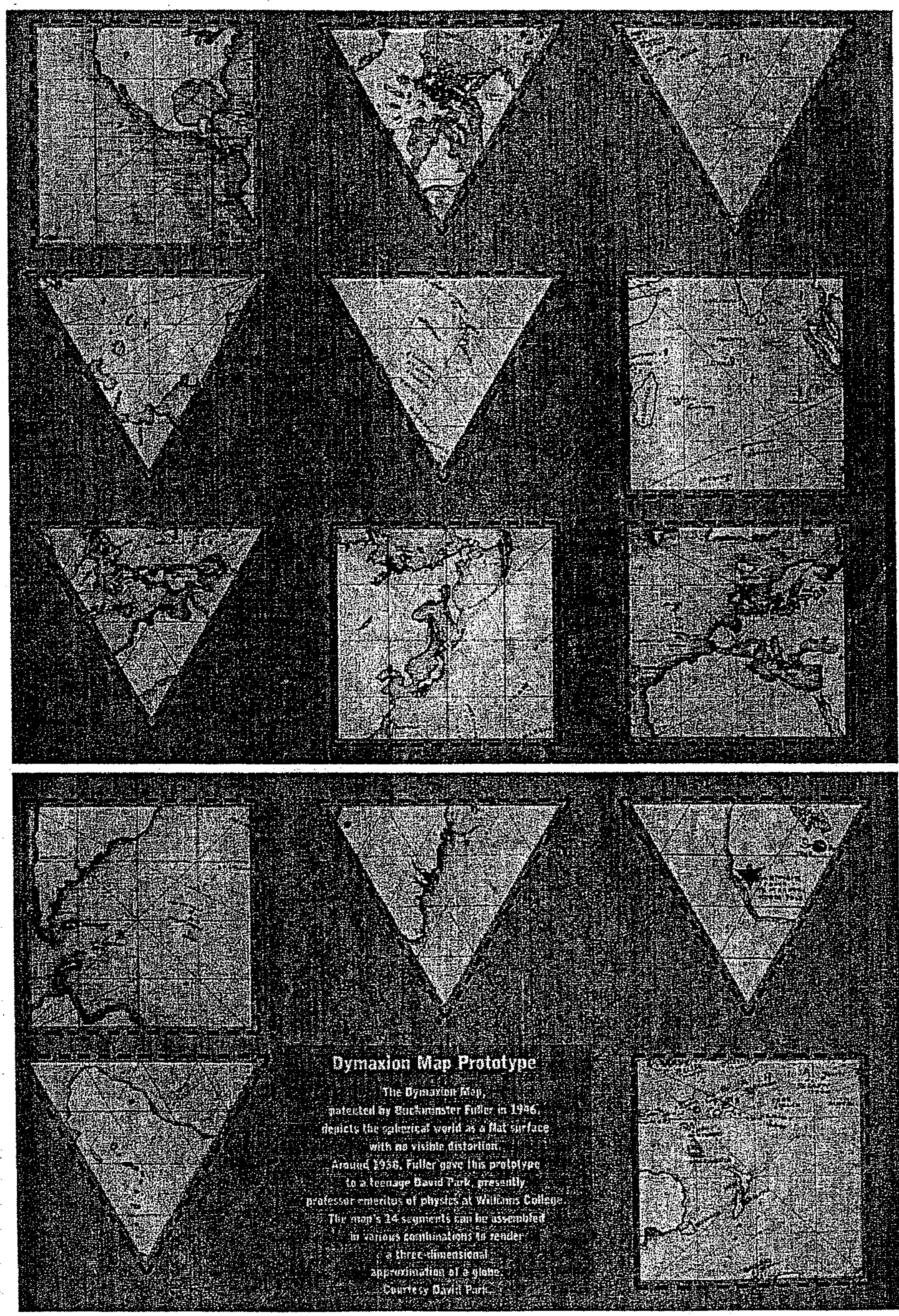


Fig.2.36a Composite Polyhedra Studies by Wentzel Jamnitzer (1508-1585). Source: D.G. Emmerich, IASS, Vol.11, No.1 & 2, 1996.

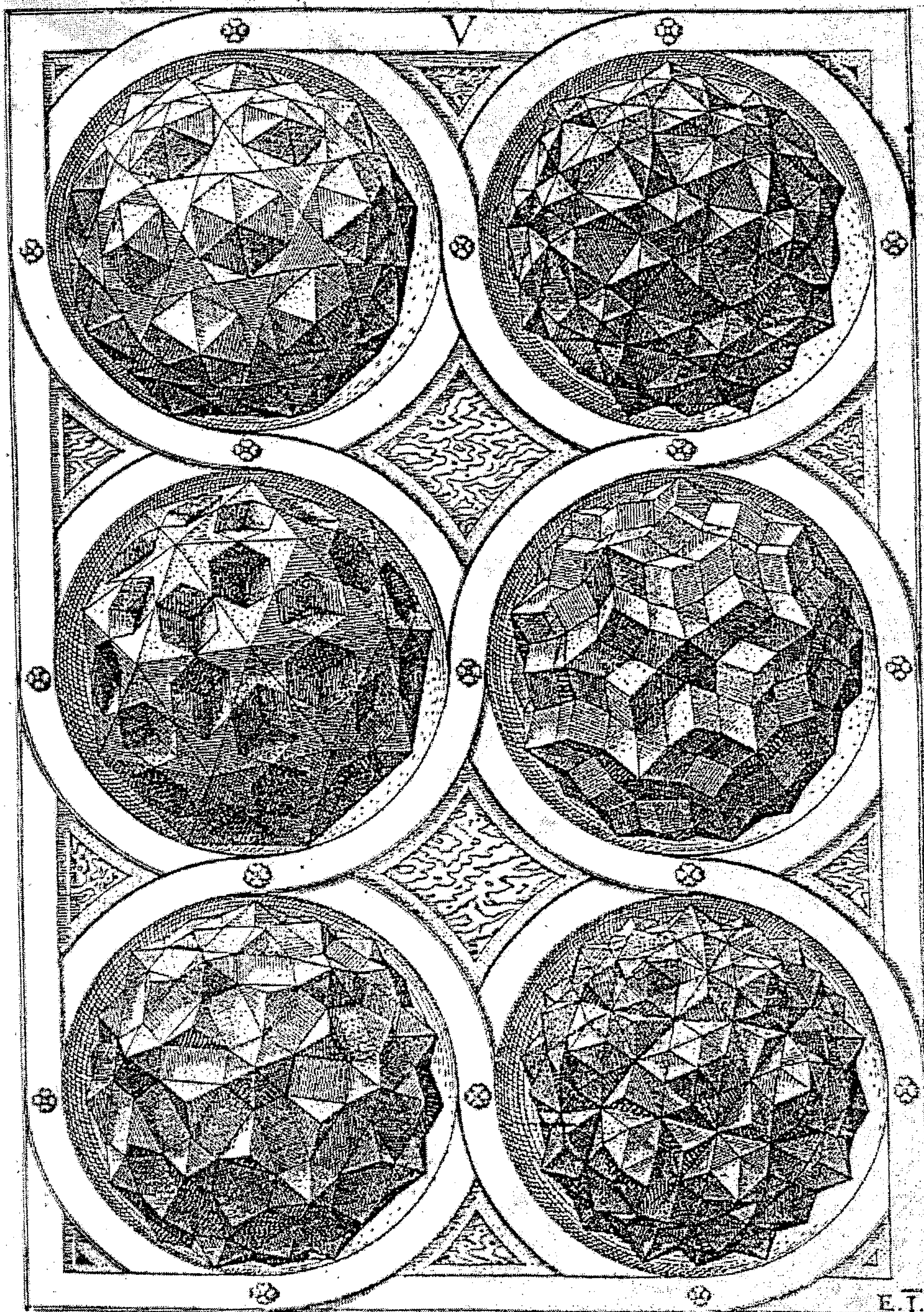


Figure 6. Composite polyhedra, Jamnitzer Wentzel.

Fig.2.36b Polyhedra studies by J. Kepler. Source: D.G. Emmerich, IASS, Vol.11, No.1 & 2, 1996.

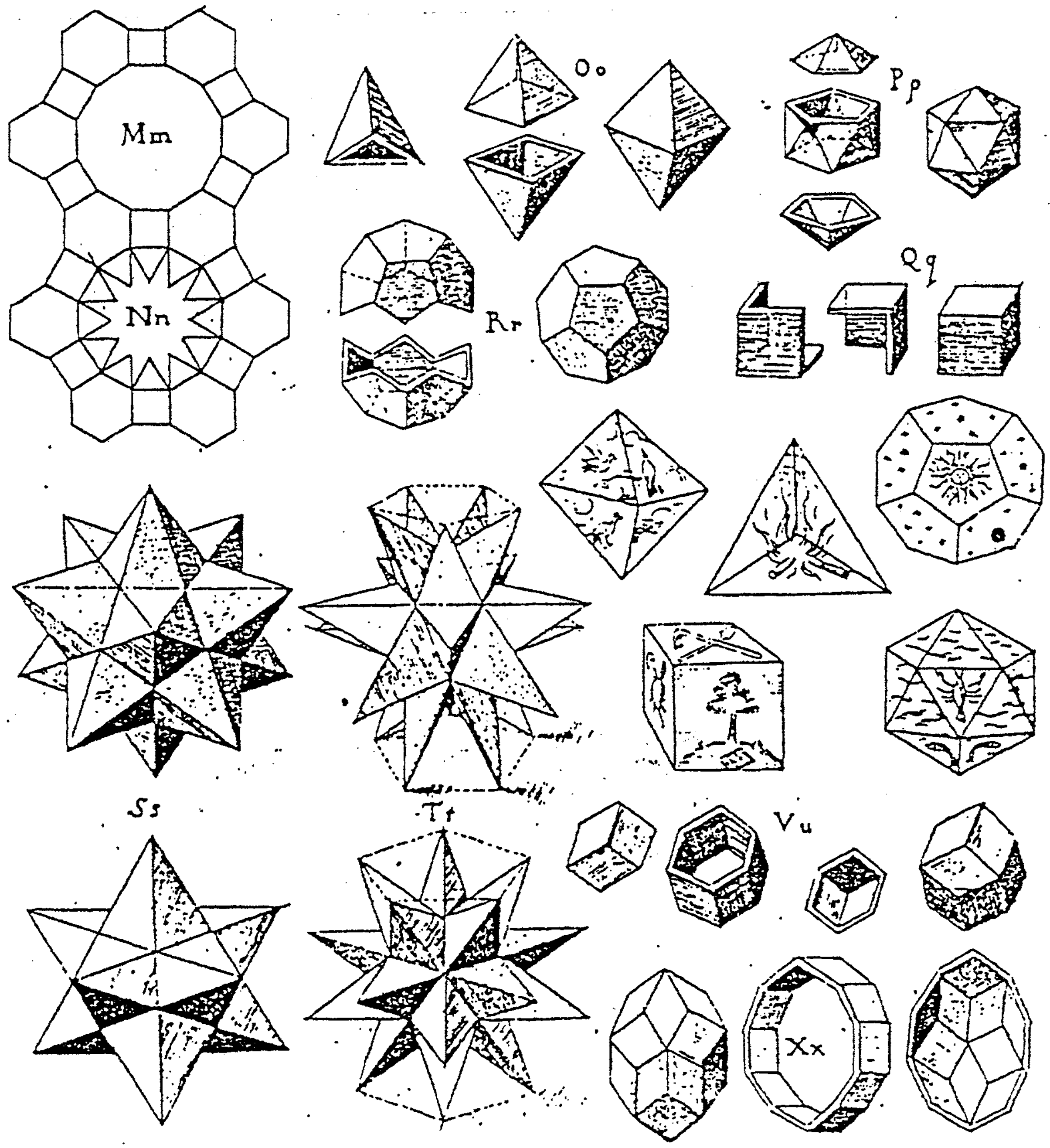


Fig.2.36c Polyhedra studies by D.G. Emmerich. Source: D.G. Emmerich, IASS, Vol.11, No.1 & 2, 1996.

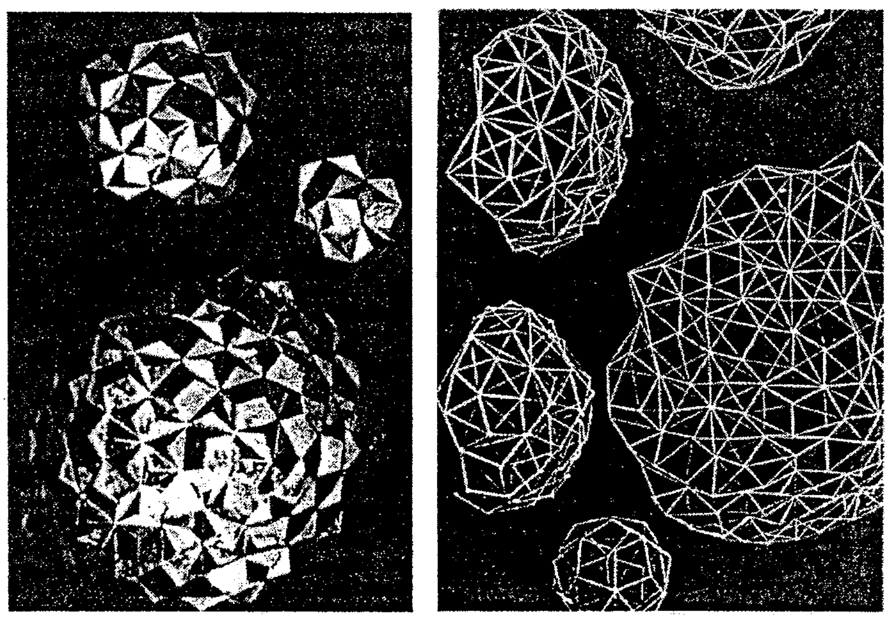
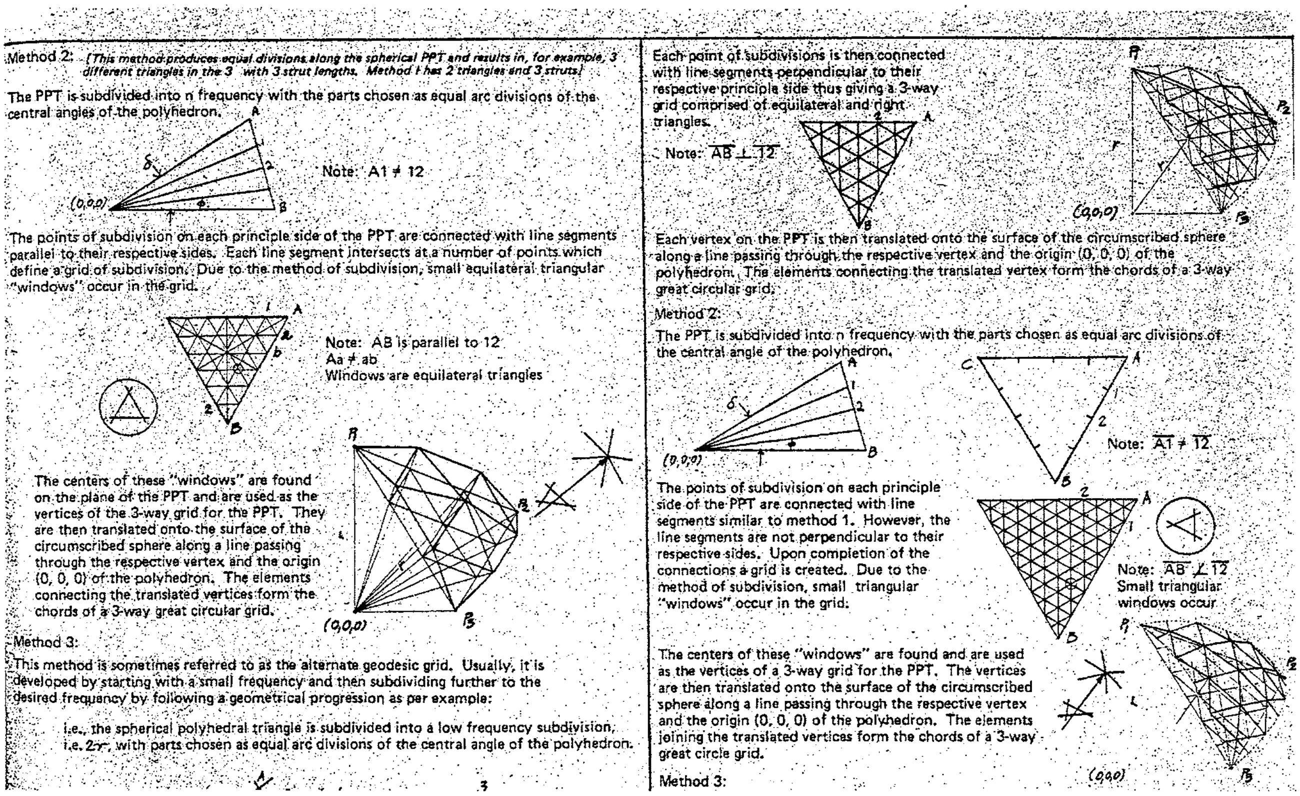


Fig.2.37 Deployment Project, NCSC-Raleigh. Source: "Deployment," *Student Publication of the School of Design* (NCSC), Vol. 2, No.1, Fall 1951, pp. 5-12.

Fig.2.38 "Windows" in higher frequency dome. Excerpts from J. Clinton's geodesic mathematics. Source: Domebook 2.



Method 2: *(This method produces equal divisions along the spherical PPT and results in, for example, 3 different triangles in the 3 with 3 strut lengths. Method I has 2 triangles and 3 struts)*

The PPT is subdivided into n frequency with the parts chosen as equal arc divisions of the central angles of the polyhedron.

Note: A1 ≠ 12

The points of subdivision on each principle side of the PPT are connected with line segments parallel to their respective sides. Each line segment intersects at a number of points which define a grid of subdivision. Due to the method of subdivision, small equilateral triangular "windows" occur in the grid.

Note: AB is parallel to 12
Aa ≠ ab
Windows are equilateral triangles

The centers of these "windows" are found on the plane of the PPT and are used as the vertices of the 3-way grid for the PPT. They are then translated onto the surface of the circumscribed sphere along a line passing through the respective vertex and the origin (0, 0, 0) of the polyhedron. The elements connecting the translated vertices form the chords of a 3-way great circular grid.

Method 3:

This method is sometimes referred to as the alternate geodesic grid. Usually, it is developed by starting with a small frequency and then subdividing further to the desired frequency by following a geometrical progression as per example:

i.e., the spherical polyhedral triangle is subdivided into a low frequency subdivision, i.e. 2ν, with parts chosen as equal arc divisions of the central angle of the polyhedron.

Each point of subdivisions is then connected with line segments perpendicular to their respective principle side thus giving a 3-way grid comprised of equilateral and right triangles.

Note: $\overline{AB} \perp \overline{12}$

Each vertex on the PPT is then translated onto the surface of the circumscribed sphere along a line passing through the respective vertex and the origin (0, 0, 0) of the polyhedron. The elements connecting the translated vertex form the chords of a 3-way great circular grid.

Method 2:

The PPT is subdivided into n frequency with the parts chosen as equal arc divisions of the central angle of the polyhedron.

Note: $\overline{A1} \neq \overline{12}$

The points of subdivision on each principle side of the PPT are connected with line segments similar to method 1. However, the line segments are not perpendicular to their respective sides. Upon completion of the connections a grid is created. Due to the method of subdivision, small triangular "windows" occur in the grid.

Note: $\overline{AB} \not\perp \overline{12}$
Small triangular windows occur

The centers of these "windows" are found and are used as the vertices of a 3-way grid for the PPT. The vertices are then translated onto the surface of the circumscribed sphere along a line passing through the respective vertex and the origin (0, 0, 0) of the polyhedron. The elements joining the translated vertices form the chords of a 3-way great circle grid.

Method 3:

Fig.3.01a Union Tank Car Company, "Proposed Baton Rouge Shop," (Scale: 1/50), 7/17/56. Source: BFI-CR184

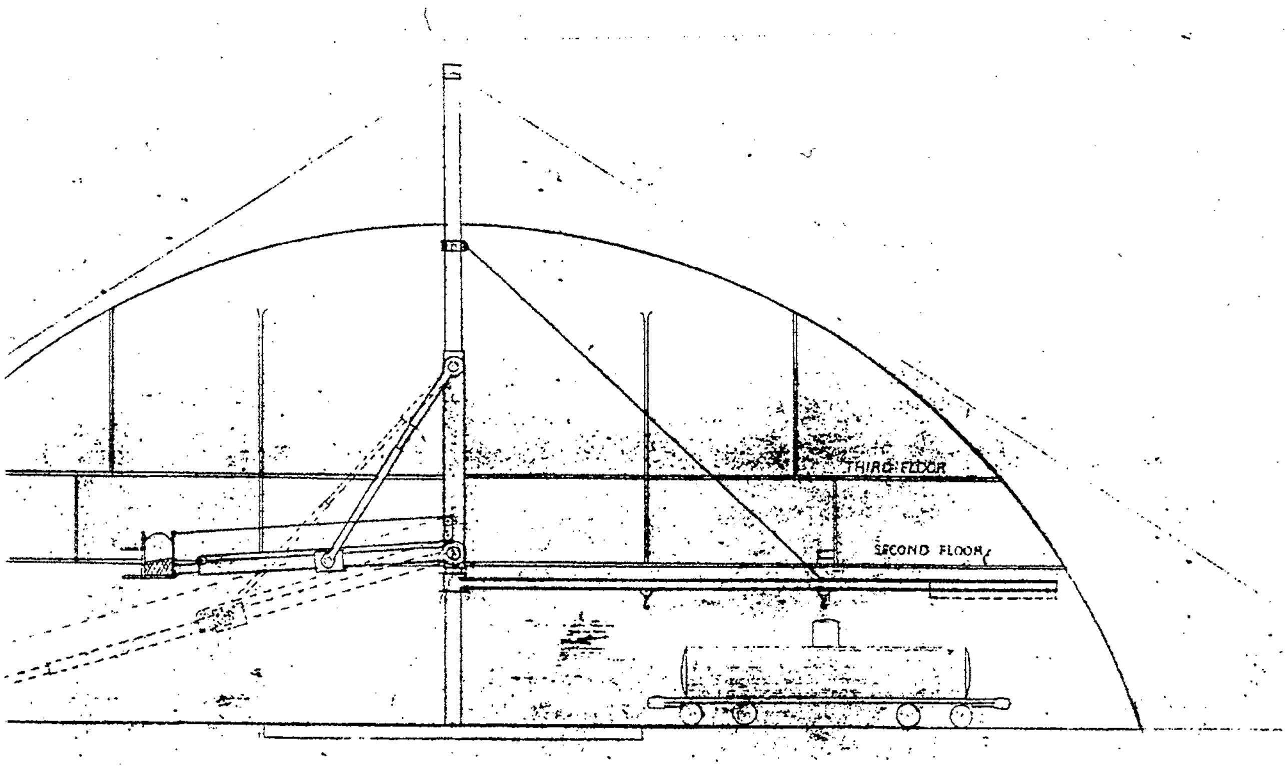


Fig.3.01b Union Tank Car Company, "Shop layout for a 200'-D Geodesic Dome," (Scale :1/32), 12/26/56. Source: BFI-CR184

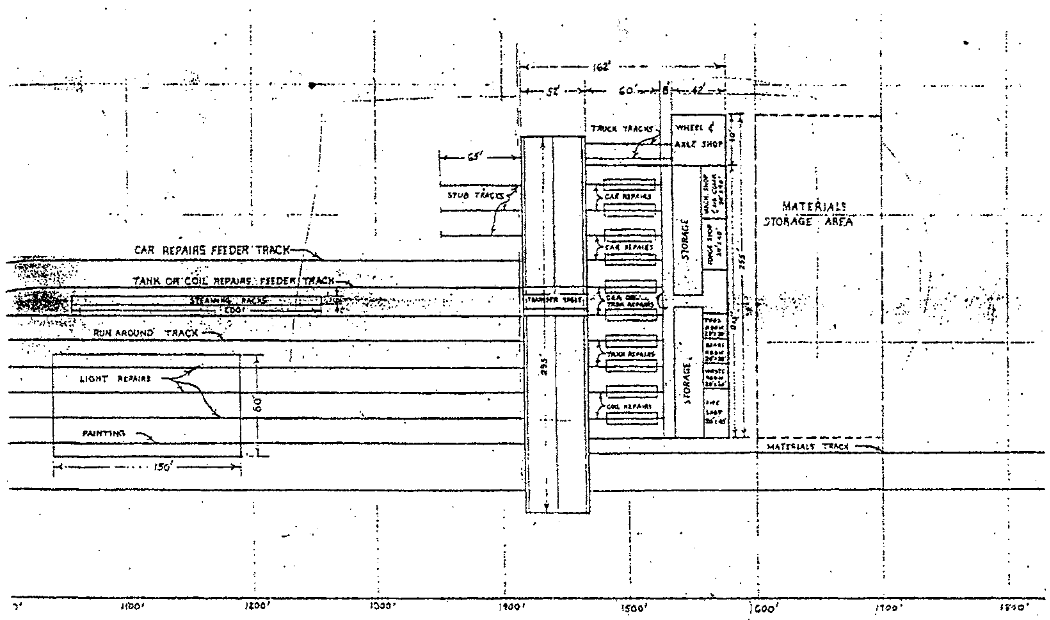


Fig.3.02a D. Stuart, Synergetics Inc., "Proposed Tankcar Manufacturing Shop, Union Tankcar Co., Chicago Ill.," (Scale: 1"=3'), 12/30/56. Source: BFI-CR184

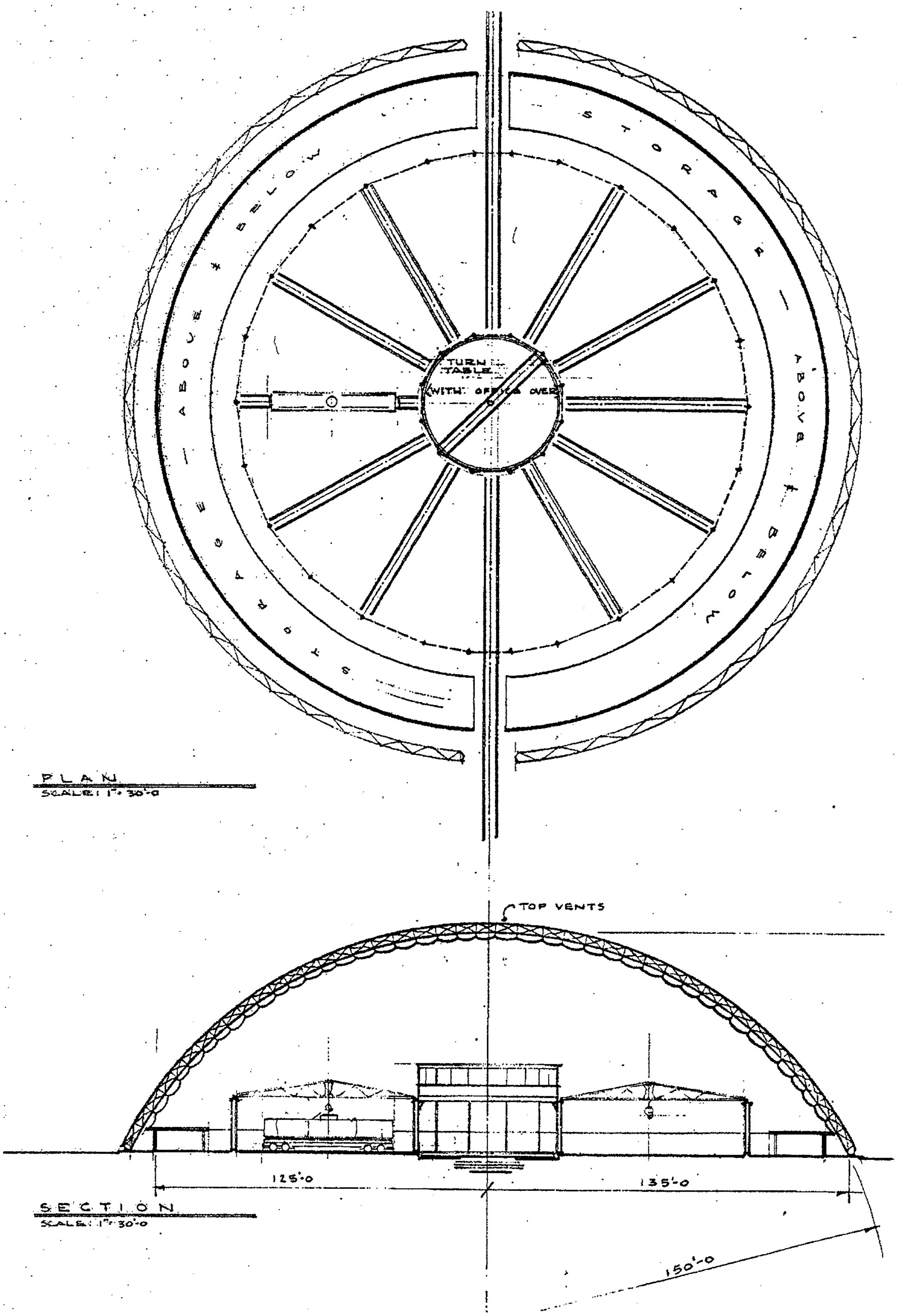


Fig.3.02b Union Tank Car Company/Synergetics Inc. [?]. Calculations for the UTCC Dome, 12/29/56.
Source: BFI-CR184

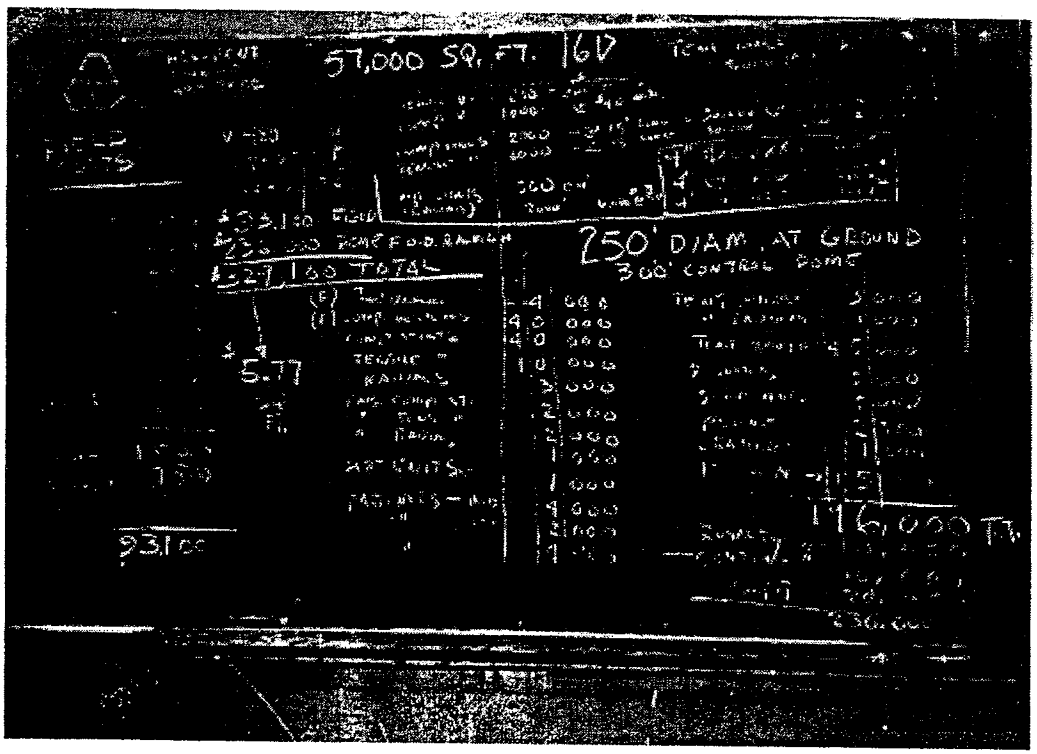
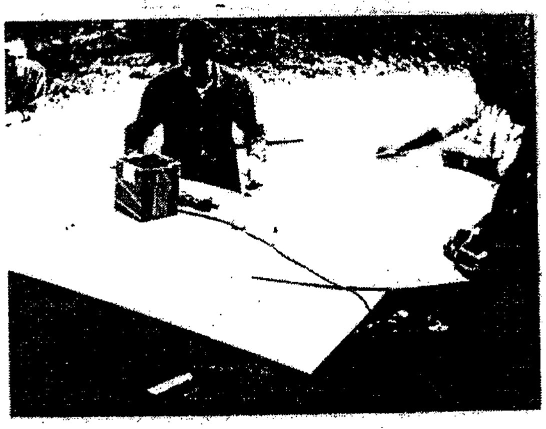


Fig.3.03a Synergetics Inc., Fabrication of UTCC domeboard Dom e of 1/4" Plywood, 2/27/57. <u>Source:</u> BFI-CR185



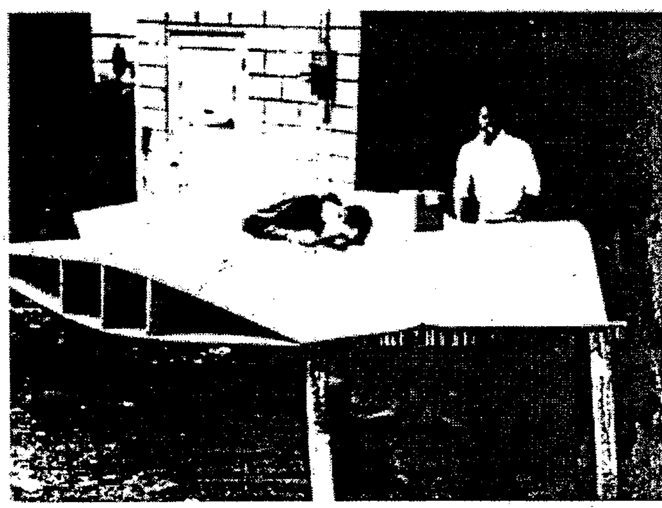
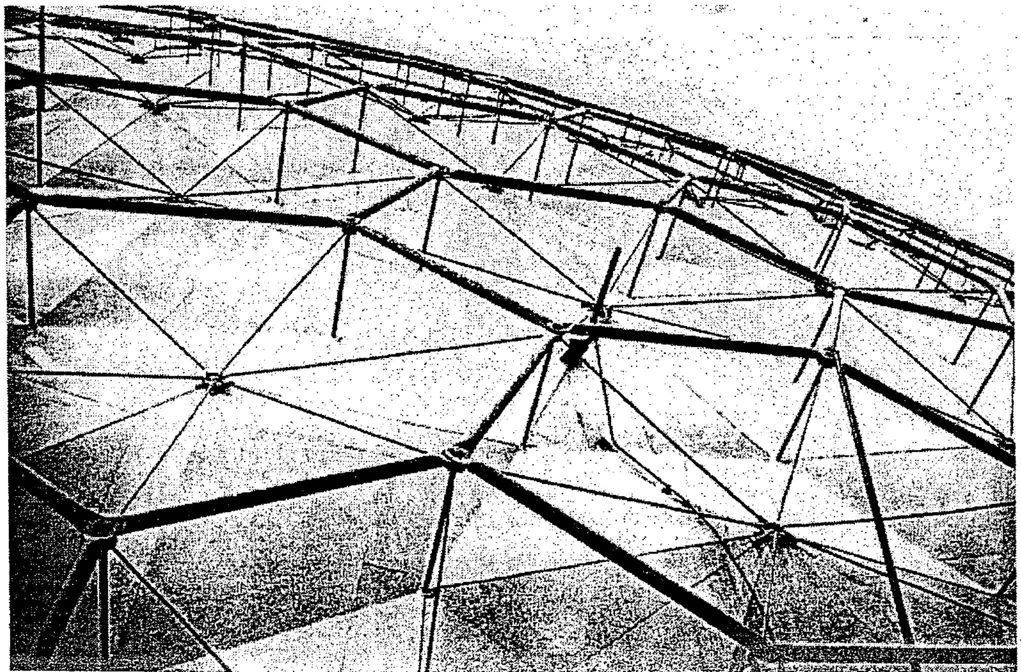


Fig.3.03b Fabrication and close-up details of UTCC Dome, undated. Source: BFI-Photos, #U-2-58 & U-2-21



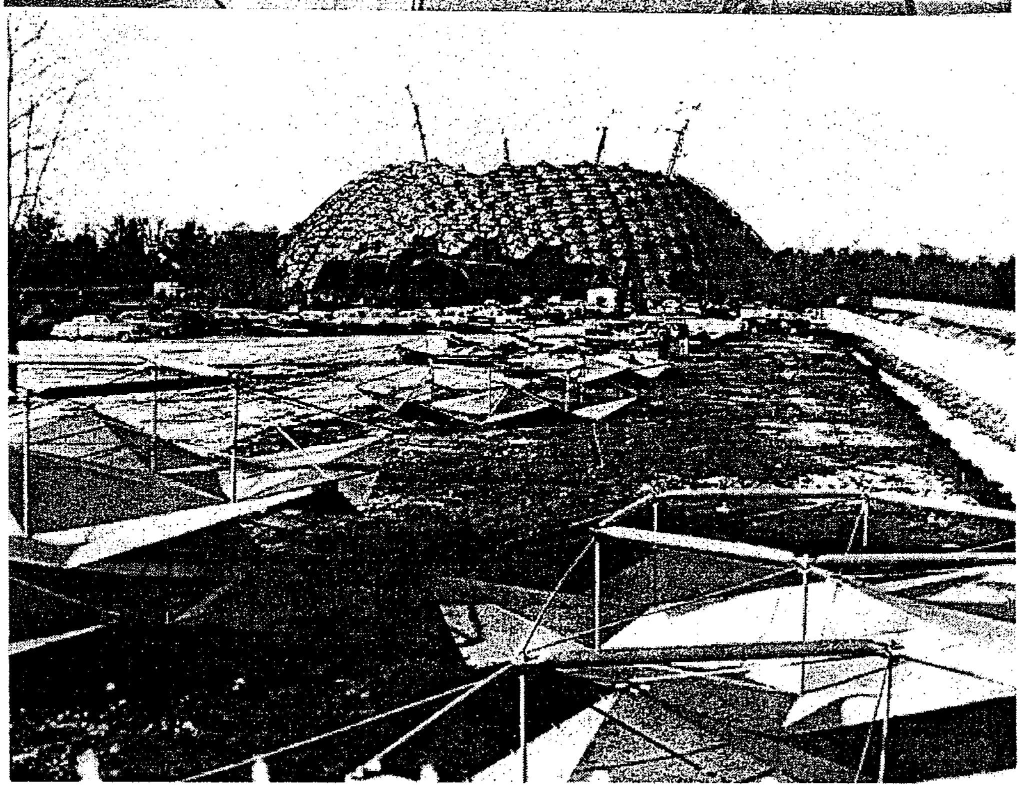
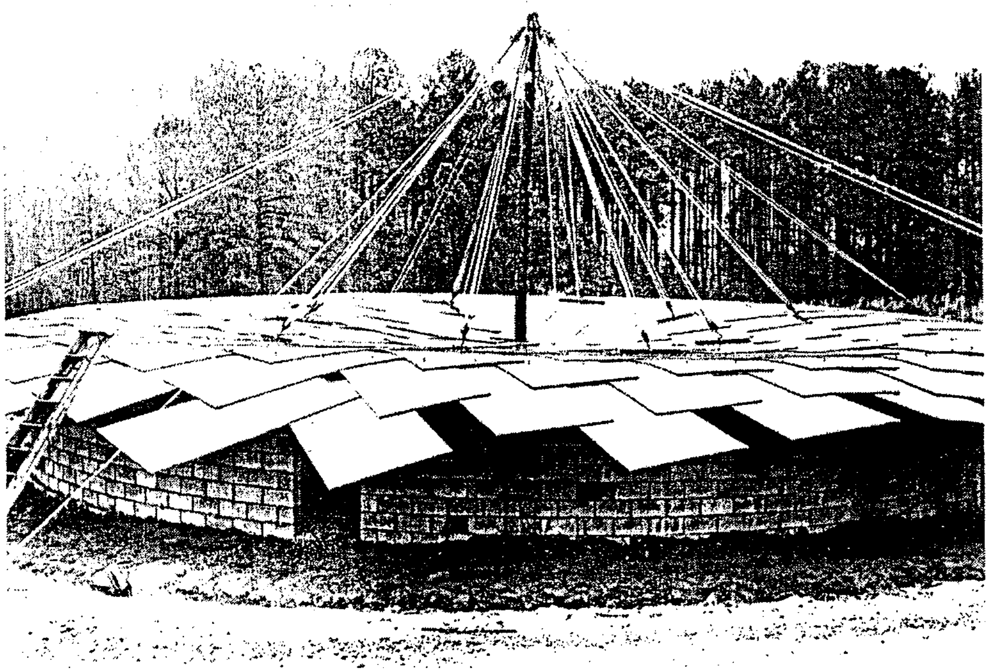


Fig.3.04a Synergetics Inc., Fabrication of UTCC domeboard Dome of 1/4" Plywood, undated. Source: T.C. Howard's Photo Collection



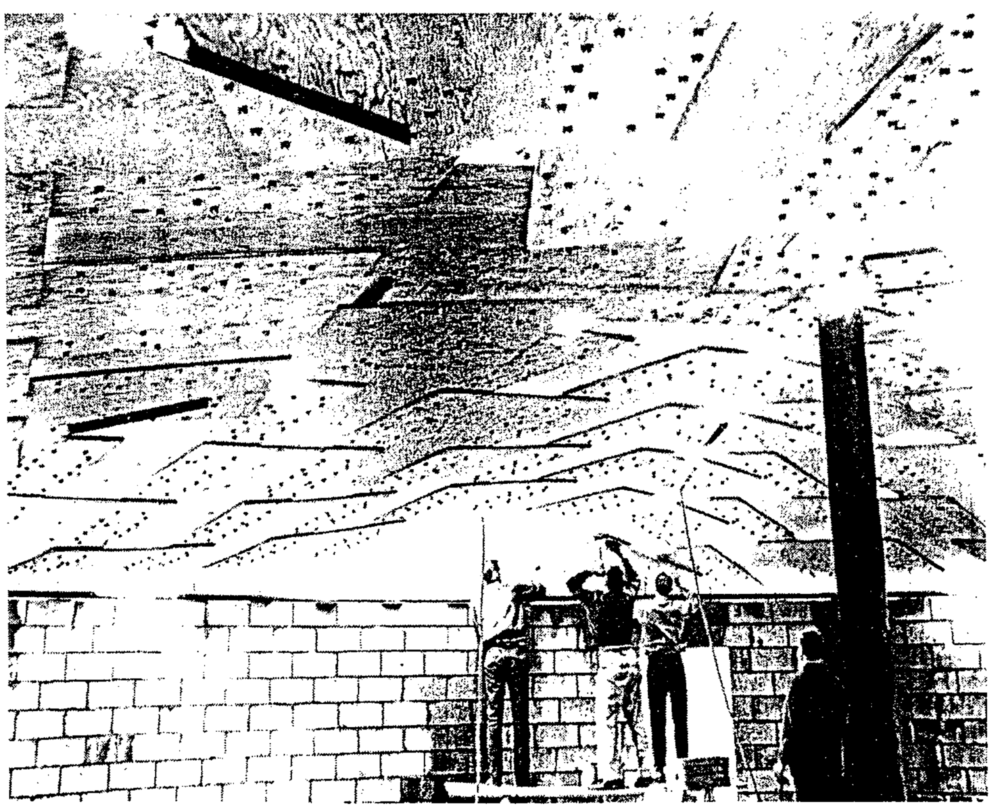


Fig.3.04b R. B. Fuller, Sketch of UTCC domeboard Dome, ca. February 1957. Source: BFI-CR183.

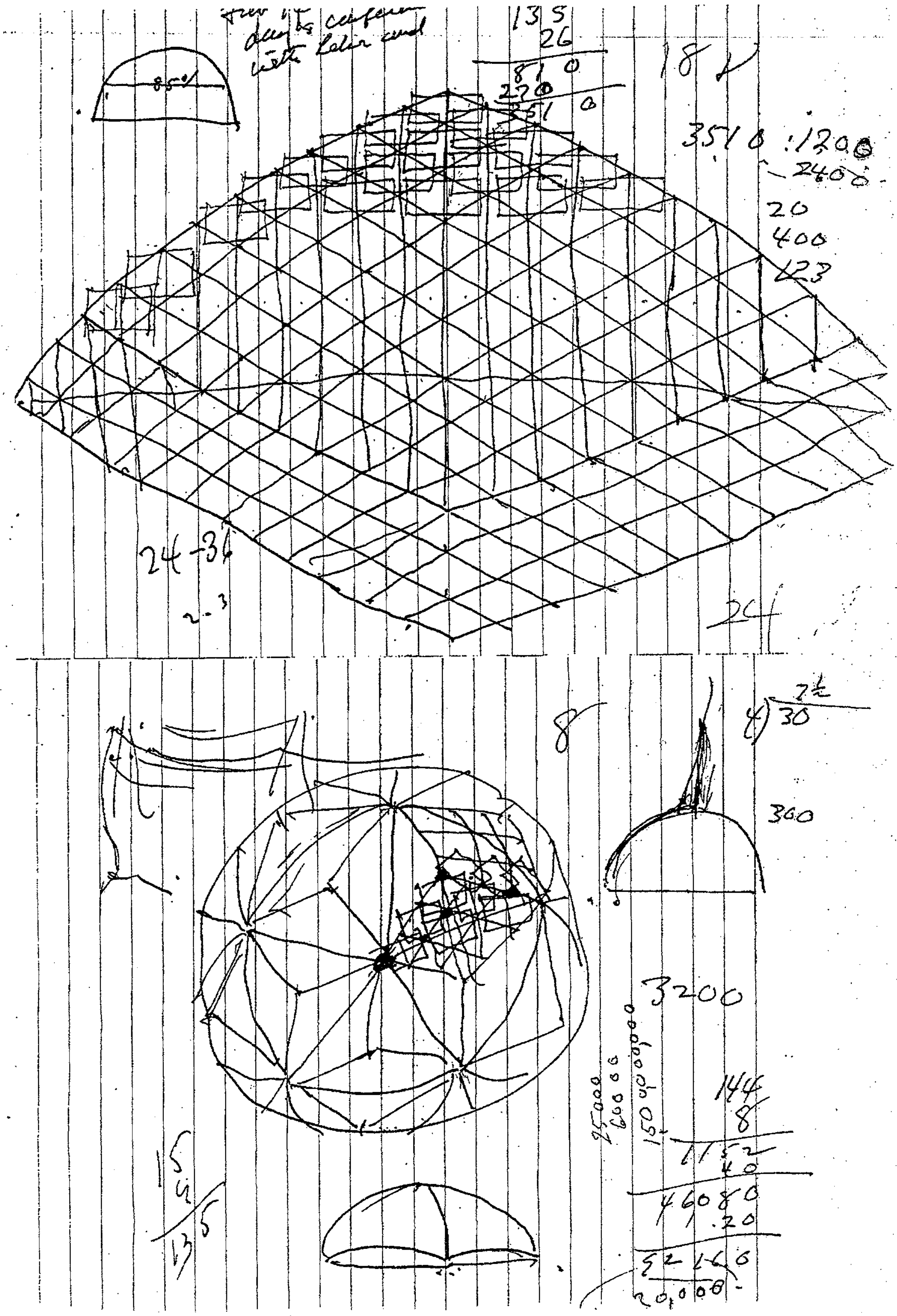


Fig.3.05a UTLx Construction. <u>Source:</u> "R. Buckminster Fuller," Architecture Design, July 1961, p.310.

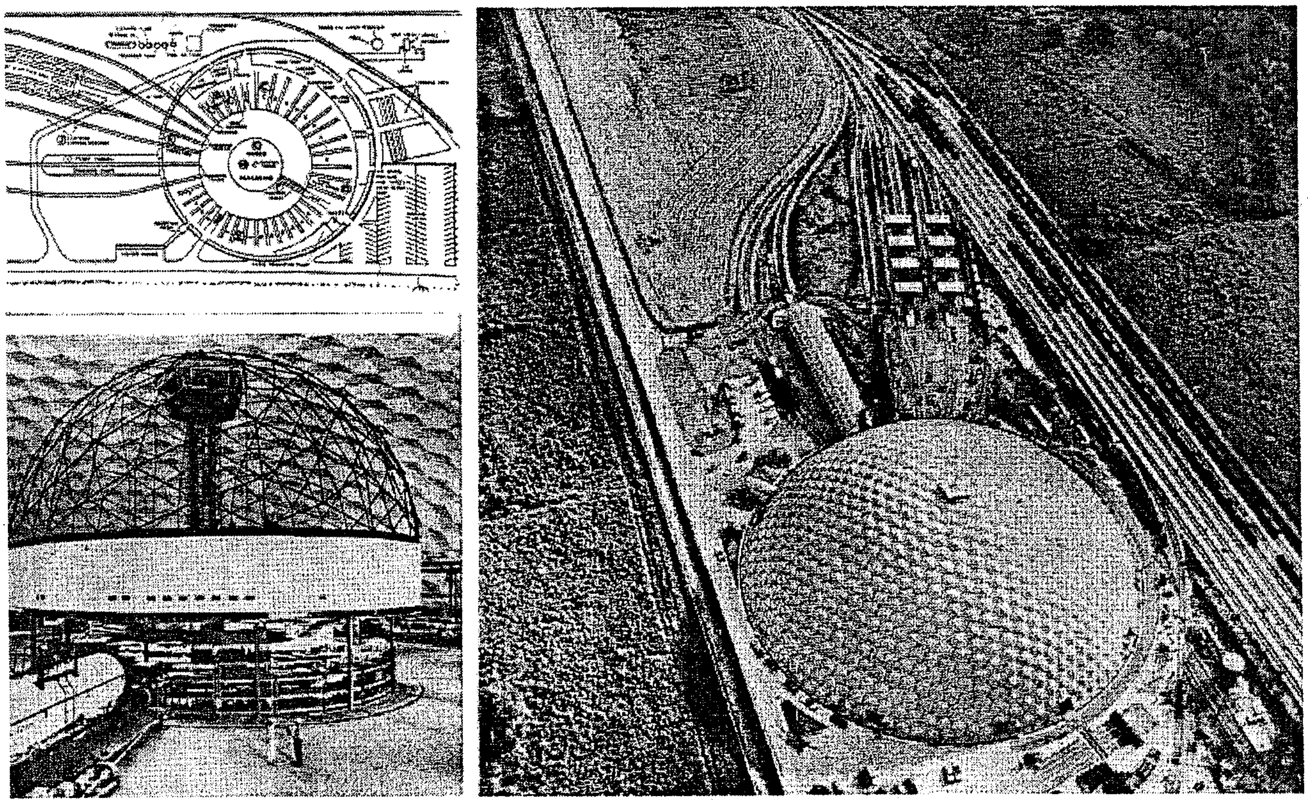


Fig.3.05b UTLx - past and present. Source: Courtesy of M. Fitzgibbon (Photos by M. Bromberg, ca. 1993.)

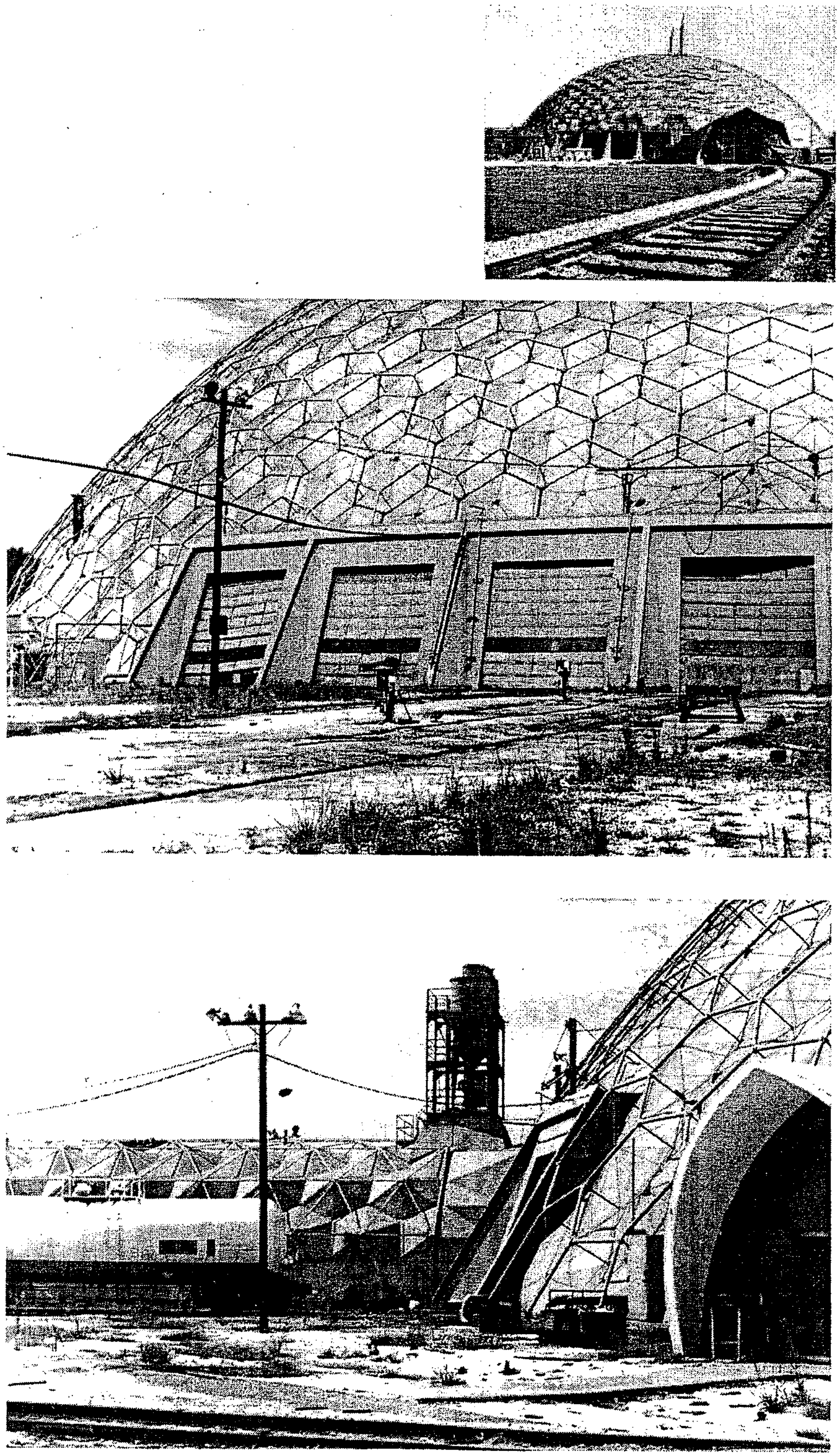


Fig.3.06 R.B. Fuller, Sketch of a 24-frequency Alternate Truncatable Dome for W. Zeckendorf Jr., 10/15/58. Source: BFI-CR197.

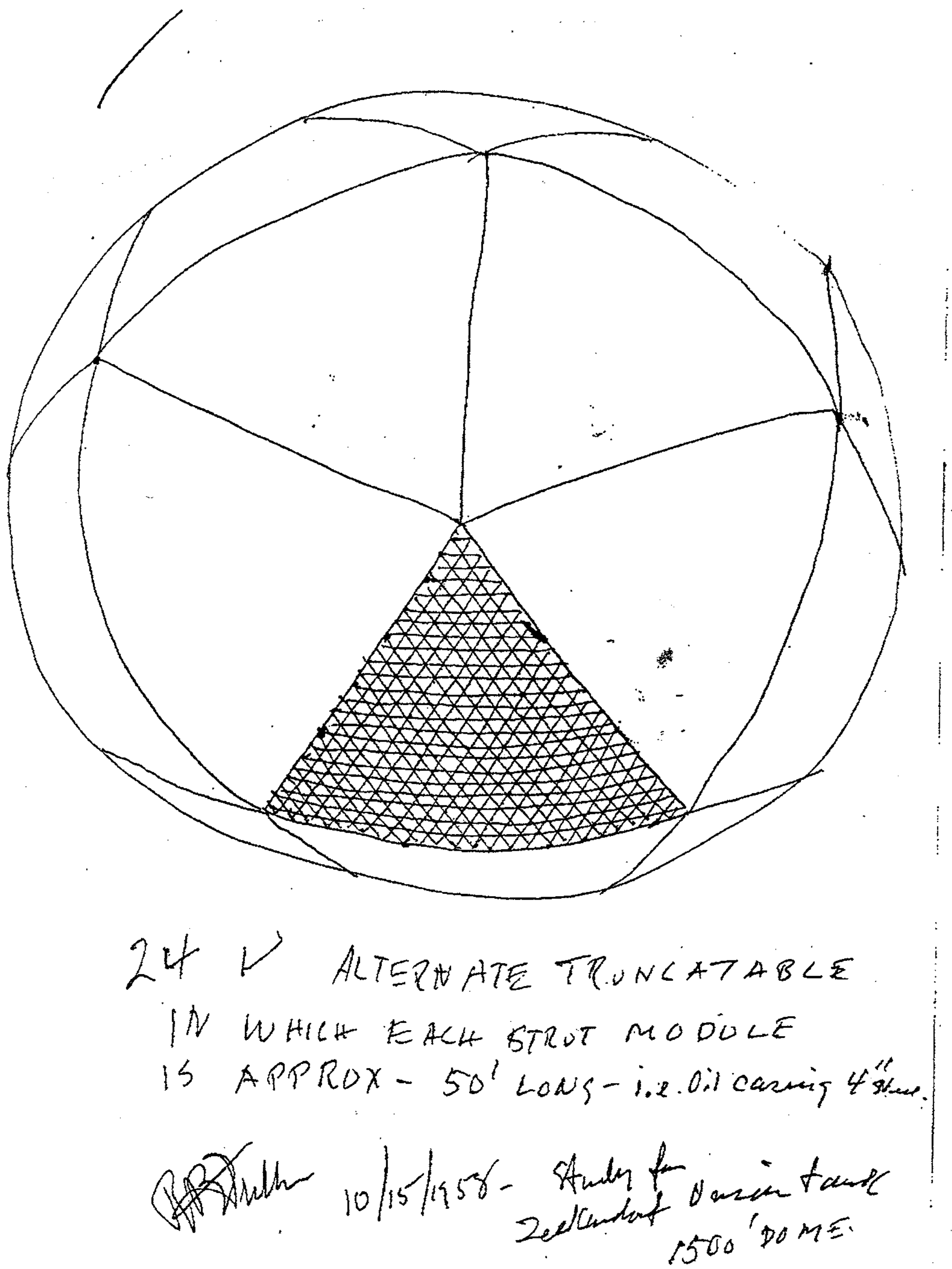
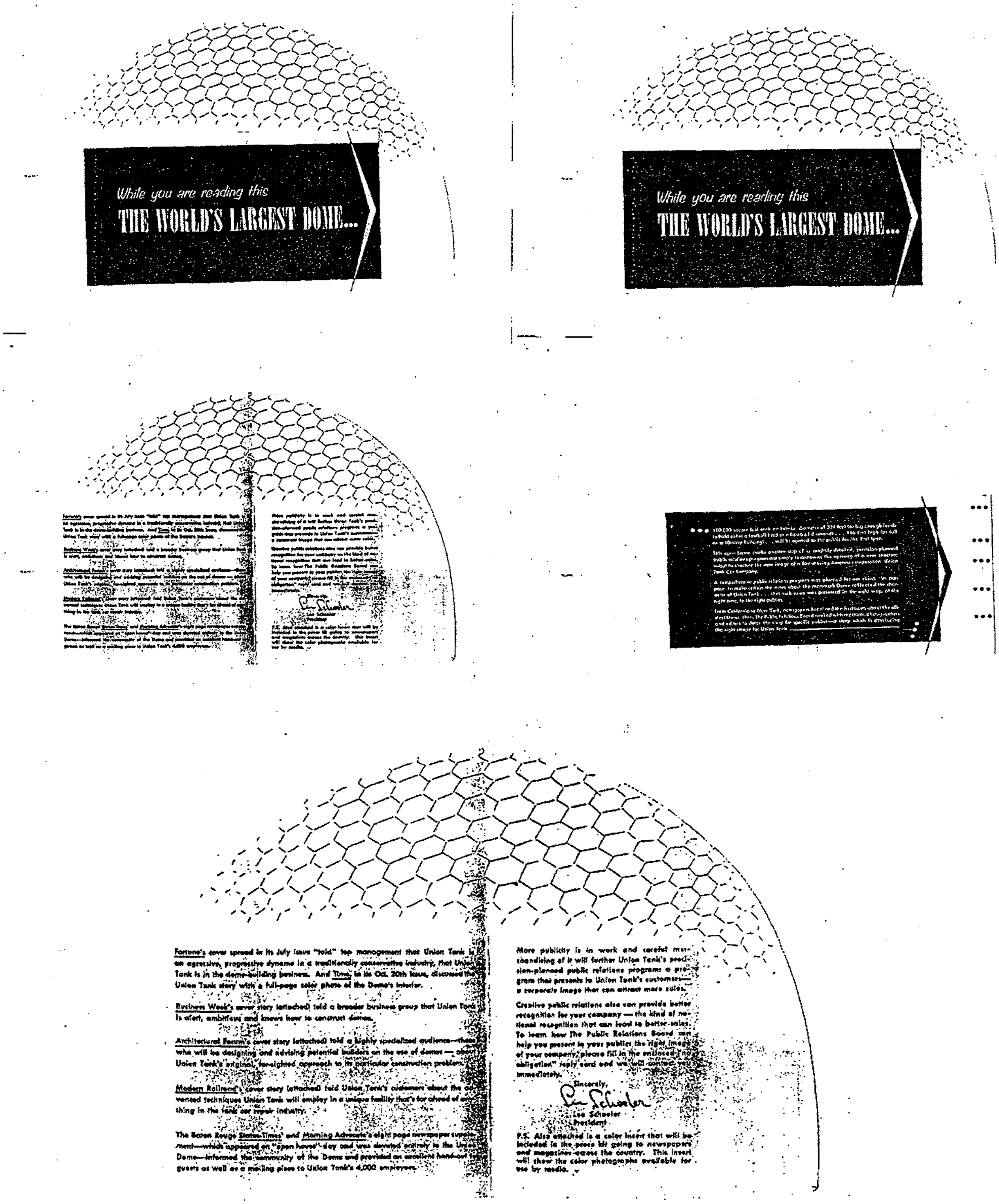


Fig.3.07 The Public Relation, Publicity pamphlet for UTCC, ca.1959. Source: BFI-[?]



Fortune's cover spread in its July issue "told" top management that Union Tank is an agressive, progressive dynamo in a traditionally conservative industry, that Union Tank is in the dome-building business. And Time, in its Oct. 20th issue, discussed the Union Tank story with a full-page color photo of the Dome's interior.

Business Week's cover story (attached) told a broader business group that Union Tank is alert, ambitious and knows how to construct domes.

Architectural Forum's cover story (attached) told a highly specialized audience—those who will be designing and advising potential builders on the use of domes — about Union Tank's original, far-sighted approach to its particular construction problem.

Modern Railroad's cover story (attached) told Union Tank's customers about the advanced techniques Union Tank will employ in a unique facility that's far ahead of anything in the tank car repair industry.

The Baton Rouge State-Times' and Morning Advocate's eight page newspaper supplement—which appeared on "open house" day and was devoted entirely to the Union Dome—informed the community of the Dome and provided an excellent hand-out for guests as well as a mailing piece to Union Tank's 4,000 employees.

More publicity is in work and careful merchandising of it will further Union Tank's precision-planned public relations program: a program that presents to Union Tank's customers— a corporate image that can attract more sales.

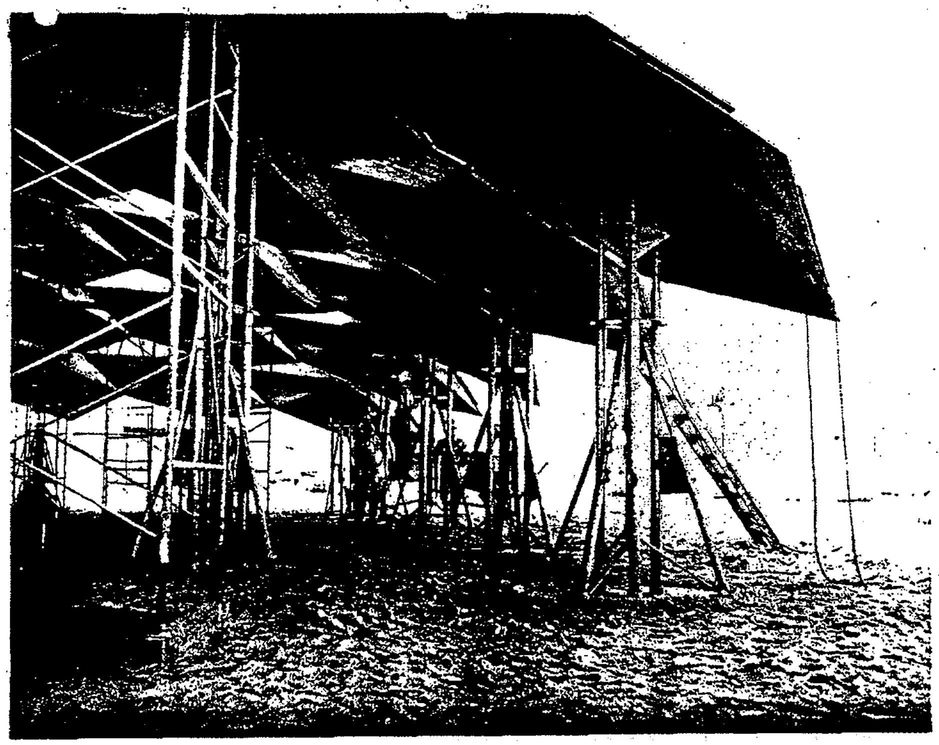
Creative public relations also can provide better recognition for your company — the kind of national recognition that can lead to better sales. To learn how The Public Relations Board can help you present to your publics the right image of your company, please fill in the enclosed "no obligation" reply card and we will contact you immediately.

Sincerely,

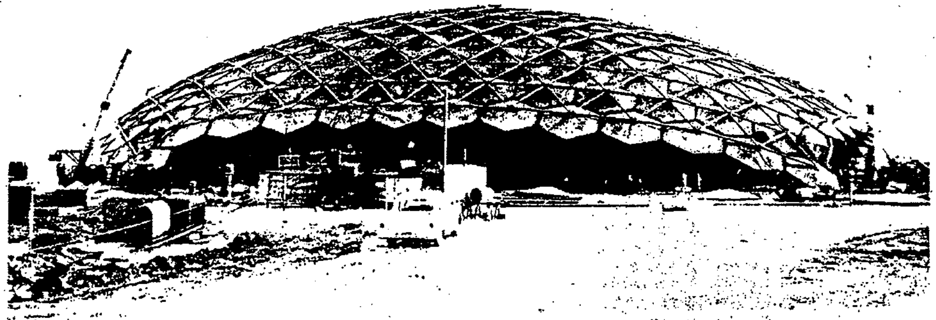
Lee Schooler
President

P.S. Also attached is a color insert that will be included in the press kit going to newspapers and magazines across the country. This insert will show the color photographs available for use by media.

Fig.3.08 Union Tank Car Company, Assembly sequence of the Wood River Dome, 1/25/59. Source: BFI-CR206



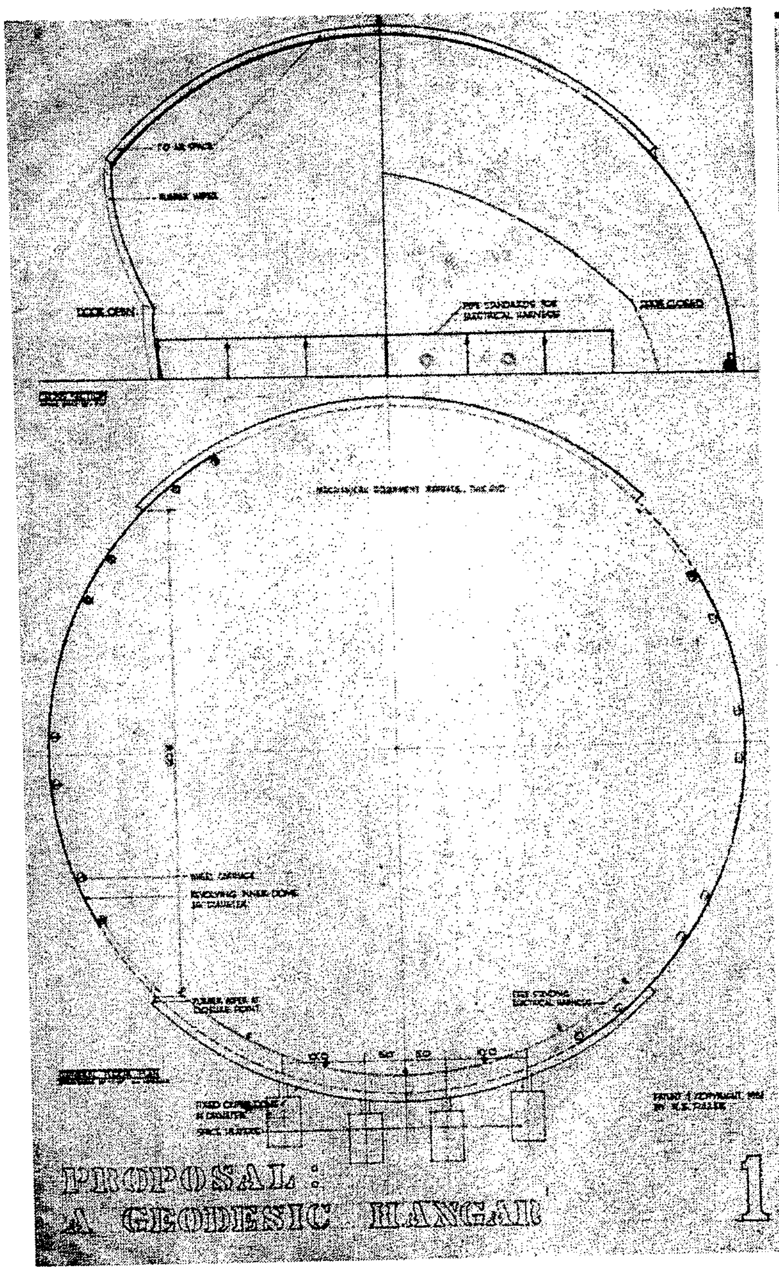
WOOD RIVER DURING FIRST STAGE OPERATION
DOME ON SCAFFOLDING & JACKS

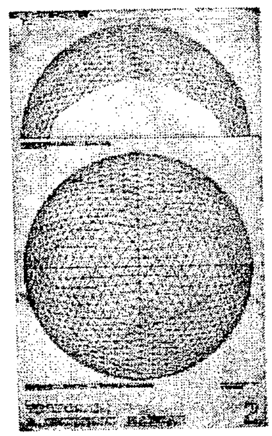


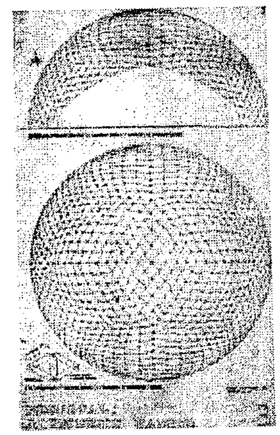
WOOD RIVER
CIRCA JAN 25, 59

Fig.3.09a USMC Geodesic Hangar, MIT, ca. 1951. Source: J. Ward ed., The Artifacts of R. Buckminster Fuller, Vol.3, p.80.

Fig.3.09b USMC Geodesic Hangar, MIT, ca. 1951. Source: J. Ward ed., The Artifacts of R. Buckminster Fuller, Vol. 81







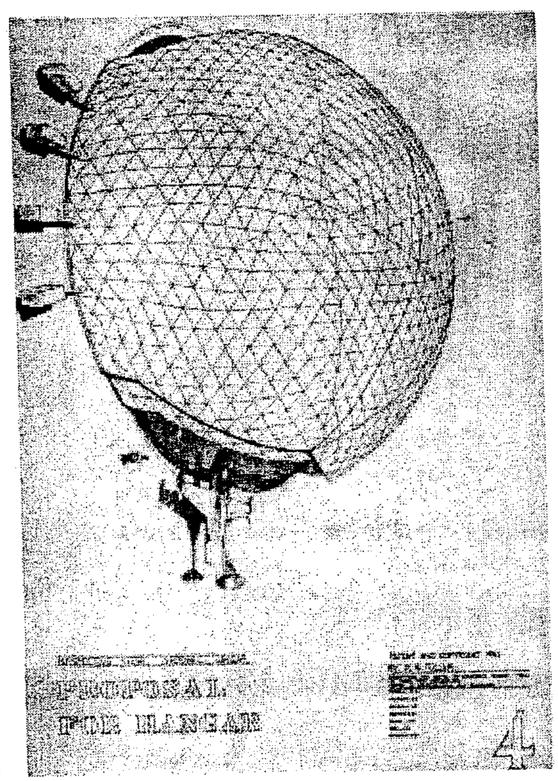


Fig.3.10 36'-D, 4-frequency alternate North Carolina State College Dome, January 1954. Source: Col. Lane's (USMC) Final Report, p.36

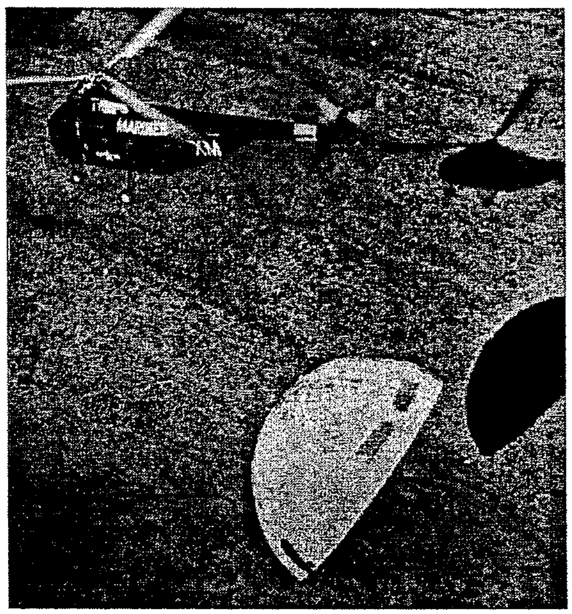


Fig.3.11 1/2 Sphere, 8-frequency alternate Tulane University Dome. Source: Col. Lane's (USMC) Final Report, p.37.

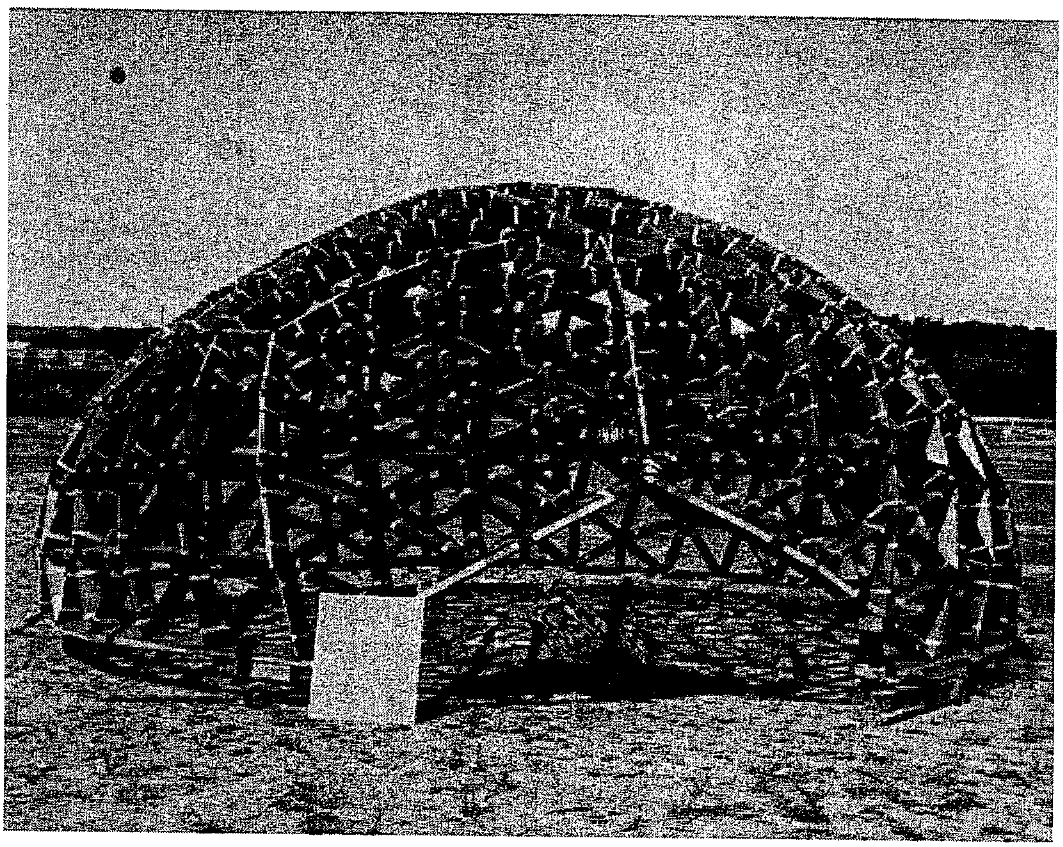
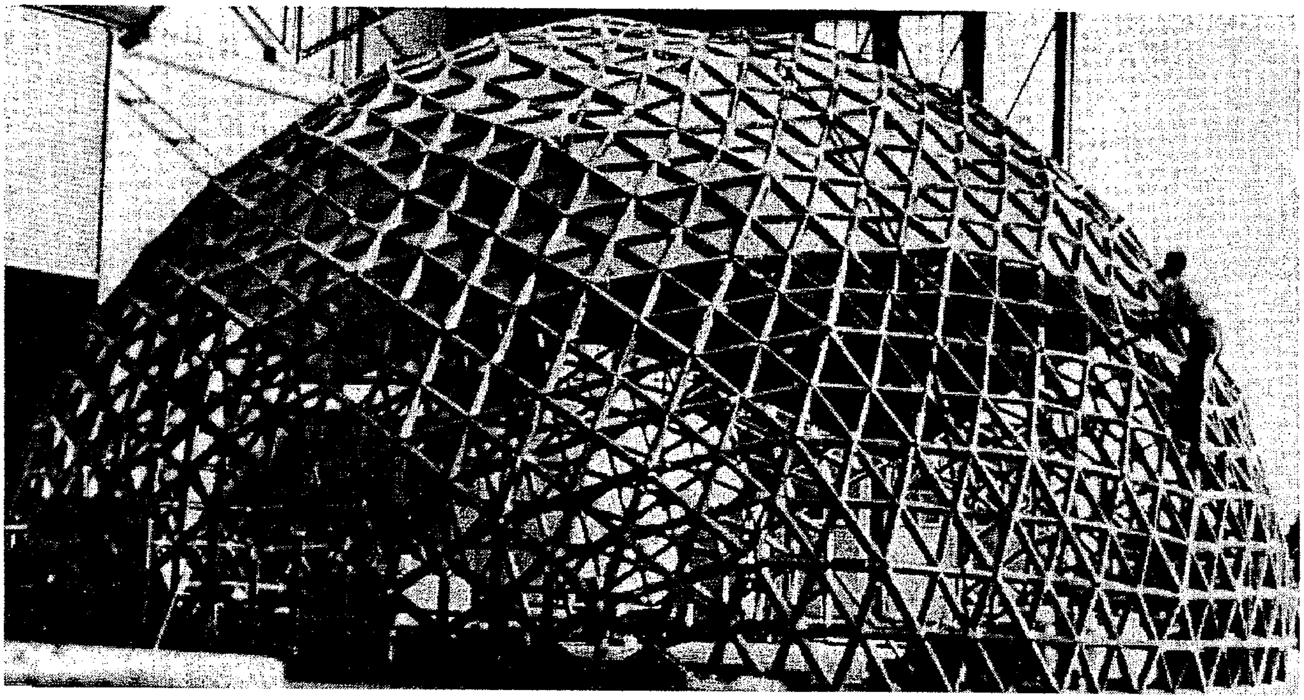


Fig.3.12 1/2 Sphere, Special BuAer(Navy Bureau of Aeronautics). Dome. Source: Col. Lane's (USMC) Final Report, p.41.



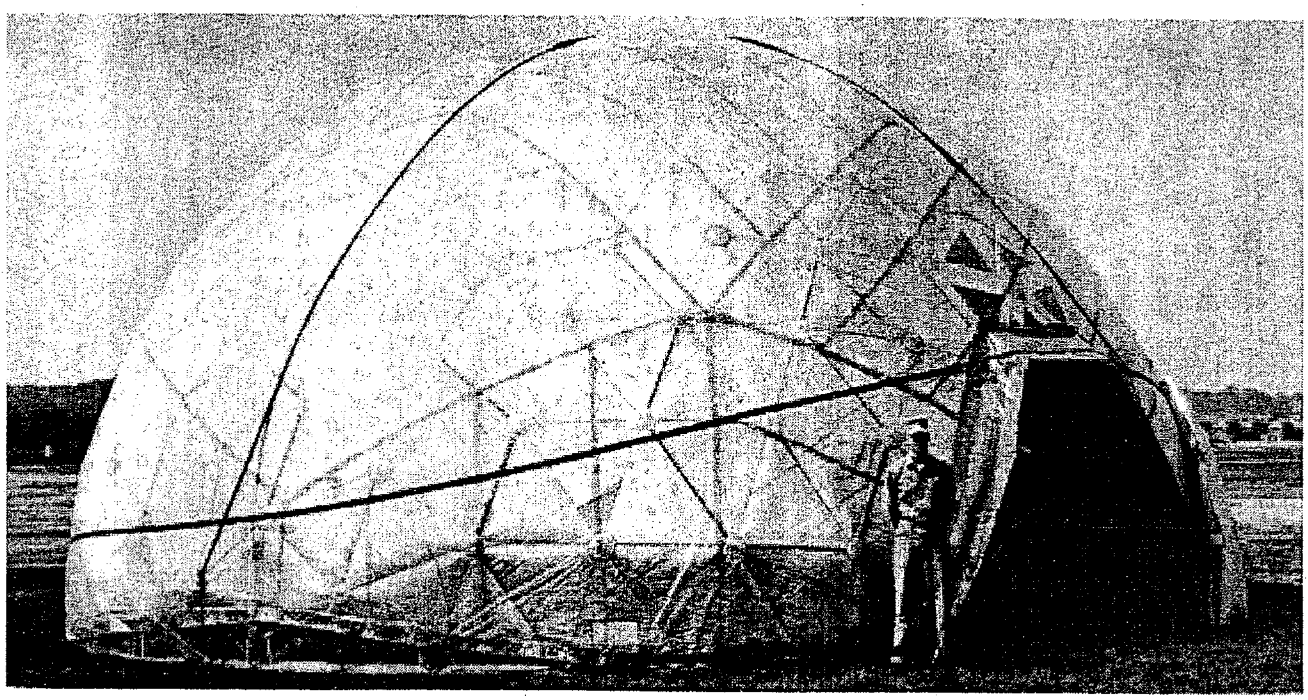
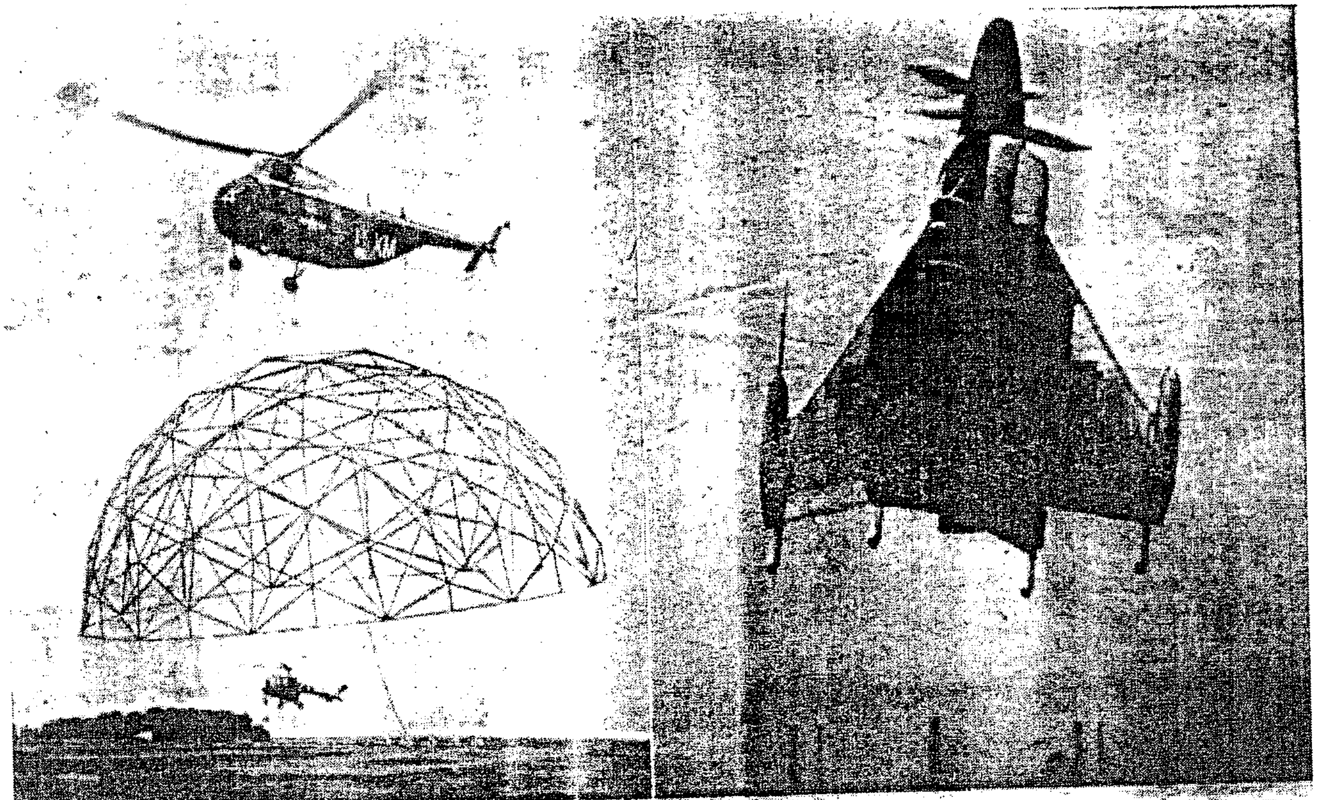


Fig.3.13 USMC Helicopter lift of a geodesic hangar featured alongside Navy's Convair XFY-1 (First un-tethered flight at Moffet Naval Air Station. Source: Washington Daily News, 5 August 1954.



Left, United Press Photo. Right, U. S. Navy Photo.

SOMETHING NEW FOR THE BIRDMEN—A Marine Corps helicopter picks up its own nest in a demonstration at Quantico. The magnesium ribbing is frame for a canvas-covered hangar which also will hold the 'copter's mate (background). At right, the Navy's Convair XFY-1 takes off on its first untethered vertical flight. It's at Moffett Naval Air Station.

Fig.3.14 Roberto Mango, Plan and section for the Milan Cardboard Dome (Autonomous House) for the Milan Triennale, undated. <u>Source:</u> BFI-CR159.

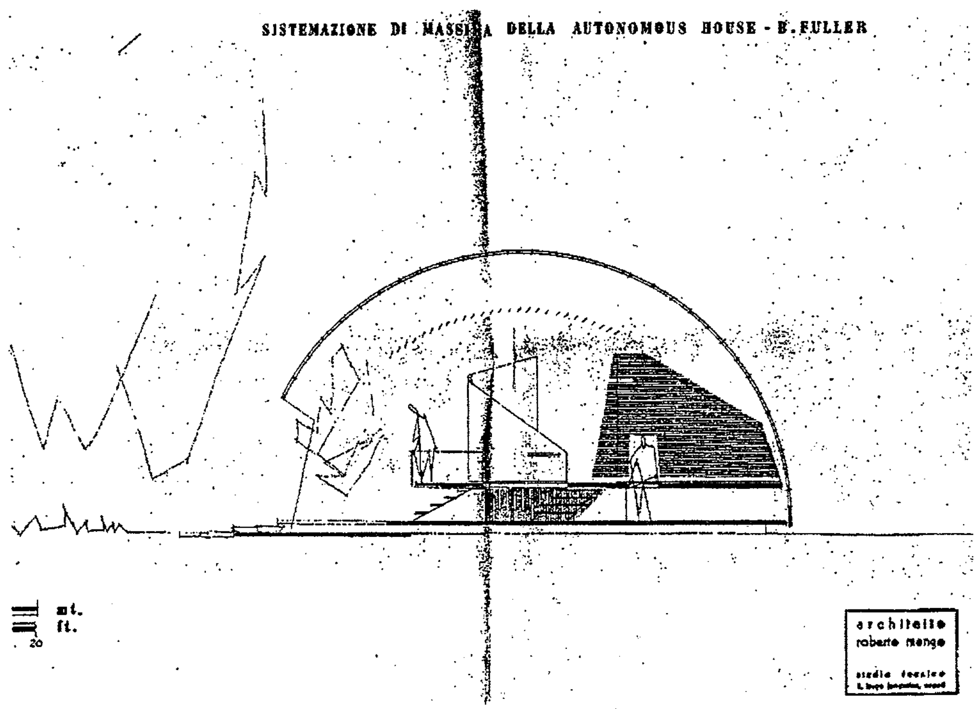
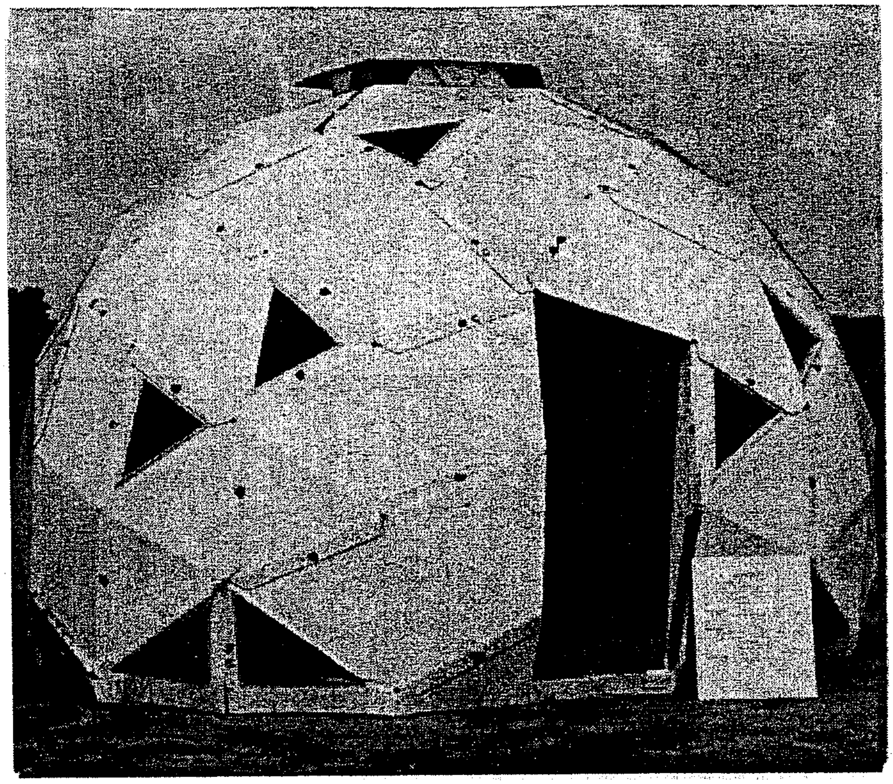


Fig.3.15 3/4 Sphere, Virginia Polytechnic Institute Dome, 5/01/54. Source: Col. Lane's (USMC) Final Report, p.39.



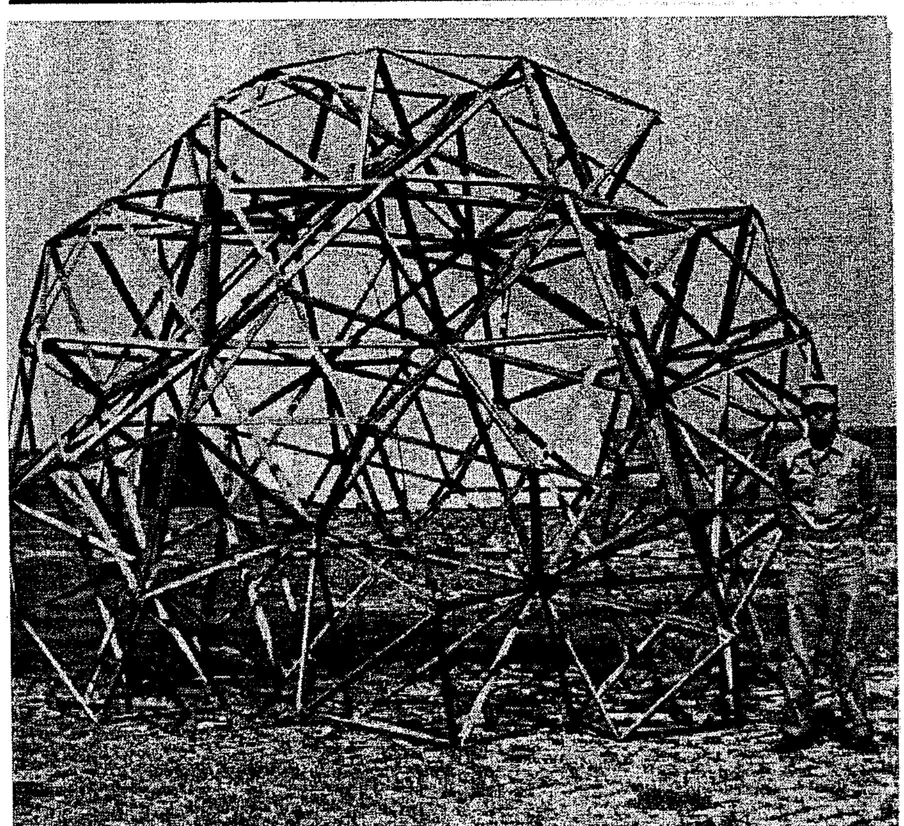


Fig.3.16a 55-foot Magnesium Hangar for USMC, ca, 1954. Source: J. Ward ed., The Artifacts of R. Buckminster Fuller, Vol.3, p.186.

Fig.3.16b 55-foot Magnesium Hangar for USMC, ca, 1954. Source: J. Ward ed., The Artifacts of R. Buckminster Fuller, Vol.3, p.187. (Renditions previously featured in "Marine Like Dome Shelters; Boon to Aircraft Wings seen," *Navy Times*, 14 August 1954, p.19).

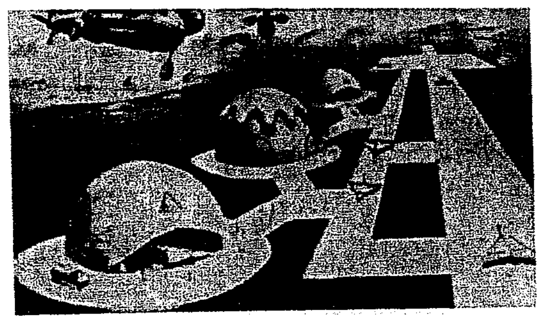
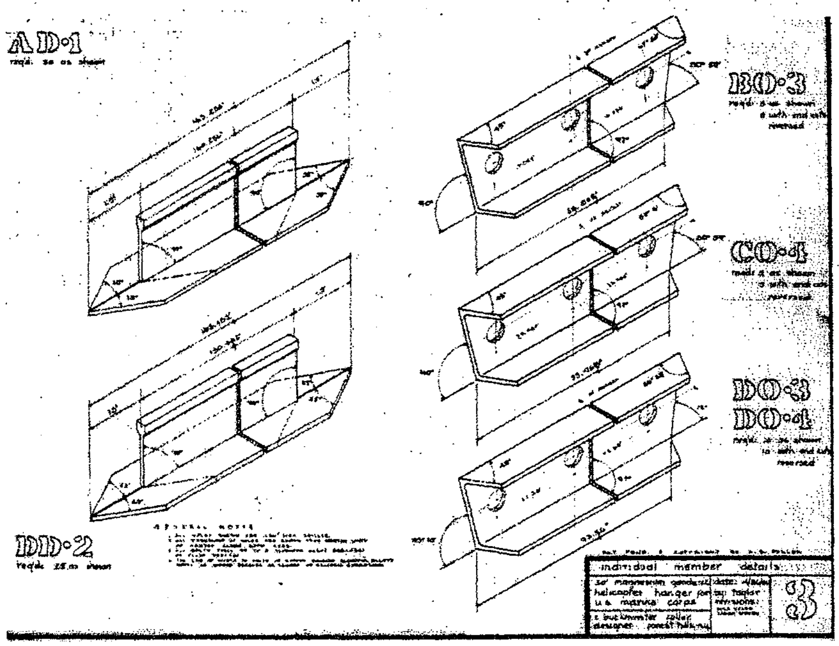


Fig.3.17a 55-foot Magnesium Hangar for USMC, ca, 1954. <u>Source:</u> J. Ward ed., <u>The Artifacts of R. Buckminster Fuller</u>, Vol.3, p.194.1-2.



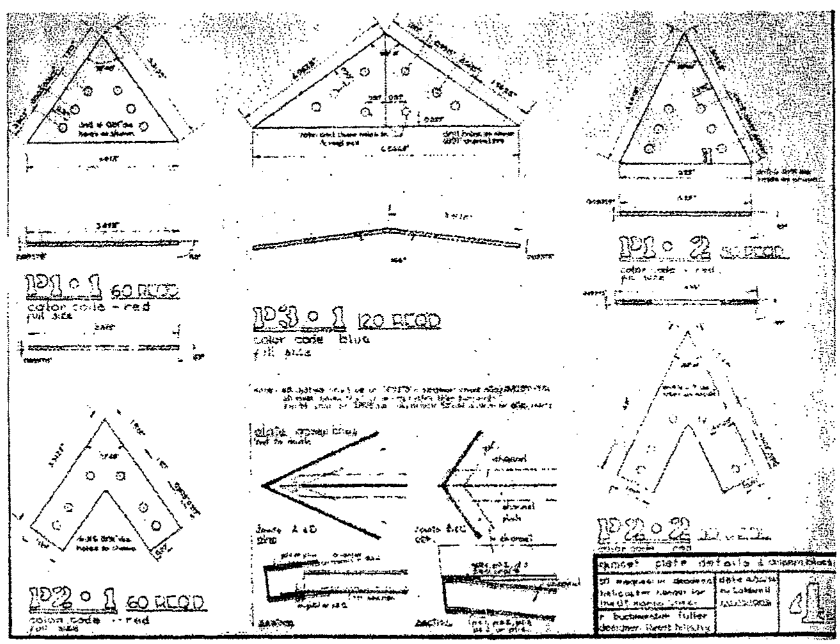
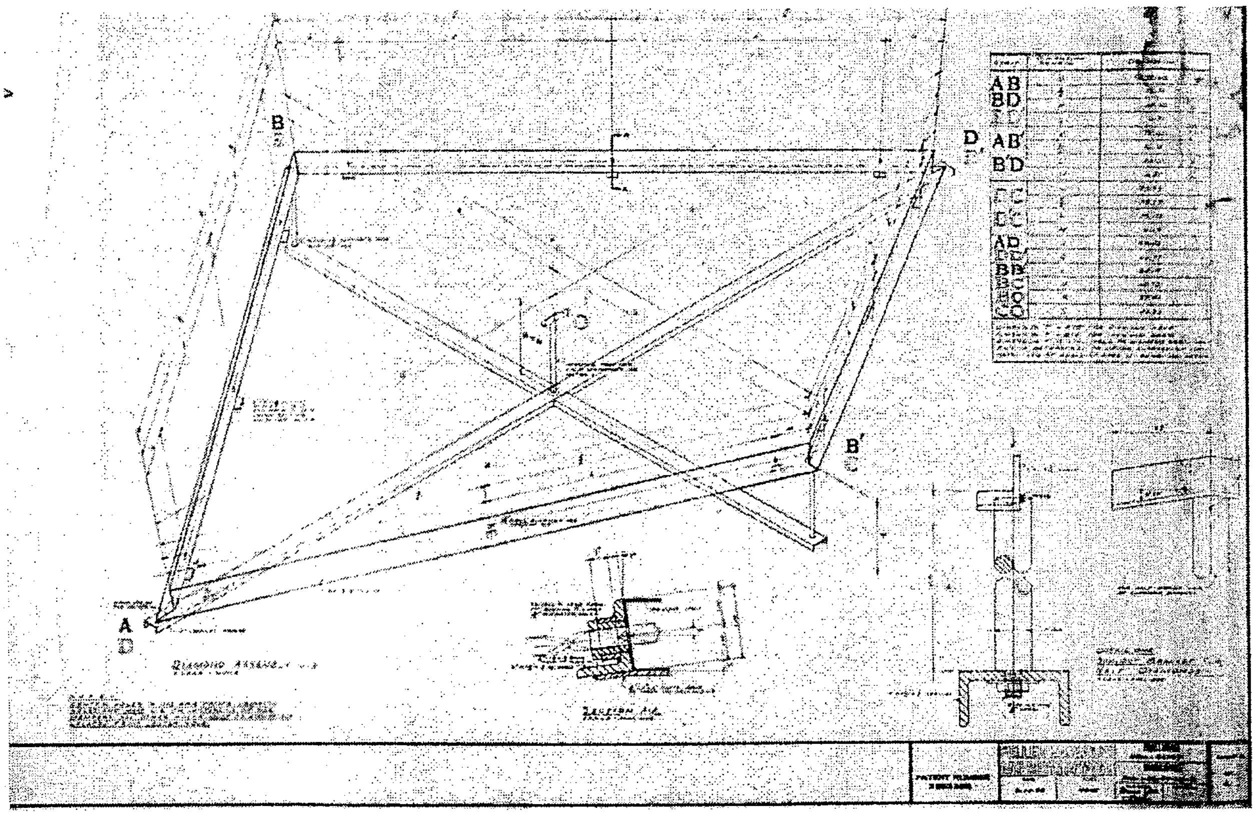


Fig.3.17b 55-foot Magnesium Hangar for USMC, ca, 1954. Source: J. Ward ed., The Artifacts of R. Buckminster Fuller, Vol.3, p.191.1-2.



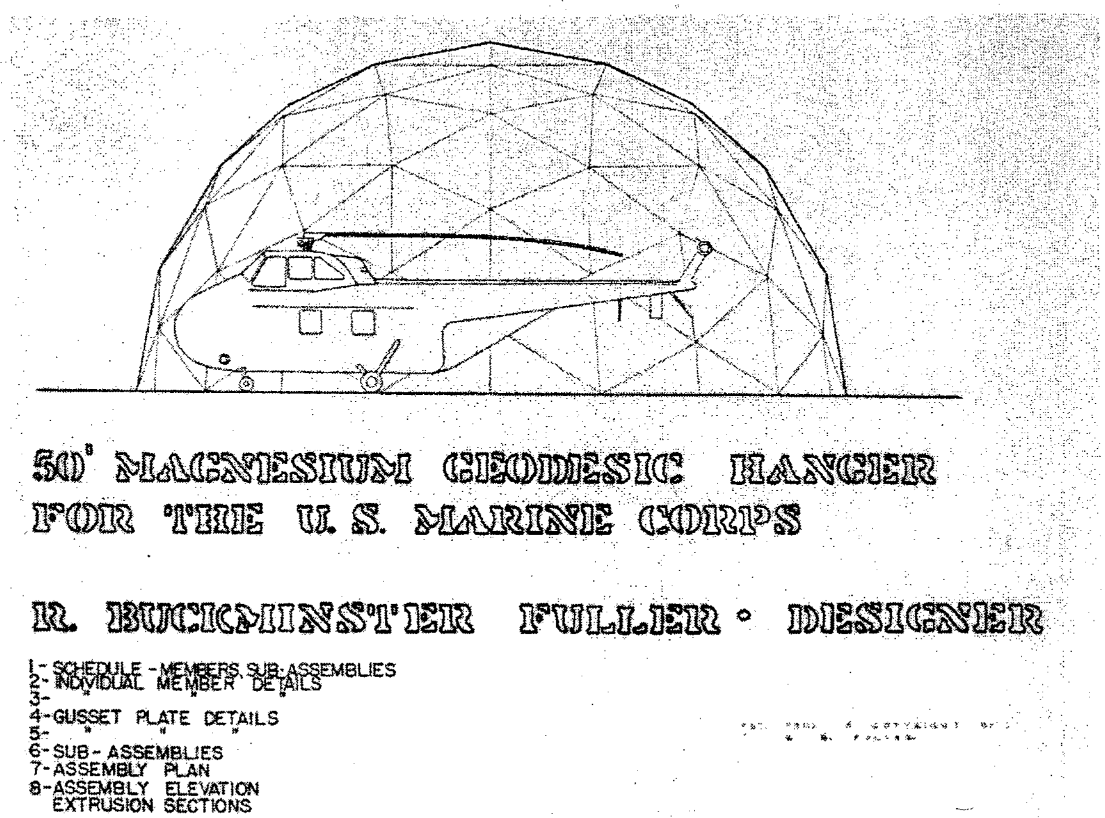
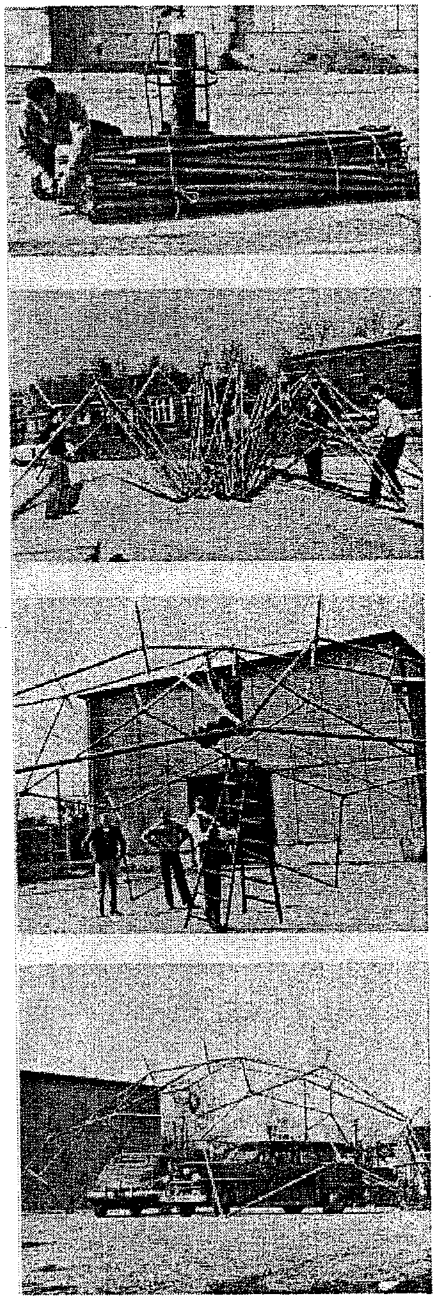
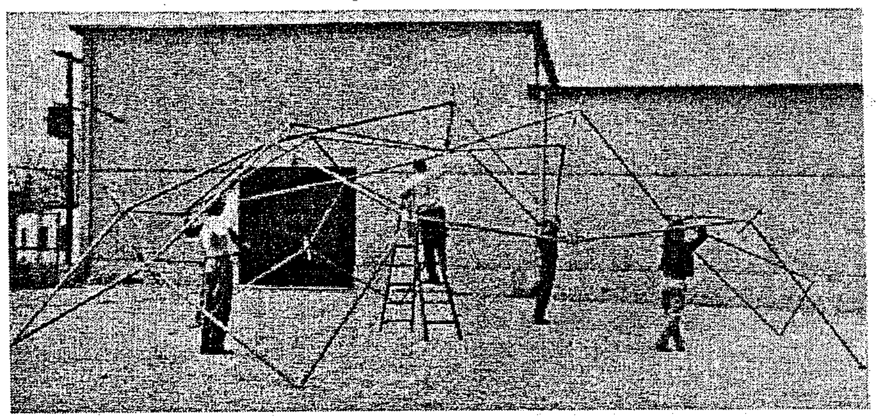


Fig.3.17c Washington University Hälsingborg project, ca 1955. Source: BFI-[?].
Fig.3.17d Washington University Hälsingborg project, ca 1955. Source: BFI-[?].





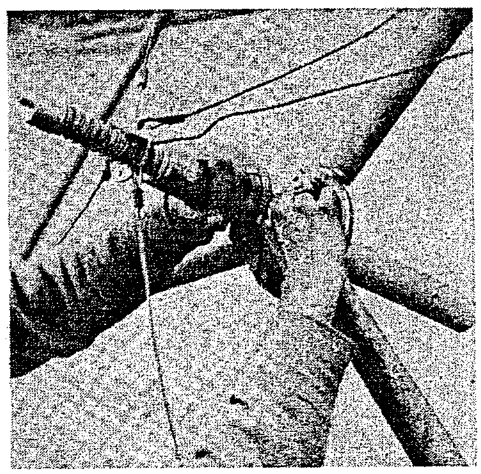
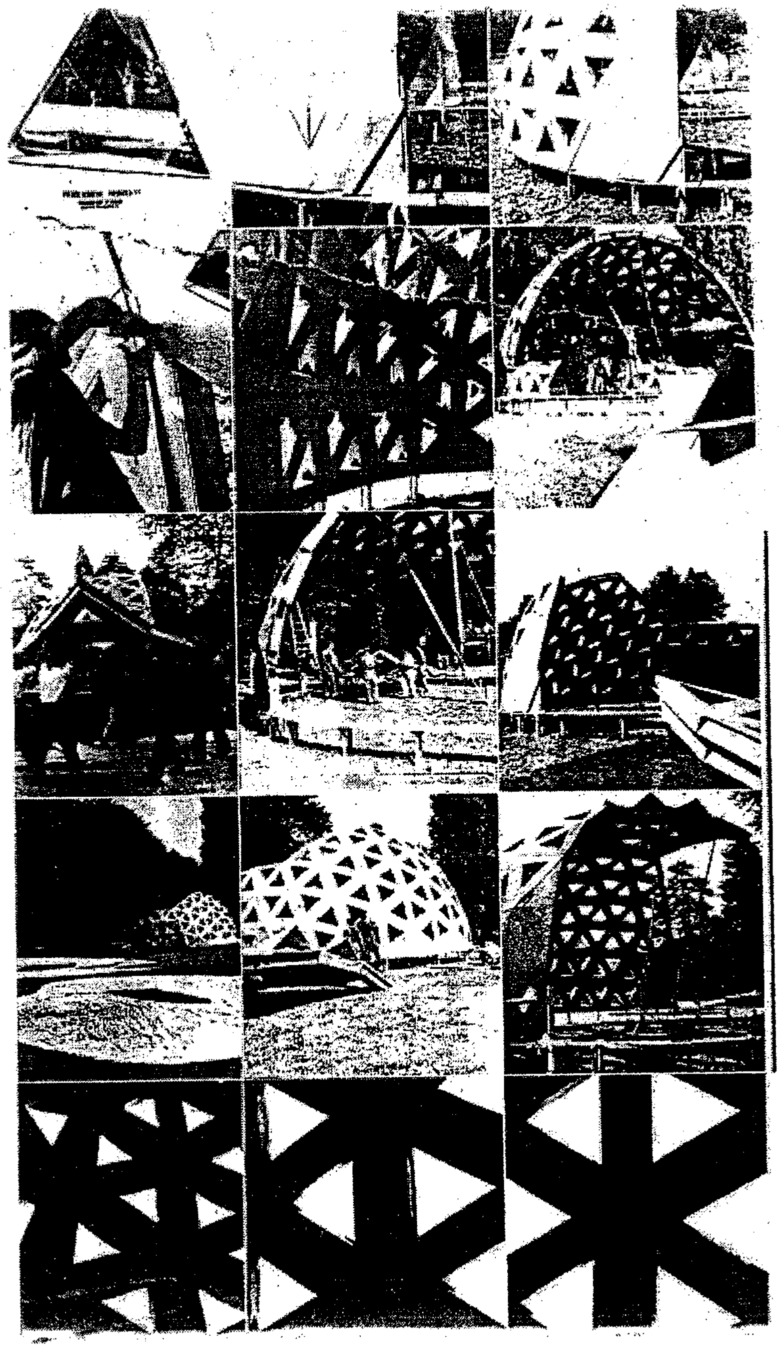


Fig.3.18 Details of the Cardboard Dome for the Milan Triennale. <u>Source:</u> *Industrial Design*, Oct. 1959.



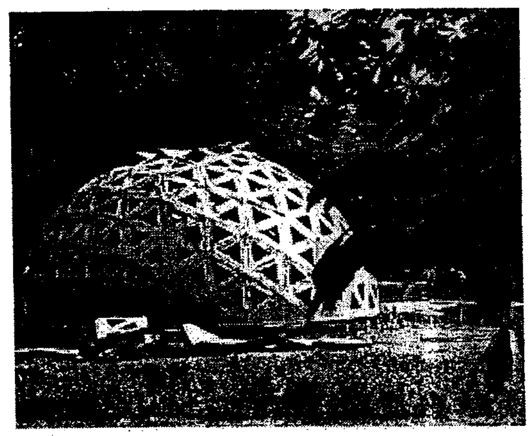


Fig.3.19 Statement of Navy Contracts, 5/9/55. Source: BFI-CR163.

MR. DONALD W. ROBERTSON
MR. R. BUCKMINSTER FULLER
MR. WILLIAM M. PARKHURST

5/9/55

NAVY CONTRACTS

CONTRACTED BY	CONTRACTED WITH	CONTRACTED FOR	AMOUNT OF CONTRACT	CONTRACT COMPLETED	CONTRACT NUMBER
R. BUCKMINSTER FULLER ENTERPRISES, SOUTHERN DIVISION (5-21-54)	DEPT. OF THE NAVY USMC AIR STATION CHERRY POINT, N.C.	1 SHELTER UNIT, FULLER S-36, 36-FT. POLYESTER REINFORCE GEODESIC DOME	$3,480.00	7-1-54	N1895-353A
FULLER ENTERPRISES SOUTHERN DIVISION (6-18-54)	DEPT. OF THE NAVY USMC SCHOOLS QUANTICO, VA.	1 GEODESIC DOME PERSONNEL SHELTER, FULLER P-36	$17,573.70	11-8-54	NO_y-66707
R. BUCKMINSTER FULLER (6-15-54)	DEPT. OF THE NAVY BUREAU OF AERONAUTICS WASHINGTON, D. C.	DRAWINGS FOR: 1 36-FT. GEODESIC DOME, 1 117-FT. " "	$34,967.00	12-5-54 12-9-54 2-2-55	NO_{AS}54-718-C
(11-26-54)		DRAWINGS FOR: 1 55-FT. GEODESIC DOME	$19,468.91	2-2-55	AMEND. #1
(4-4-55)		PHYSICAL TEST	$ 9,880.00	INCOMPLETE	AMEND. #2
(PROPOSED)		IMPROVED DESIGN DRAWINGS, TESTING, COLOR CODING FOR 55-FT. DOME	$ 4,880.17	(PROPOSED)	"PROPOSED" AMEND. #3
GEODESICS, INC. (4-20-55)	DEPT. OF THE NAVY USMC SCHOOLS QUANTICO, VA.	FRAME FOR GEODESIC DOME SHELTER, ALUMINUM	$ 7,957.00	INCOMPLETE	NO_y-67443
GEODESICS, INC. (3-8-55)	DEPT. OF THE NAVY USMC SCHOOLS QUANTICO, VA.	GEODESIC DOME PERSONNEL SHELTER	$15,698.00	INCOMPLETE	NO_y-67433
GEODESICS, INC. (4-25-55)	DEPT. OF THE NAVY USMC AIR STATION QUANTICO, VA.	EXTRUSIONS (FOR CONSTRUCTION OF 1 GEODESIC DOME	$ 900.00	INCOMPLETE	ORDER #625-55

Fig.3.20a Fuller and Colonel Lane (Head of Aviation Logistics, USMC) at Princeton University award ceremony, ca. 1956. Source: BFI Photo #F-3-90.

Fig.3.20b Fuller and Colonel Lane examining one of the dome models. Source: Interiors, July 1954.

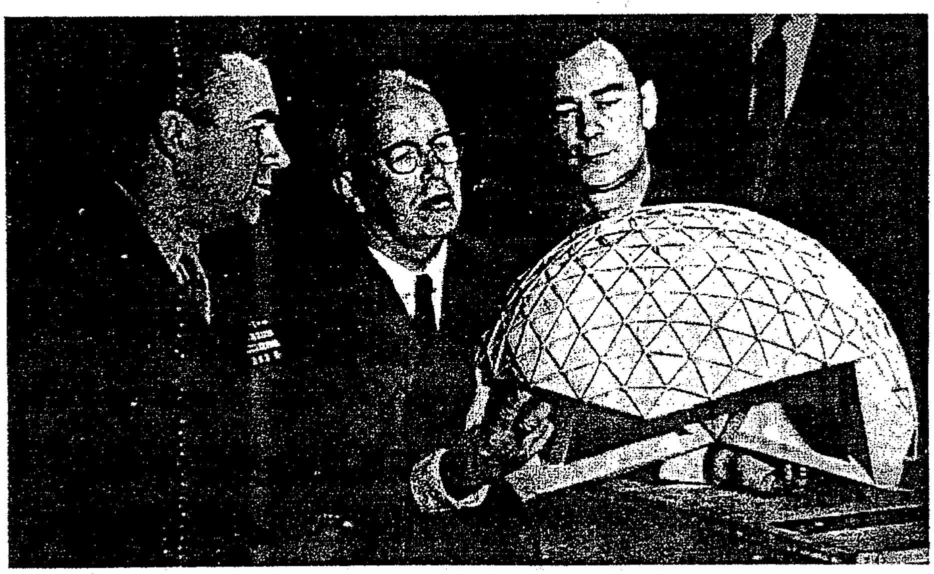


Fig.3.20c Sketches for a 108'-diameter maintenance and ready hangar. Source: Colonel Lane Informal Report.

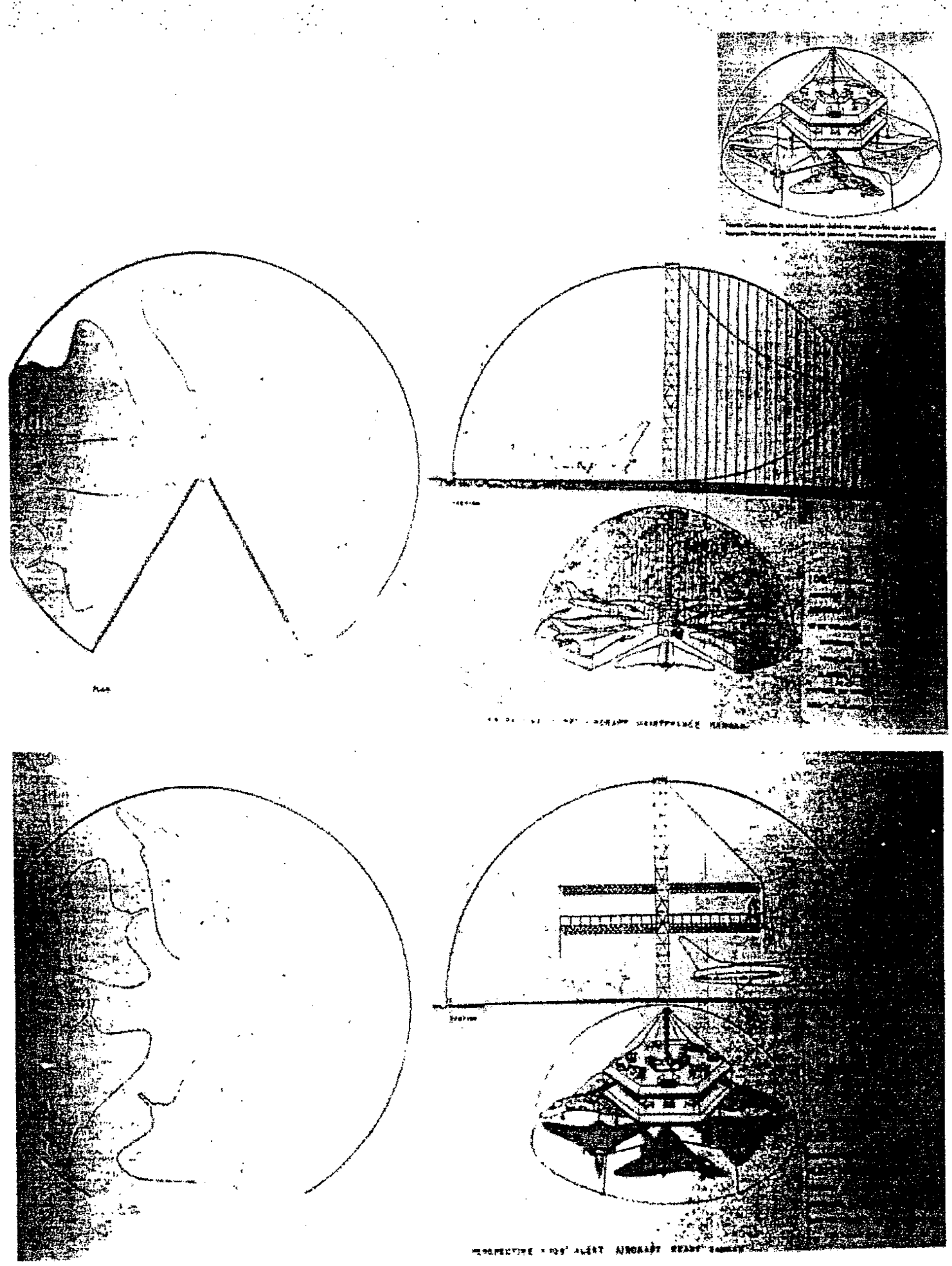


Fig.3.21 Advertisement, on Kraft paper technology. Source: BFI-CR155.

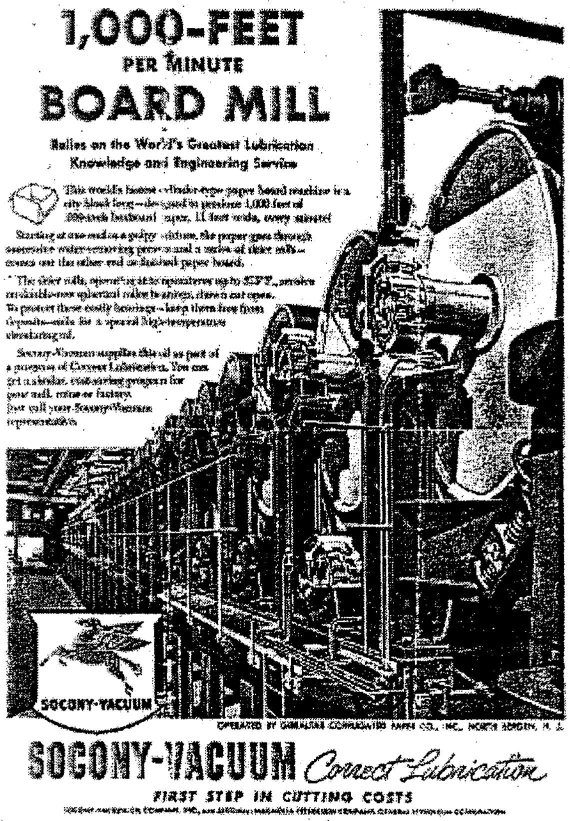


Fig.3.22 Yale Cardboard Dome, 11/01/52. Source: "The Cardboard House" in *Perspecta 2*, Yale Architectural Journal, , Autumn 1953, pp.34-35.

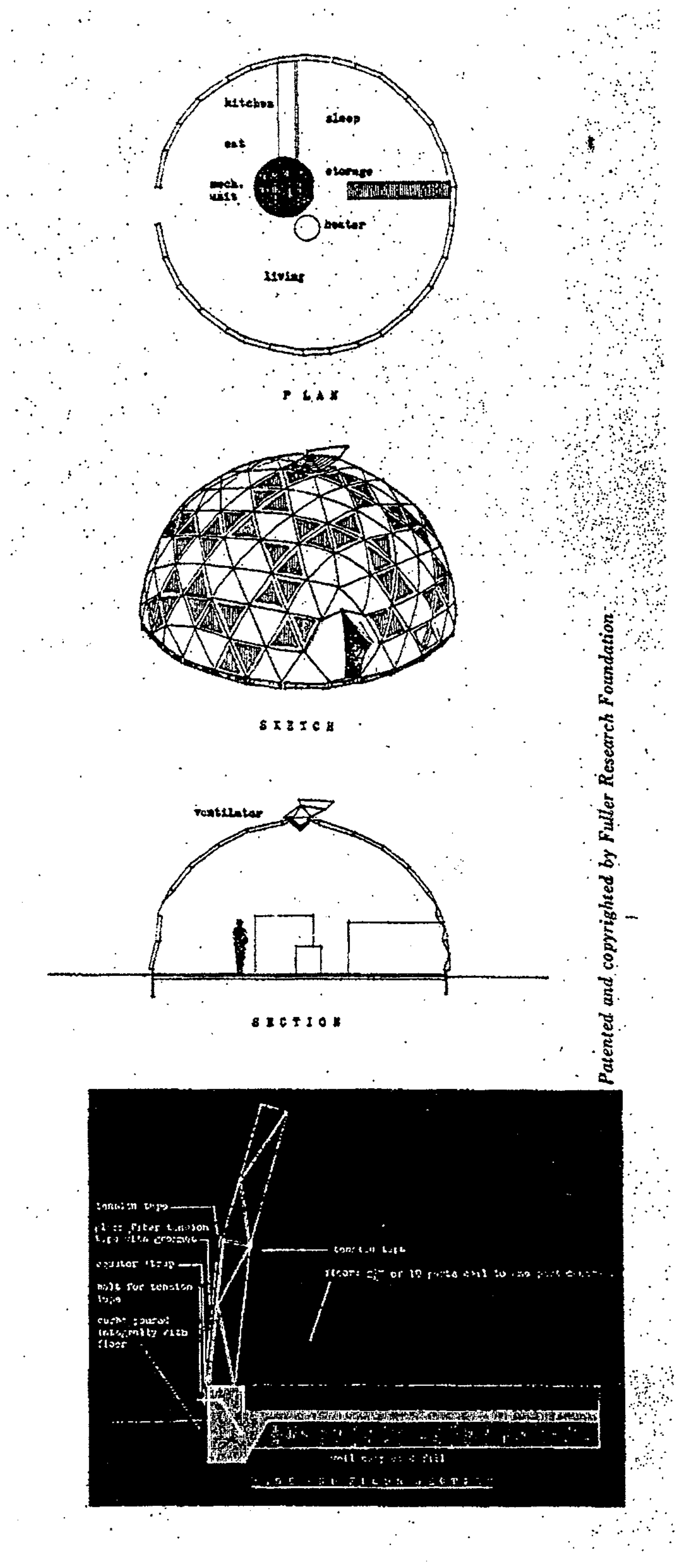


Fig.3.23a Geodesics Inc.(Raleigh), Submission to GE(Electronic Division) Portable Electronic Equipment & Shelter, 8/21/58. <u>Source:</u> BFI-CR193.

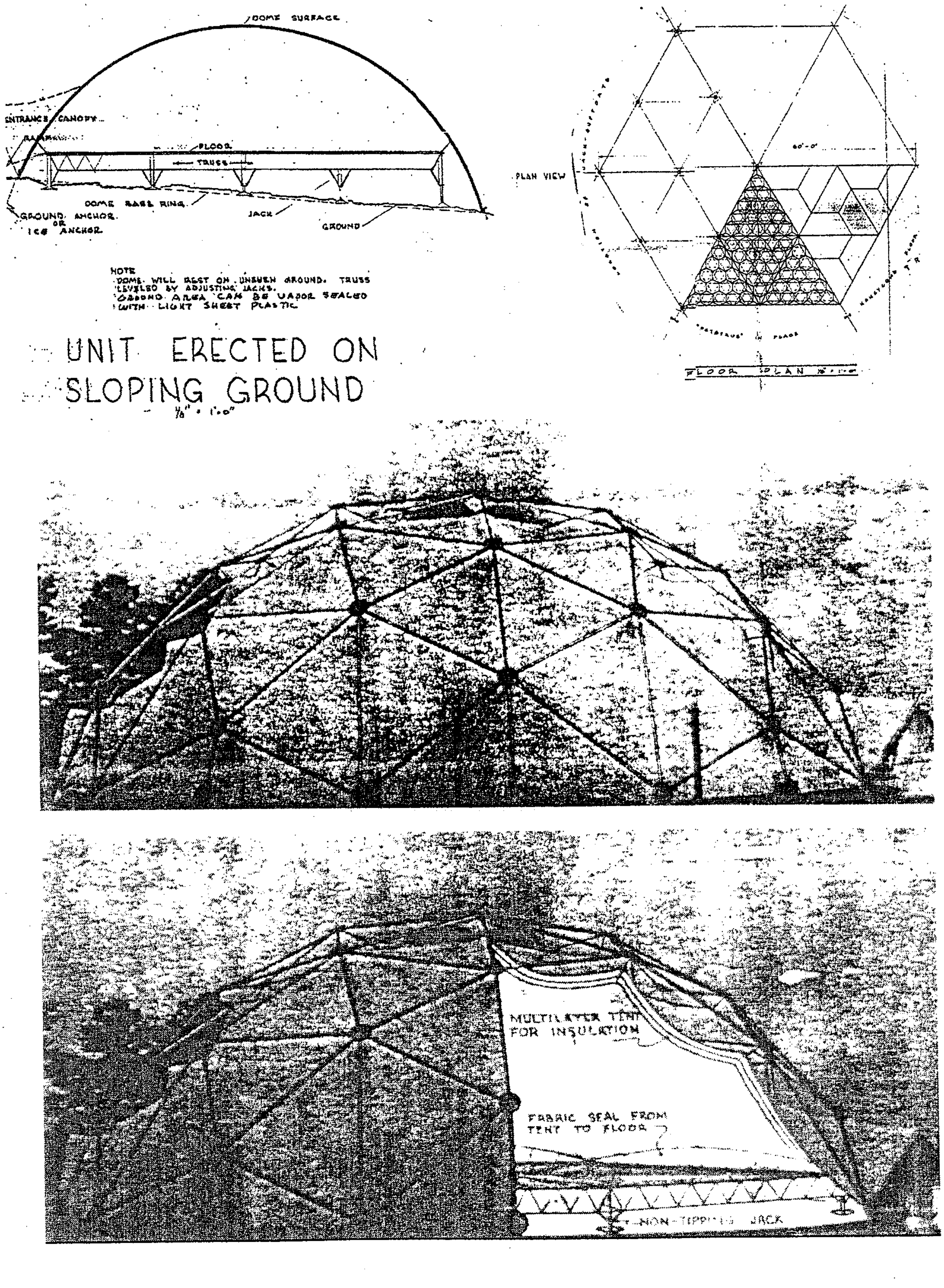


Fig.3.23b Geodesics Inc.(Raleigh), Rotating Geodesic Arctic Shelter, 12/12/55. Source: BFI-CR173.

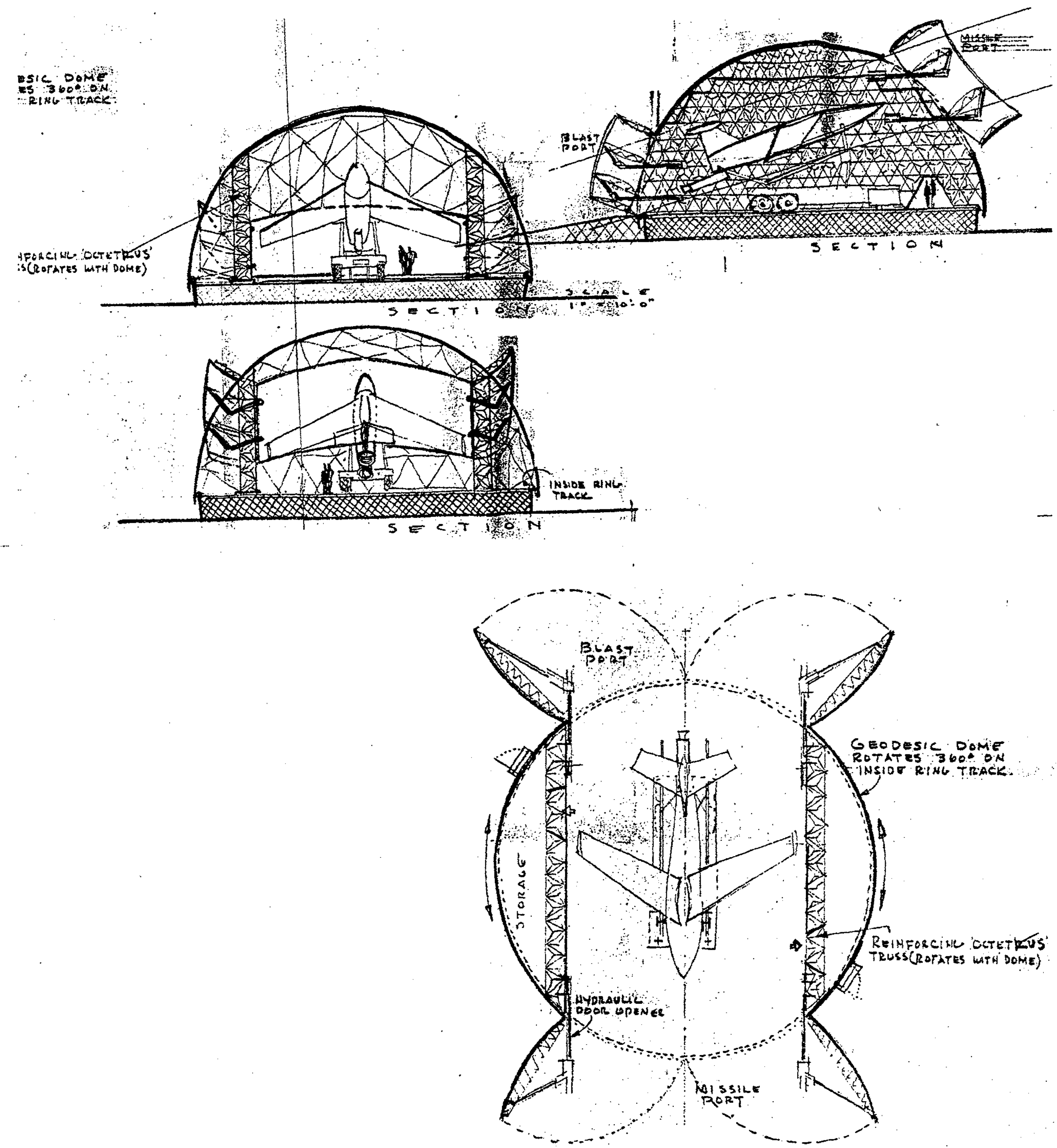


Fig.3.23c Geodesics Inc.(Raleigh), Geodesic Dome Octet Truss Retractable Shelter, 12/12/55.
Source: BFI-CR173.

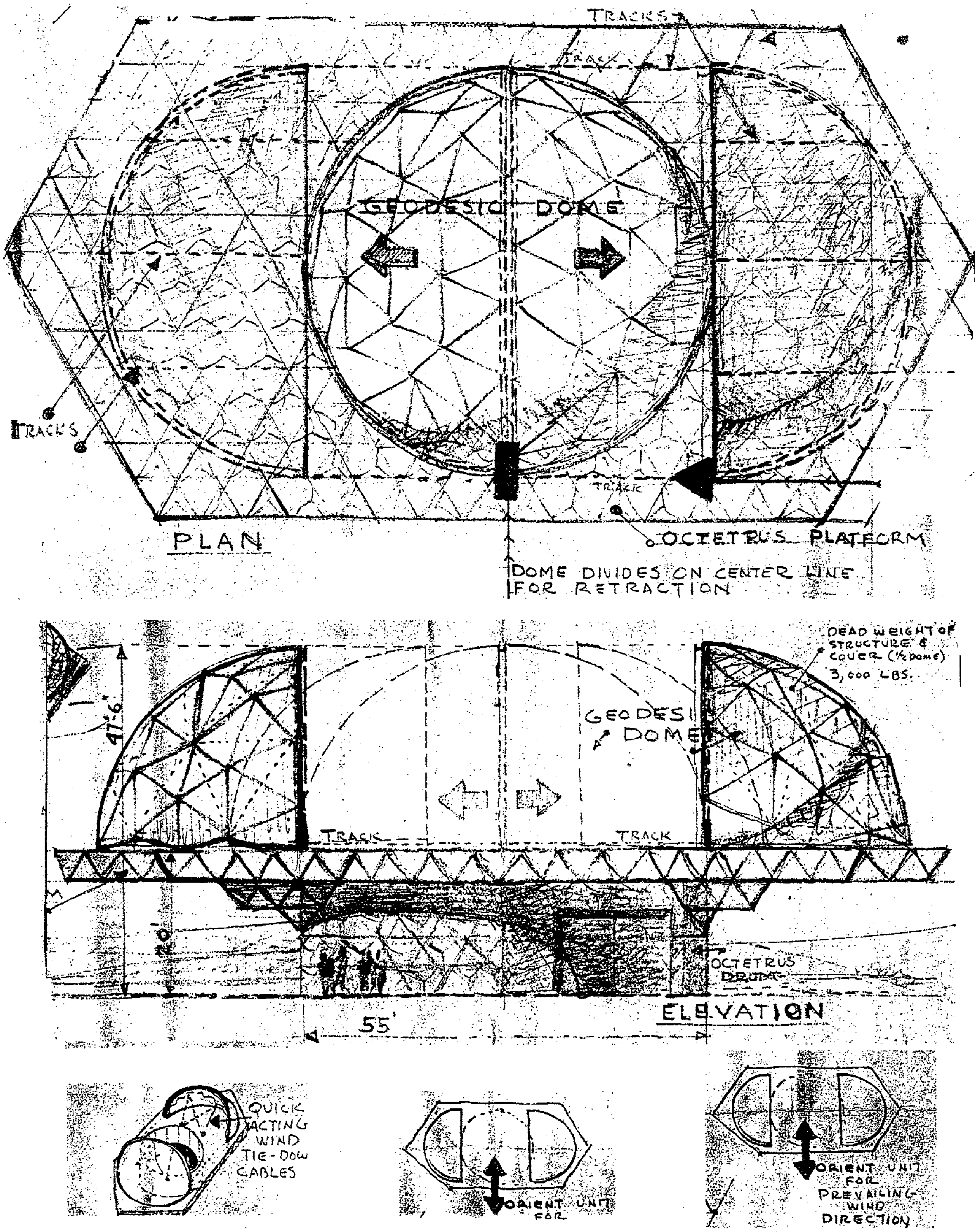


Fig.3.23d Geodesics Inc.(Raleigh), Geodesic Dome Frame & Tent Shelter - Tropics, 12/12/55.
Source: BFI-CR173.

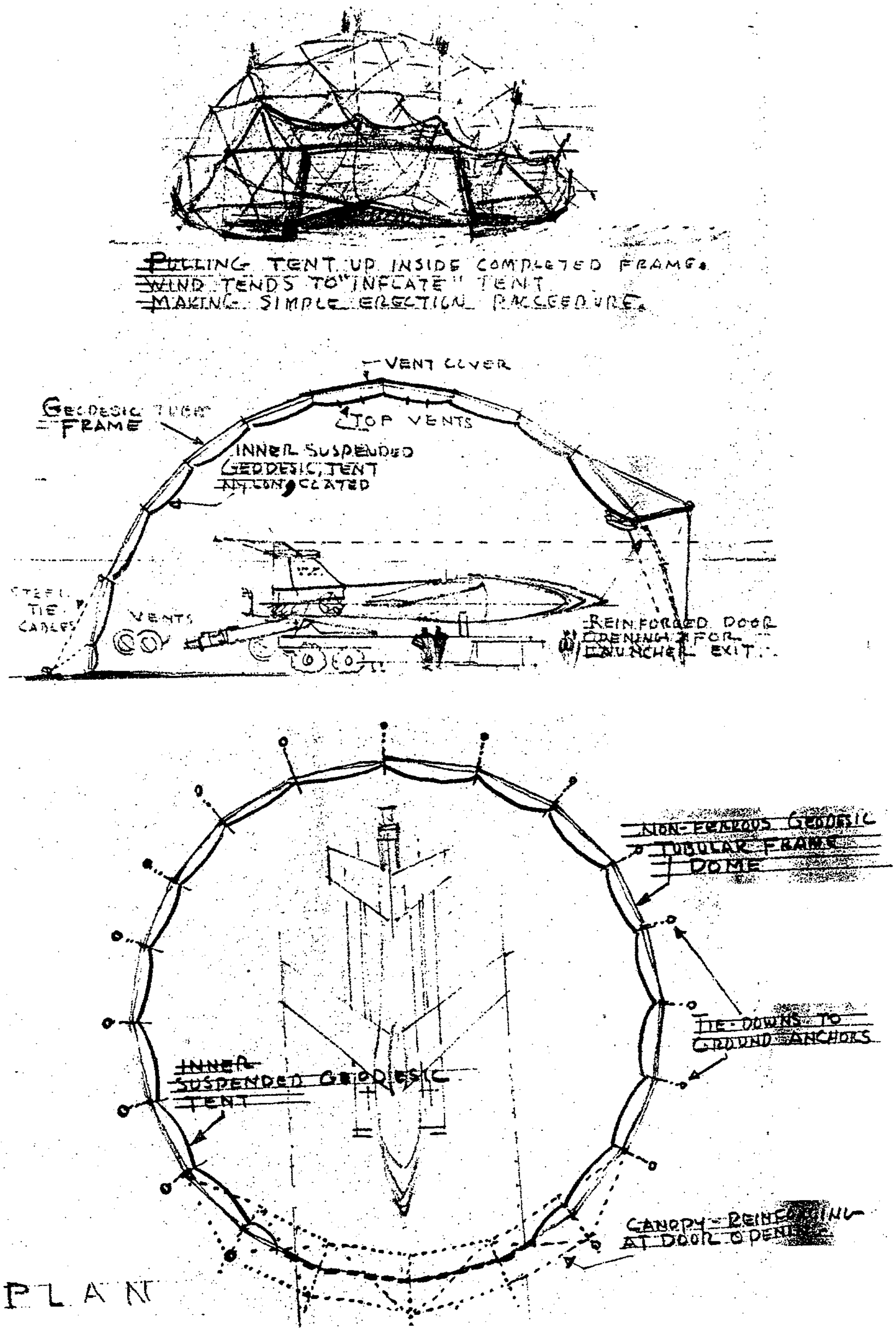


Fig.3.23e Geodesics Inc.(Raleigh), "Mk II," ca. December 1956. <u>Source:</u> BFI-CR181.

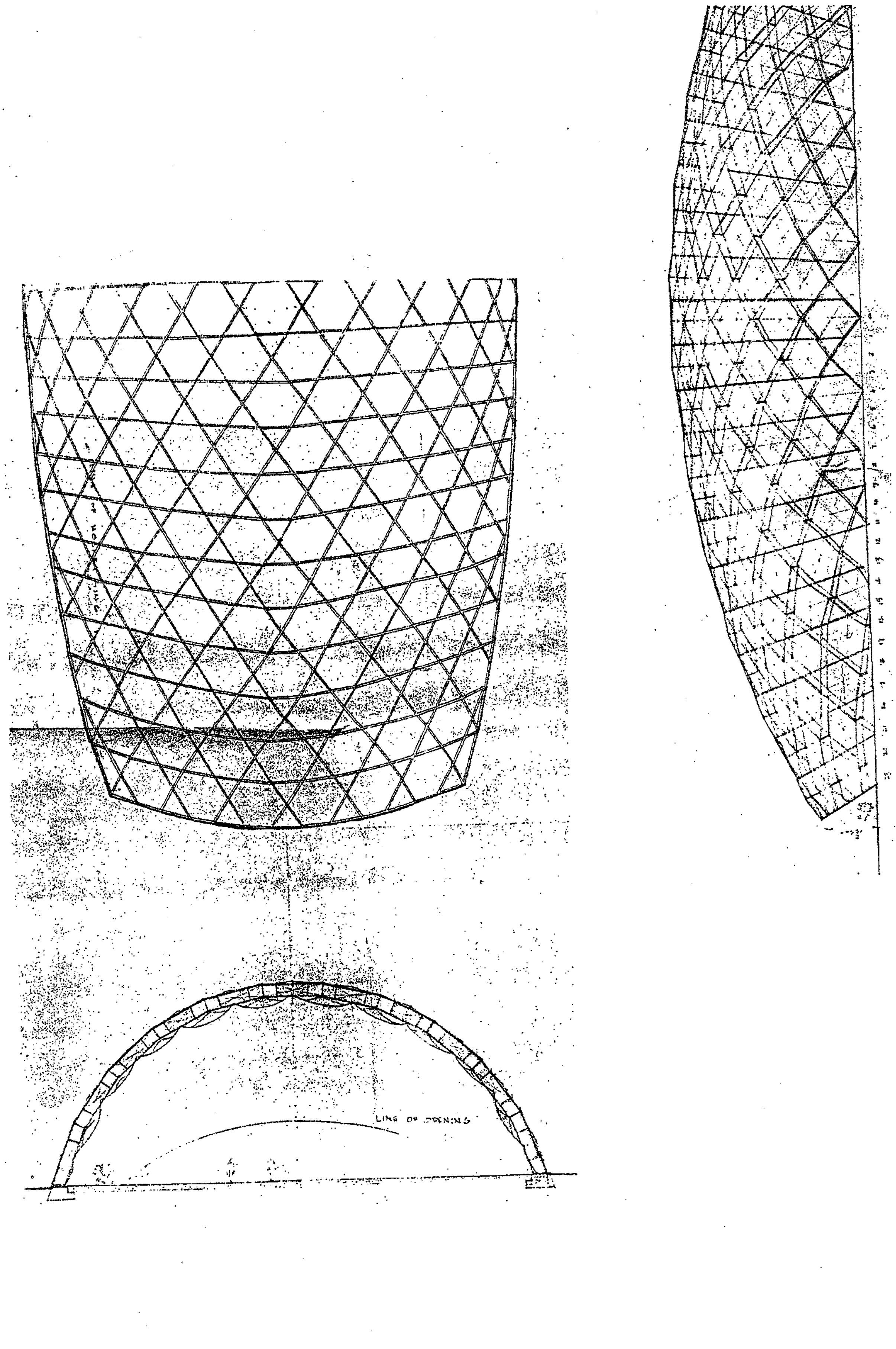
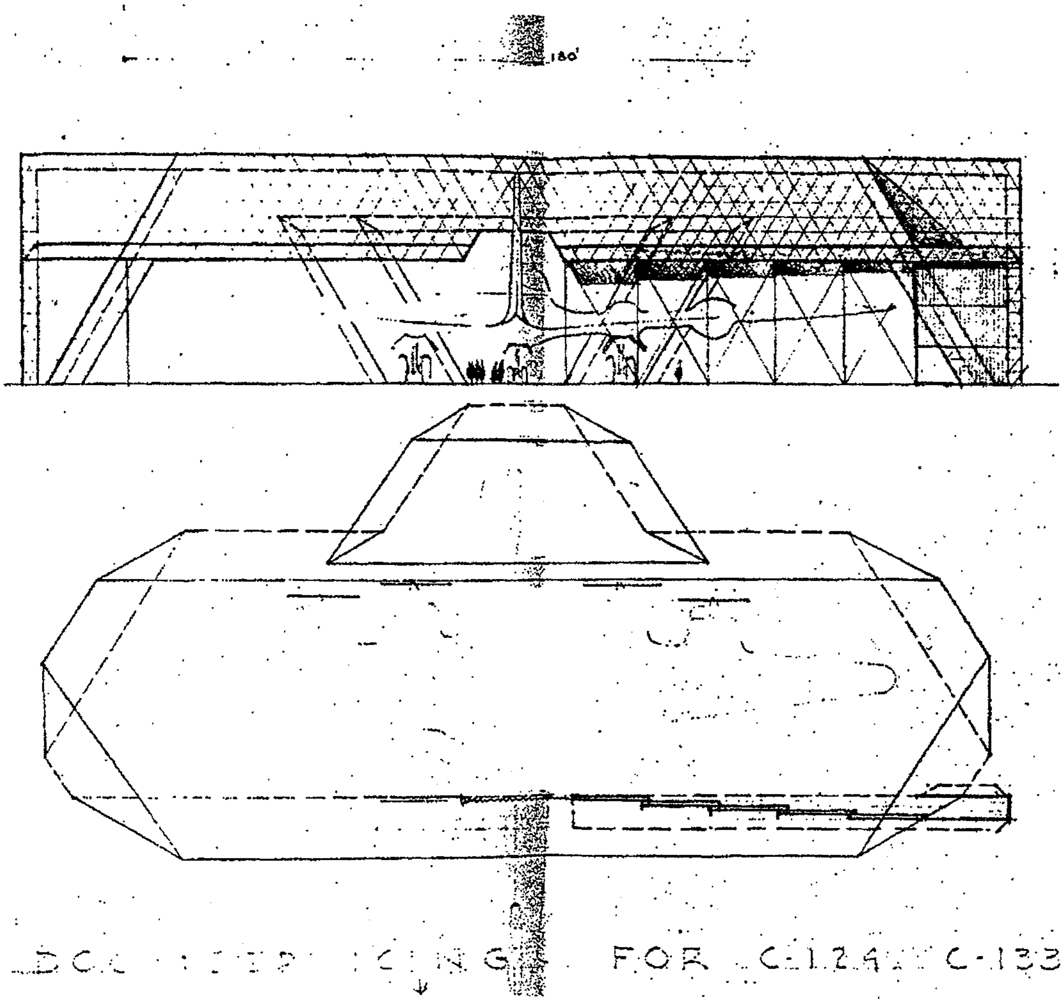
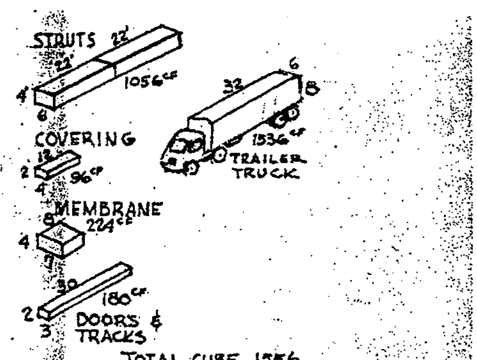


Fig.3.23f Geodesics Inc.(Raleigh), Octet Truss Hangar, 12/12/55. Source: BFI-CR162.

GEODESICS INC.
3013 Hillsboro Raleigh, N. C.



	INTERNAL	EXTERNAL	
DOOR OPENING			180'
DOCK WIDTH	60'	68'	
DOCK LENGTH	200'		
NOSE SECTION	48x32		
COVERED AREA	13,020		
AIR PLANE	C-124		C-133
DOCK COVER	CORRUG. ALUMINUM		
Nº OF STRUTS	ALUMINUM		38,000
LENGTH STRUT			4'-0"
WEIGHT STRUT			1.25 LBS
TOTAL WGT STRUTS			47,500 LBS
WEIGHT COVER			10,000 LBS
WEIGHT MEMBRANE			3,900 LBS
WEIGHT DOORS			8,800 LBS
WEIGHT TRACKS	@ 5 LBS FOOT		2,000 LBS
TOTAL WEIGHT			72,000 LBS
PACKAGED CUBE	TOTAL		1,556 CFT



Scale 1" = 24'
May 30 1955

GEODESICS INC.
3013 Hillsboro Raleigh, N. C.

Fig.3.23g Geodesics Inc.(Raleigh), Hangar 12/12/55. <u>Source:</u> BFI-CR181.

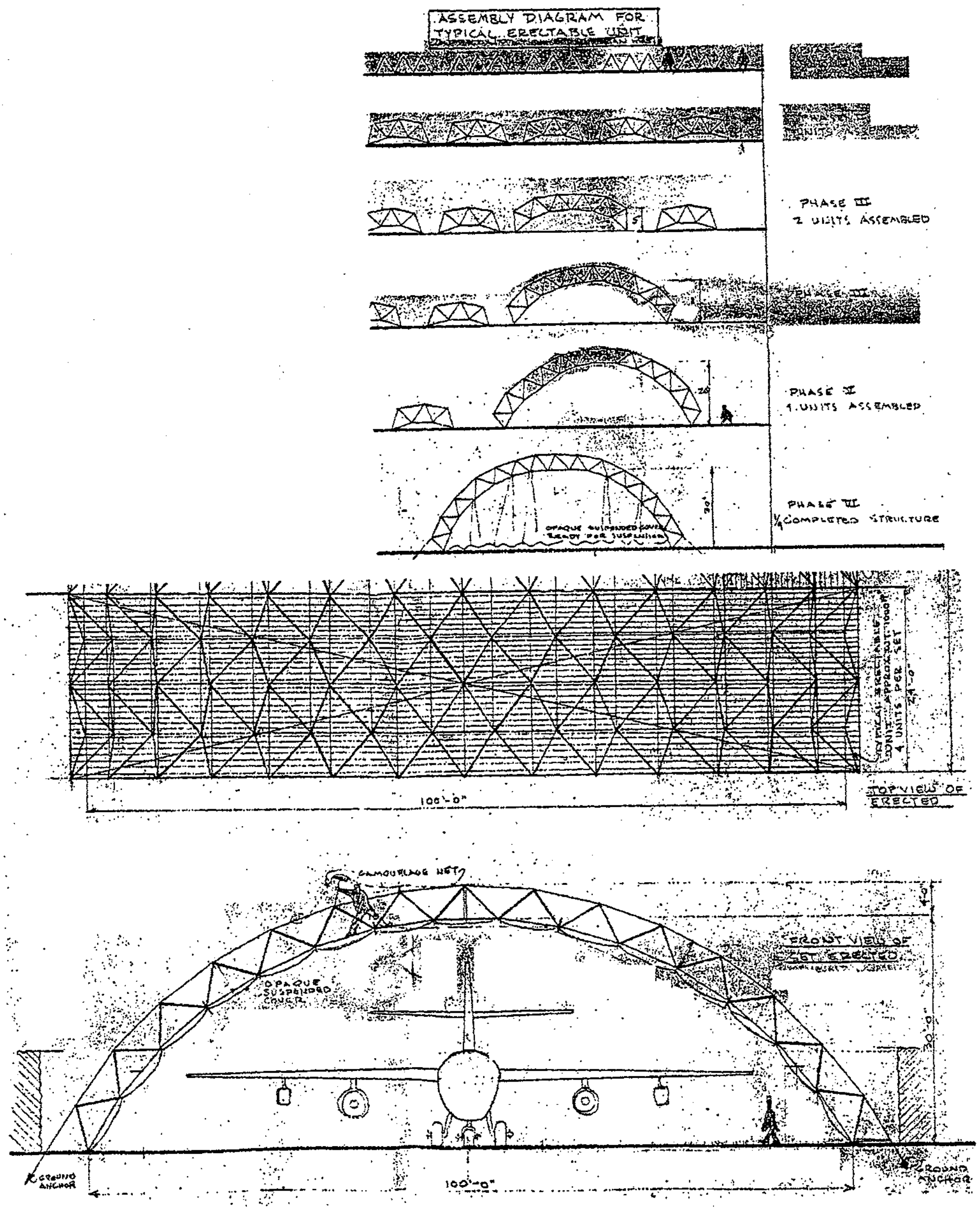


Fig.3.24 Geodesics Inc.(Raleigh), Photos of USMC-NCSC Heli-lift & 30'-D 16-frequency Plastic-cocoon Dome, January 1954. Source: BFI-[?].

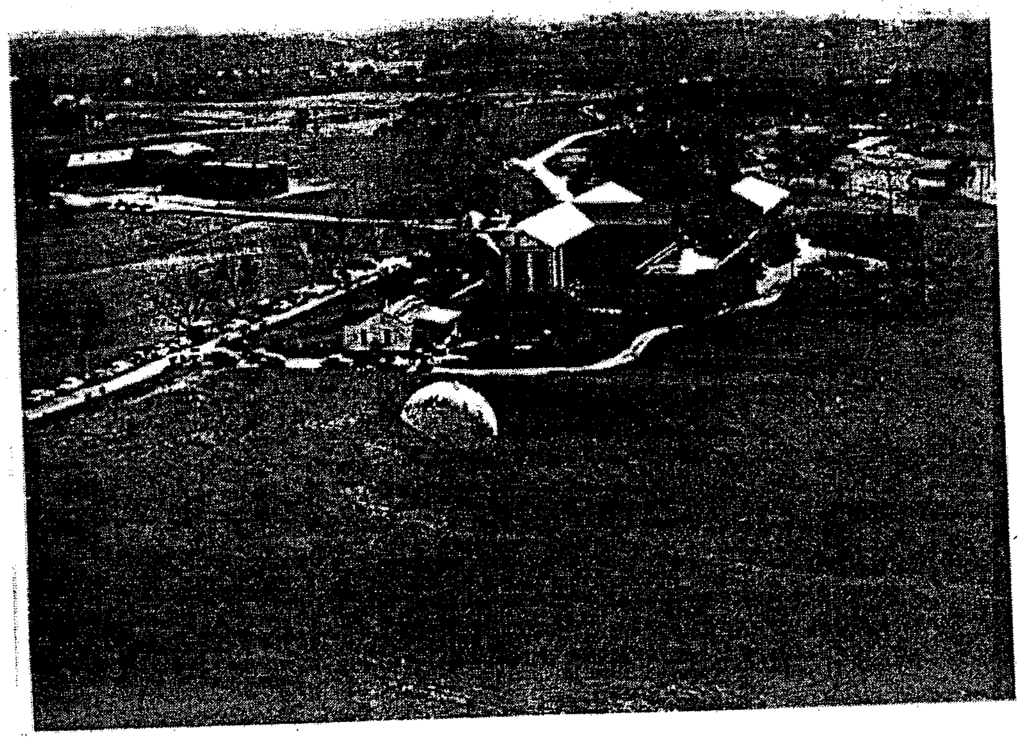


Fig.3.25 Photography with caption: " Fuller witnesses successful completion of first airlift of 'delivery' of shelter after 27 years of experimental development to that event," January 1954. Source: BFI-Photo #N-7-4.

Fig.3.26 Synergetics Inc., Projects Time-line, ca. 1955. Source: BFI-[?].

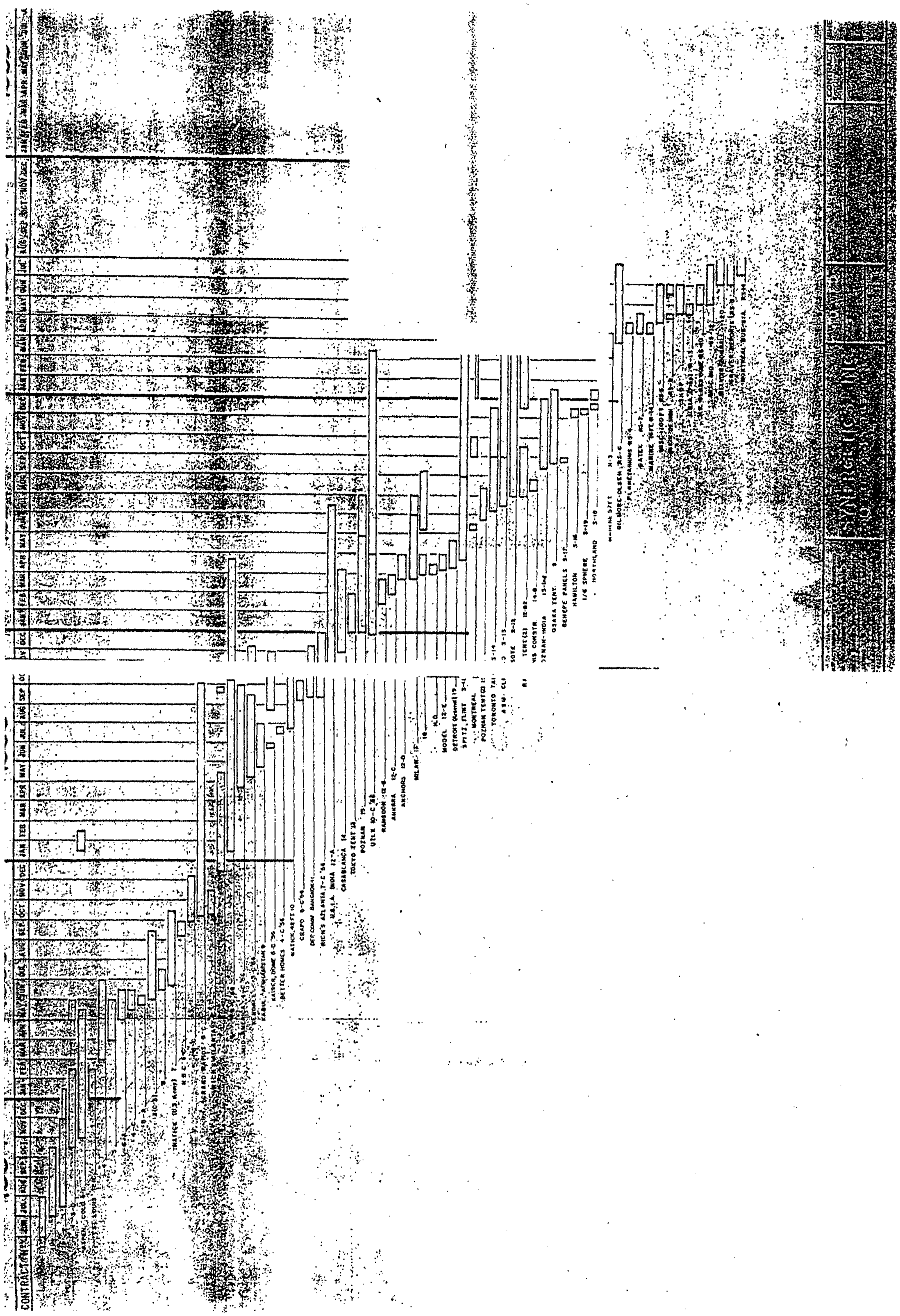
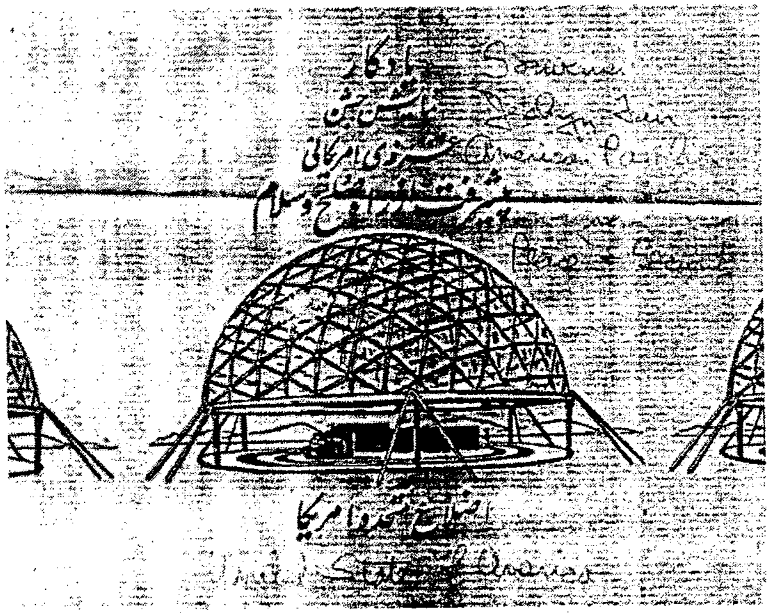


Fig.3.27a General View, American Pavilion, Jeshyn-Fair, Kabul-Afghanistan, ca. July 1956. Source: BFI-Photo #K-2-1.



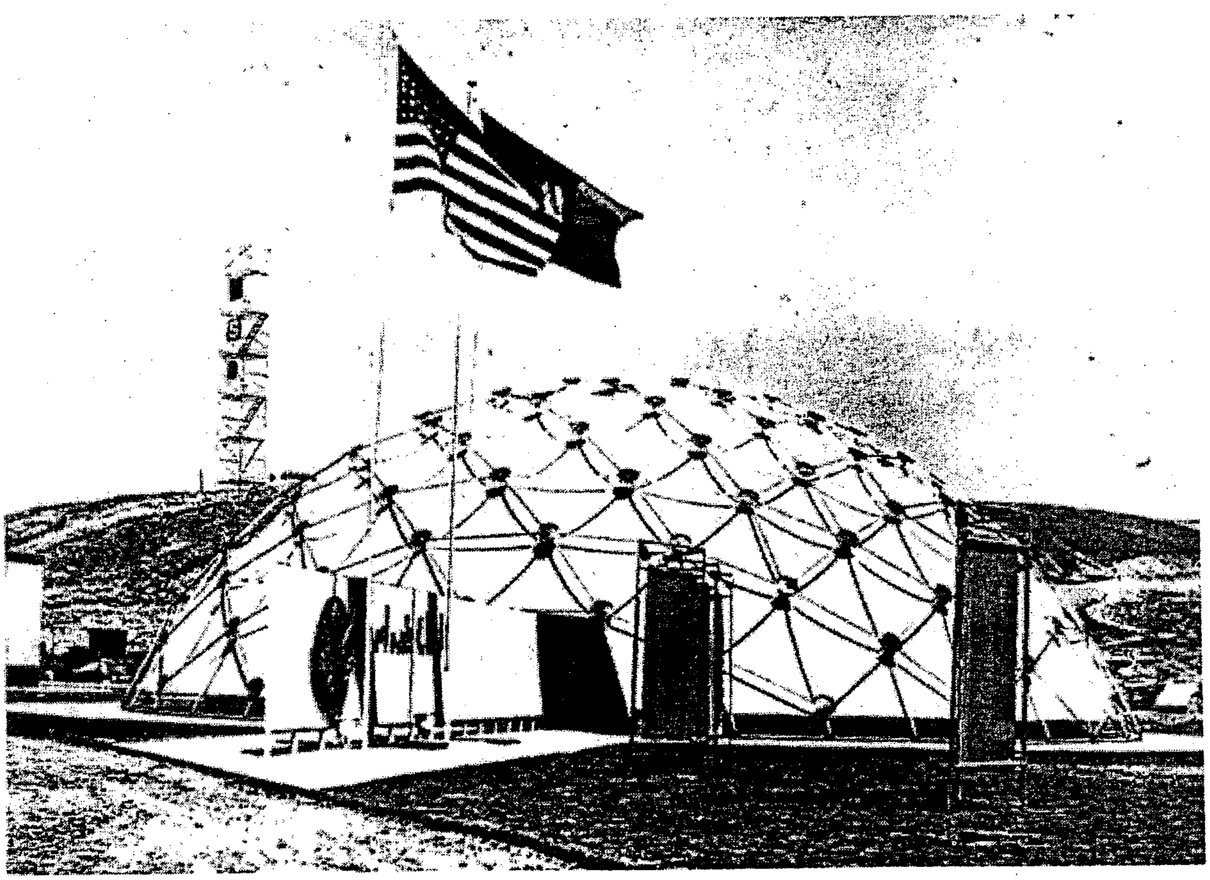


Fig.3.27b Assemblage process, American Pavilion, Jeshyn-Fair, Kabul-Afghanistan, ca. July 1956.
Source: BFI-Photo #K-2-1.

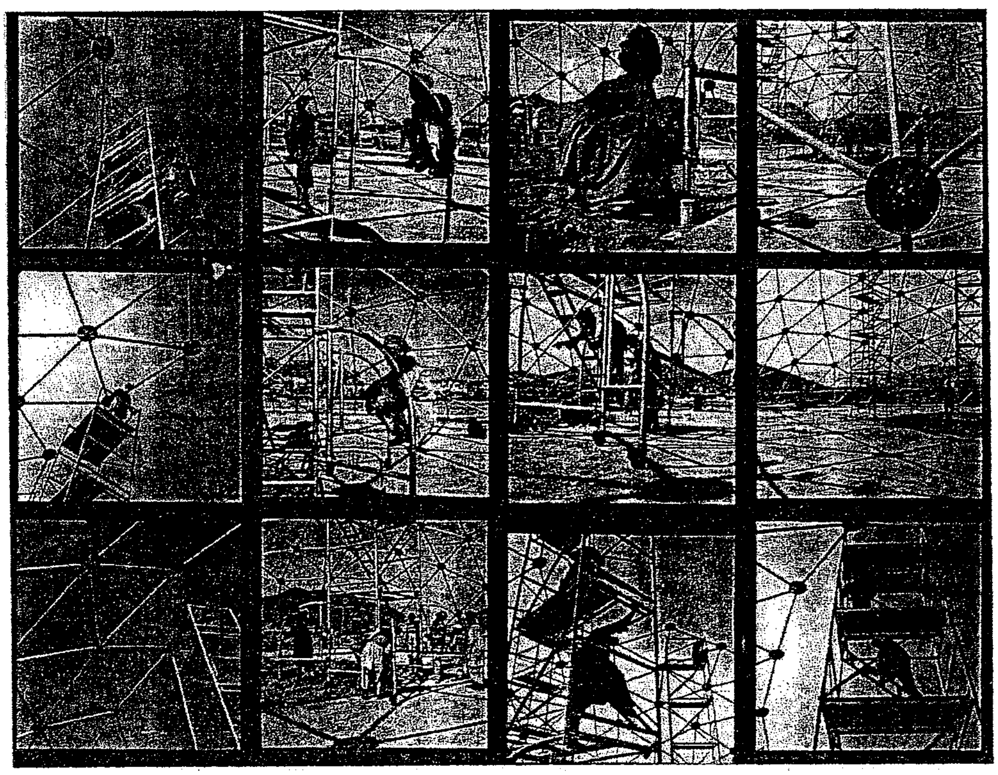


Fig.3.28a Russian Pavilion Jeshyn-Fair, Kabul-Afghanistan, ca. August 1956. Source: BFI-Photo.

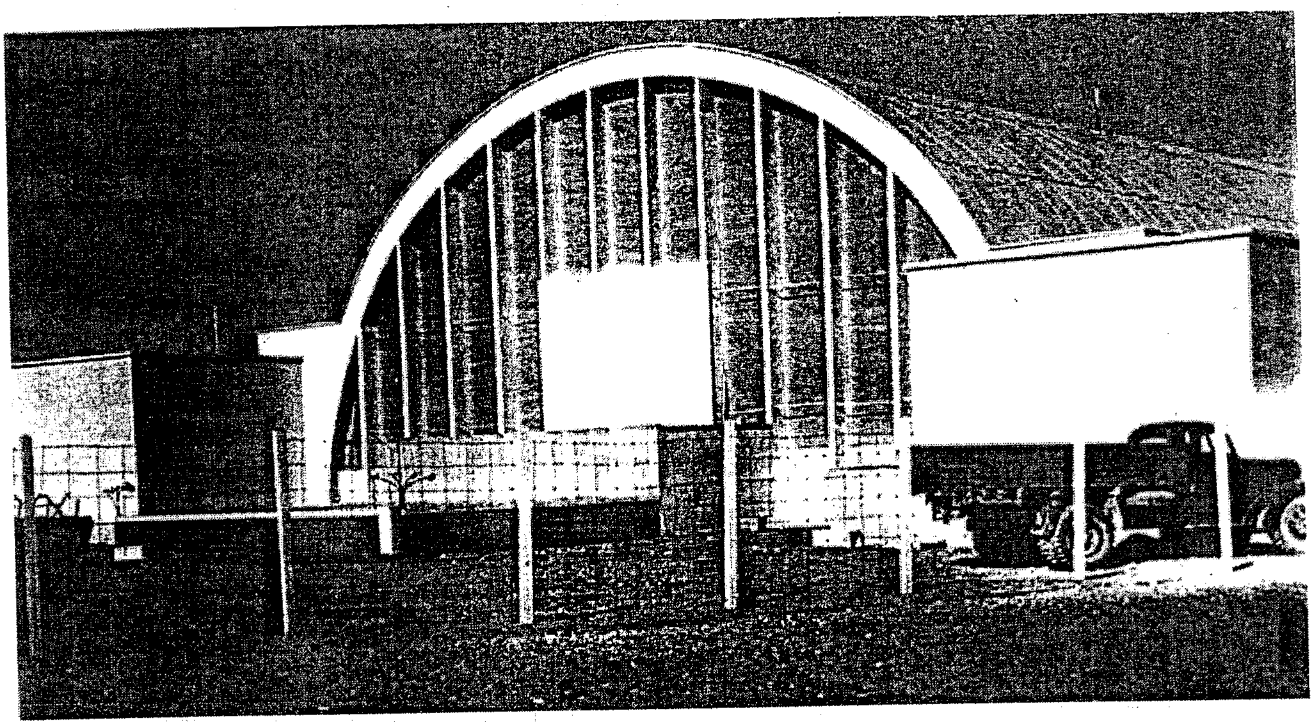


Fig.3.28b HM Mohammed Zahir Shah & U.S. Ambassador Sheldon Mills at the Fair opening viewing model of the American Pavilion, Jeshyn-Fair, Kabul-Afghanistan, ca. August 1956. Source: BFI-Photo #K-2-1.

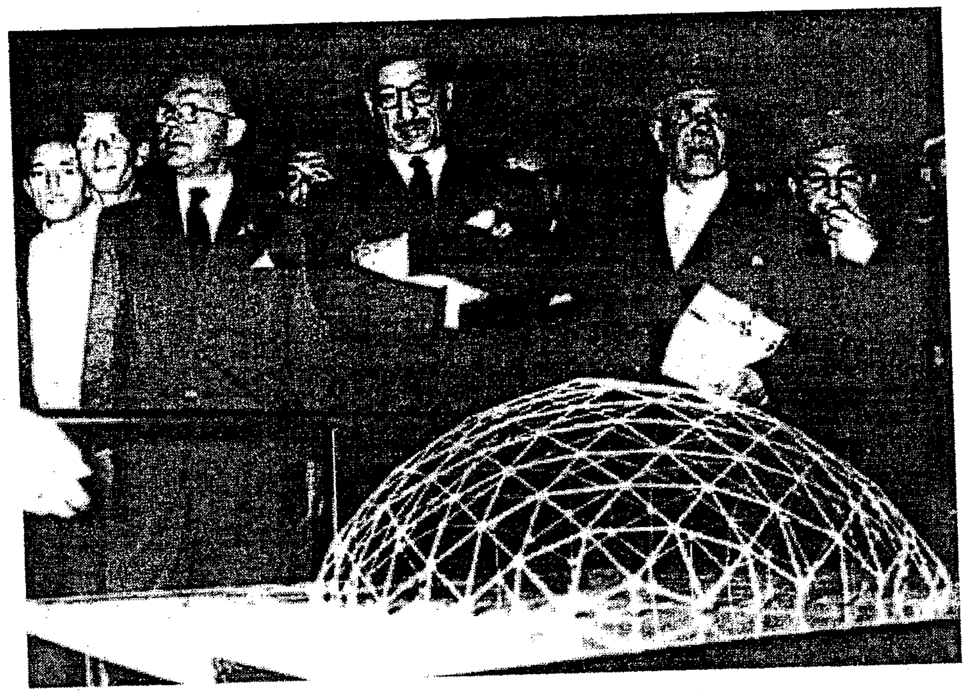


Fig.3.29a American National Exhibition in Moscow. <u>Source:</u> *Newsweek* 1/19/59, p.24.

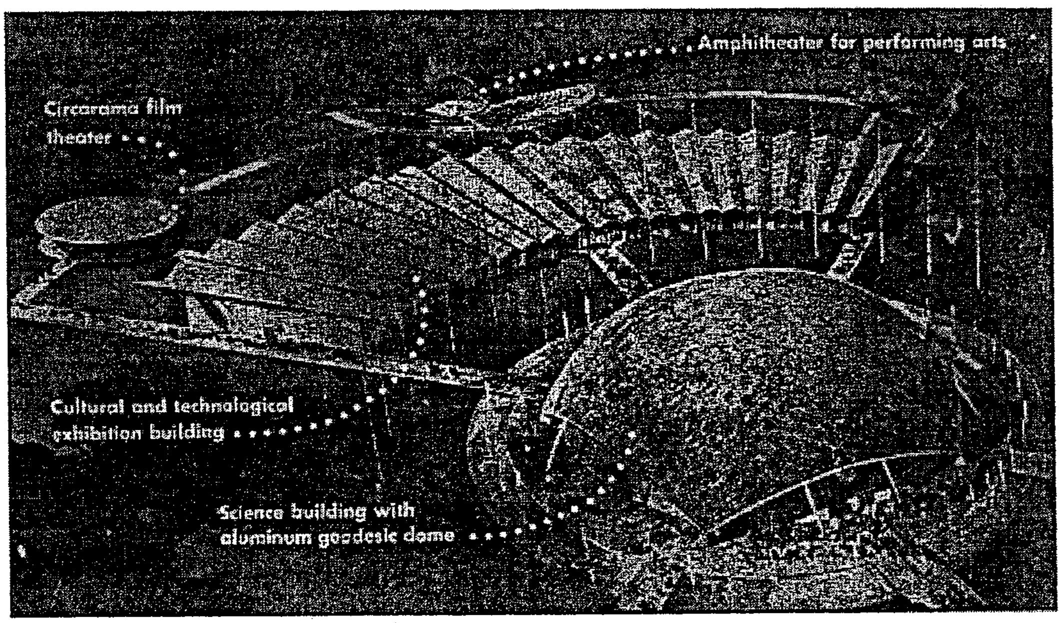


Fig.3.29b Vice-President R M Nixon & Chairman Nikita Khrushchev outside the American National Pavilion in Sokolniki Park-Moscow, July 1959. Source: "The Amazing Doings in Moscow," *Newsweek*, August 3' 59.

Fig.3.29c Construction of the 150-foot diameter Kaiser Aluminum Dome, Hawaii. Source: BFI-Photo #K-5-16 & K-5-6.

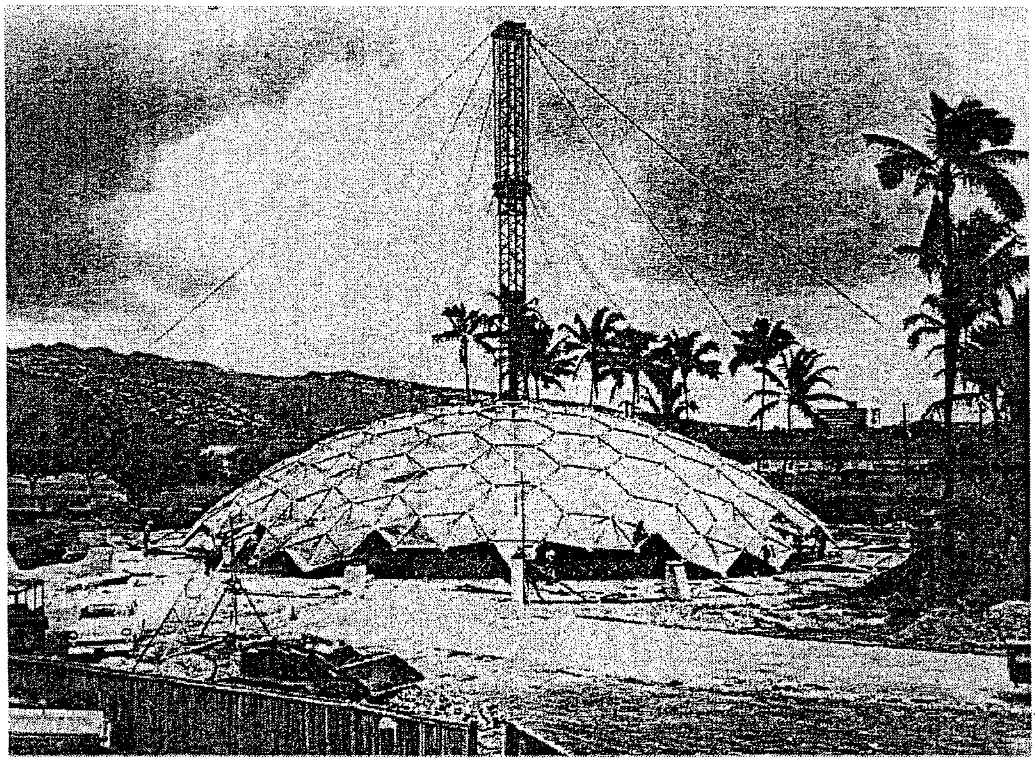


Fig.3.29d Fuller in front of Kaiser Dome for the American National Exhibition in Moscow, ca. 1959.
Source: "Prime Design," Bennington College Bulletin, May 1960.

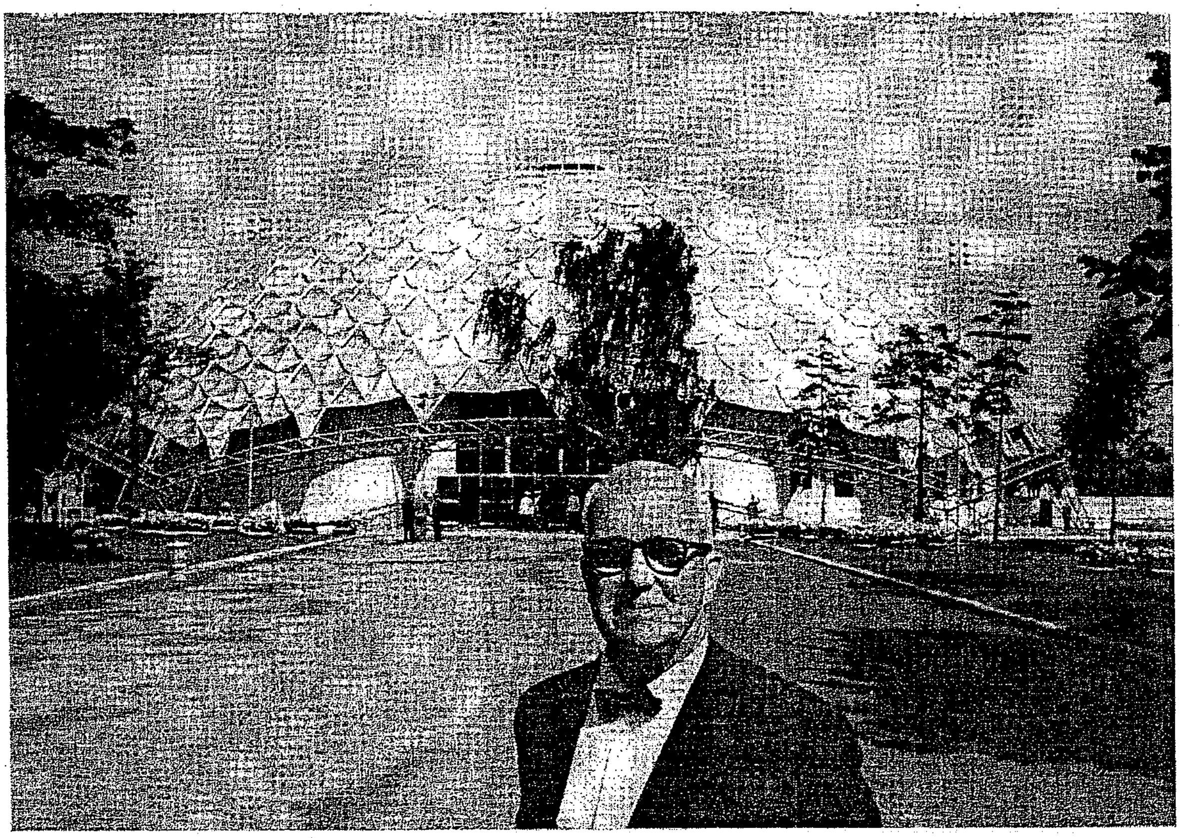


Fig.3.29e Close-up Evolute diamonds of the 150-foot diameter Kaiser Aluminum Dome, Hawaii.
Source: BFI-Photo #K-5-5 & K-5-22.

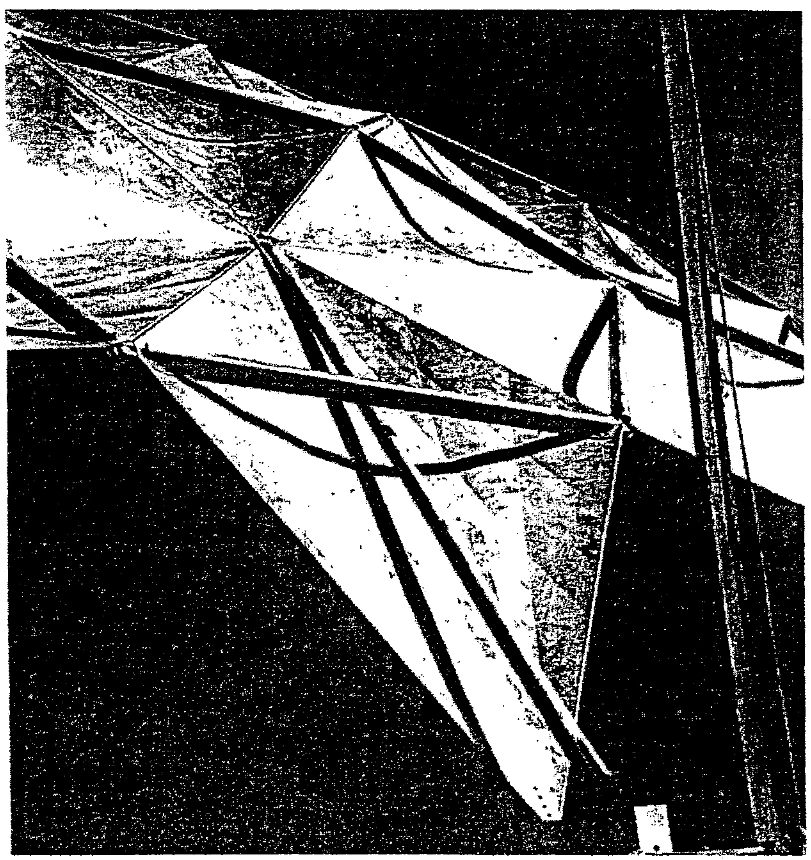
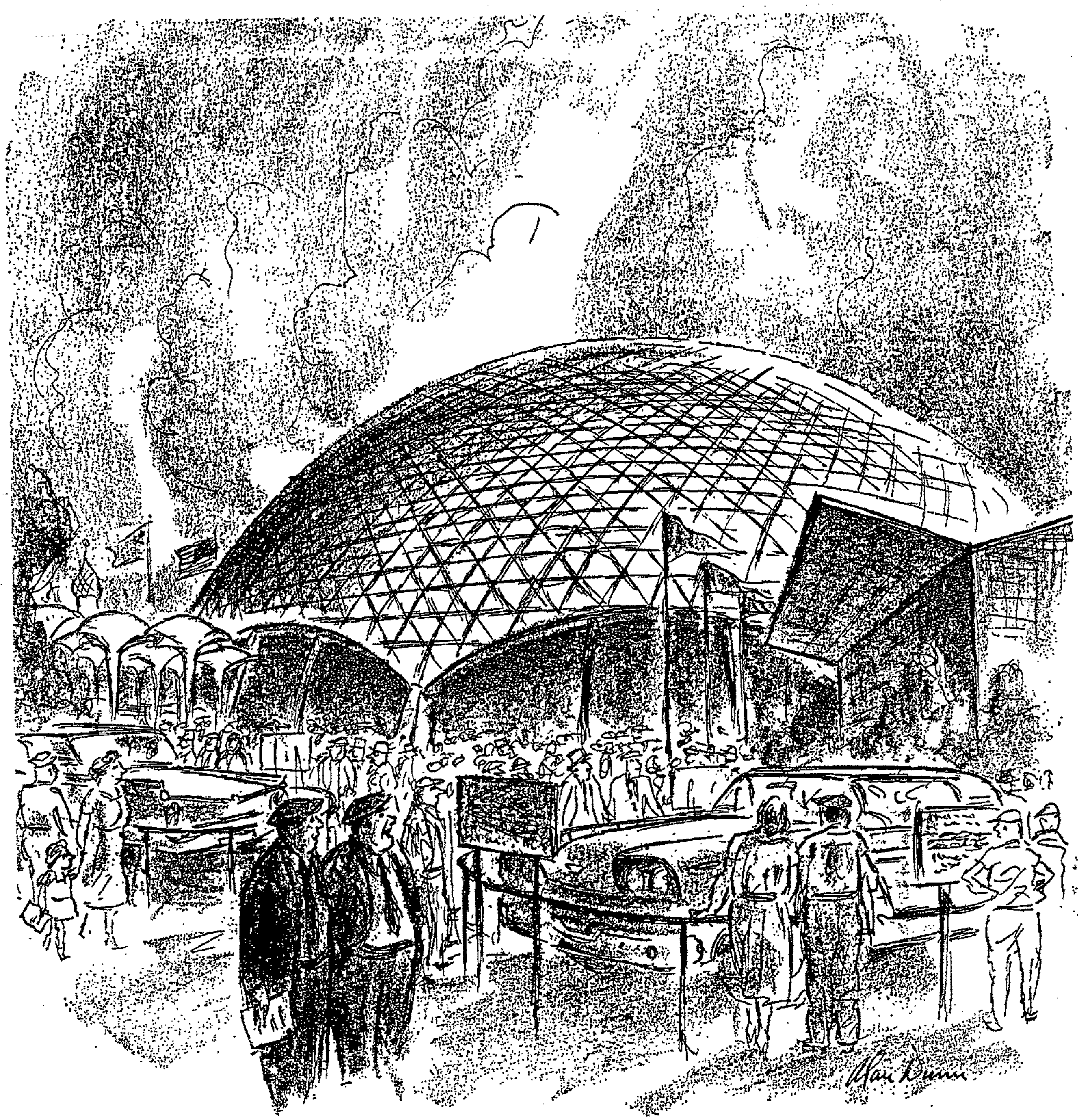


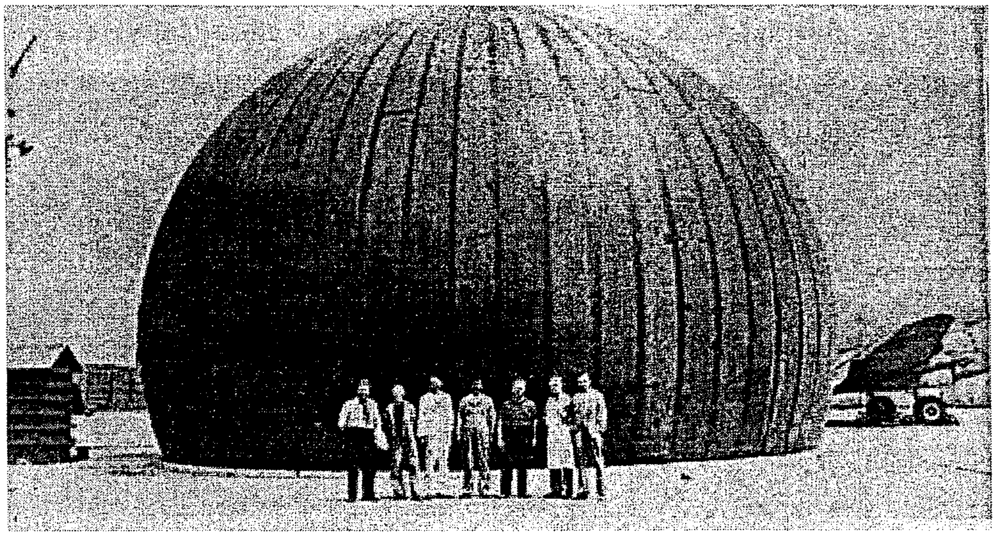
Fig.3.29f Cartoon of American National Pavilion in Sokolniki Park-Moscow, Source: *The New Yorker*, August 15, 1959.

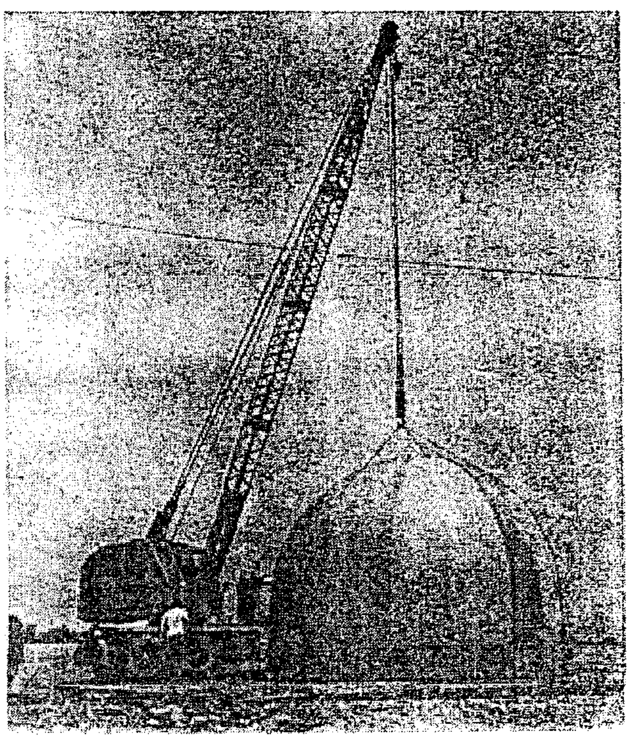


"America needn't feel so cocky. In a few years we'll have traffic snarls, too."

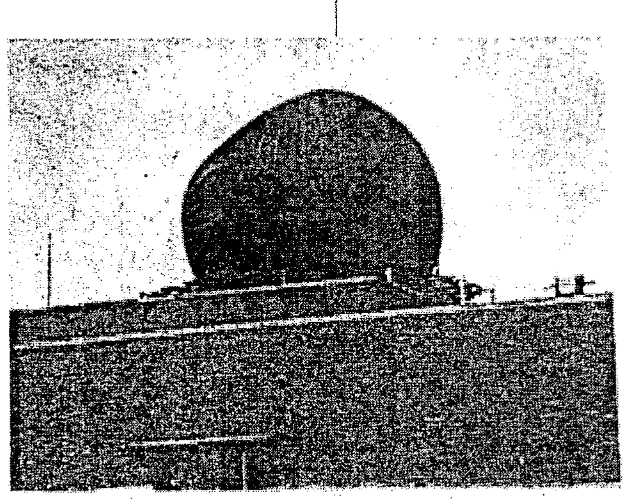
Fig.3.30a 54'-D Air-supported Radome prototype. <u>Source:</u> Annual Report, Cornell Aeronautical Laboratory Inc. Buffalo-NY., 1951.

Fig.3.30b Dual-wall air supported radome at Griffiss Air Force Base, Rome, NY. <u>Source:</u> *WAVE GUIDE*, Newsletter of GAFB-The Ground Electronics Center of the World, Vol.7, No.2, Rome-NY, p.5.



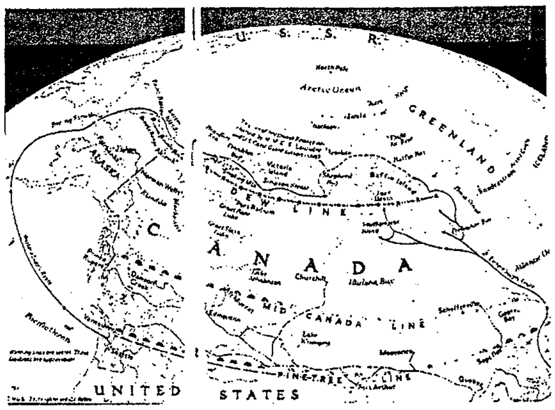


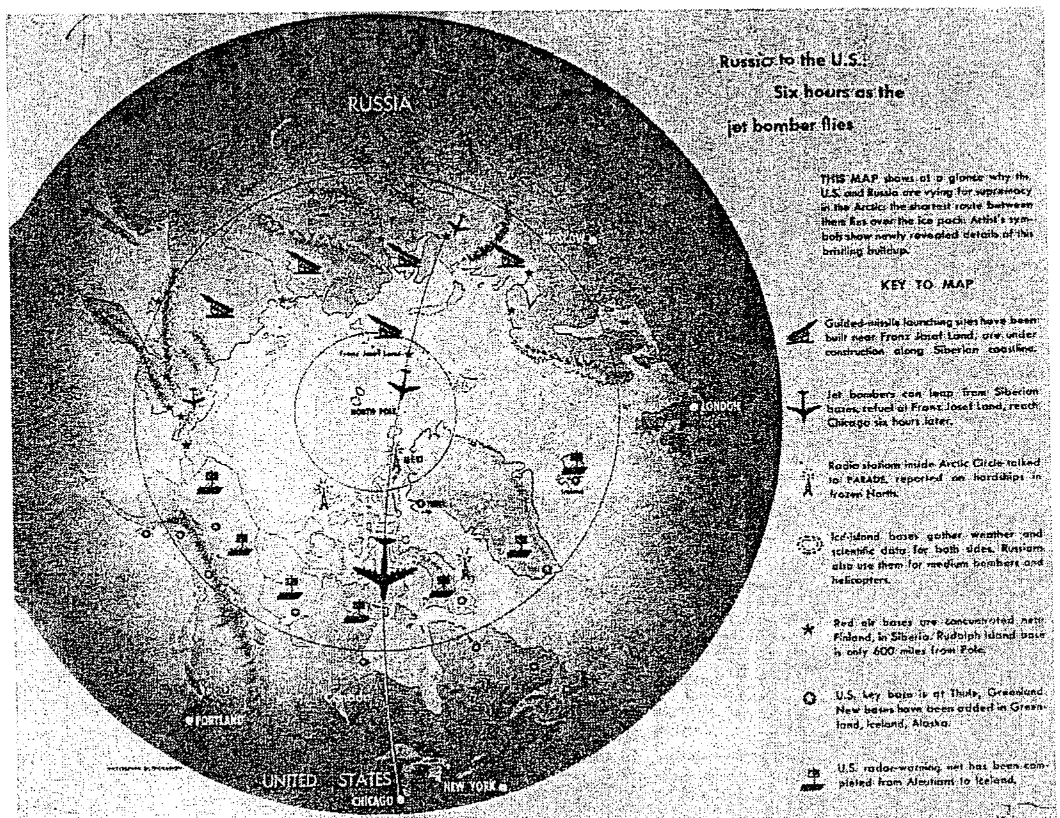
Plastic radomes are being considered for use at large early warning radar sites. Here a crane prepares to lift the radome over an antenna at RADC's Newport site.

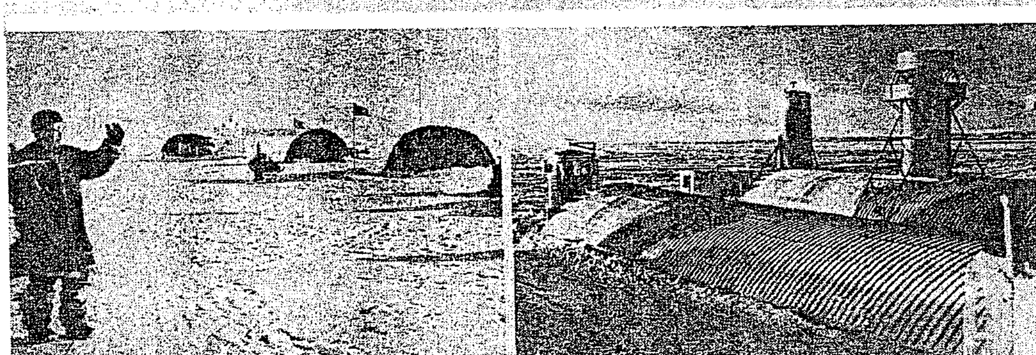


Newest addition to the GAFB "skyline" is this dual-wall air supported radome atop the General Engineering Lab. Pressure is maintained between the two walls in this experimental model.

Fig.3.31a Views of DEW-line's eastern anchor on the Baffin Island, Canada. Source: *National Geographic*, July 1958, p.129.







RUSSIAN: Armed soldier stands guard over "scientific" station on floating ice island. Medium bombers and helicopters can land here.

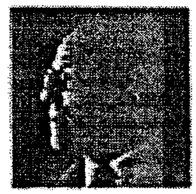
AMERICAN: "Sinking" barracks like these are U.S. answer to constru- problem in Far North. Men enter through "conning towe

Fig.3.31b Geometric Inc.-Cambridge. Source: *Architectural & Engineering News,* November 1964.

NAMES

GEOMETRICS INC

Ahern



Cutting

Floyd

Wainwright

Wallace

November 1964

Architectural & Engineering News

Fig.3.32 Mark I Radome at Huntington-LI & View of Rigging, August 1955. Source: BFI-Photo #L-6-56.

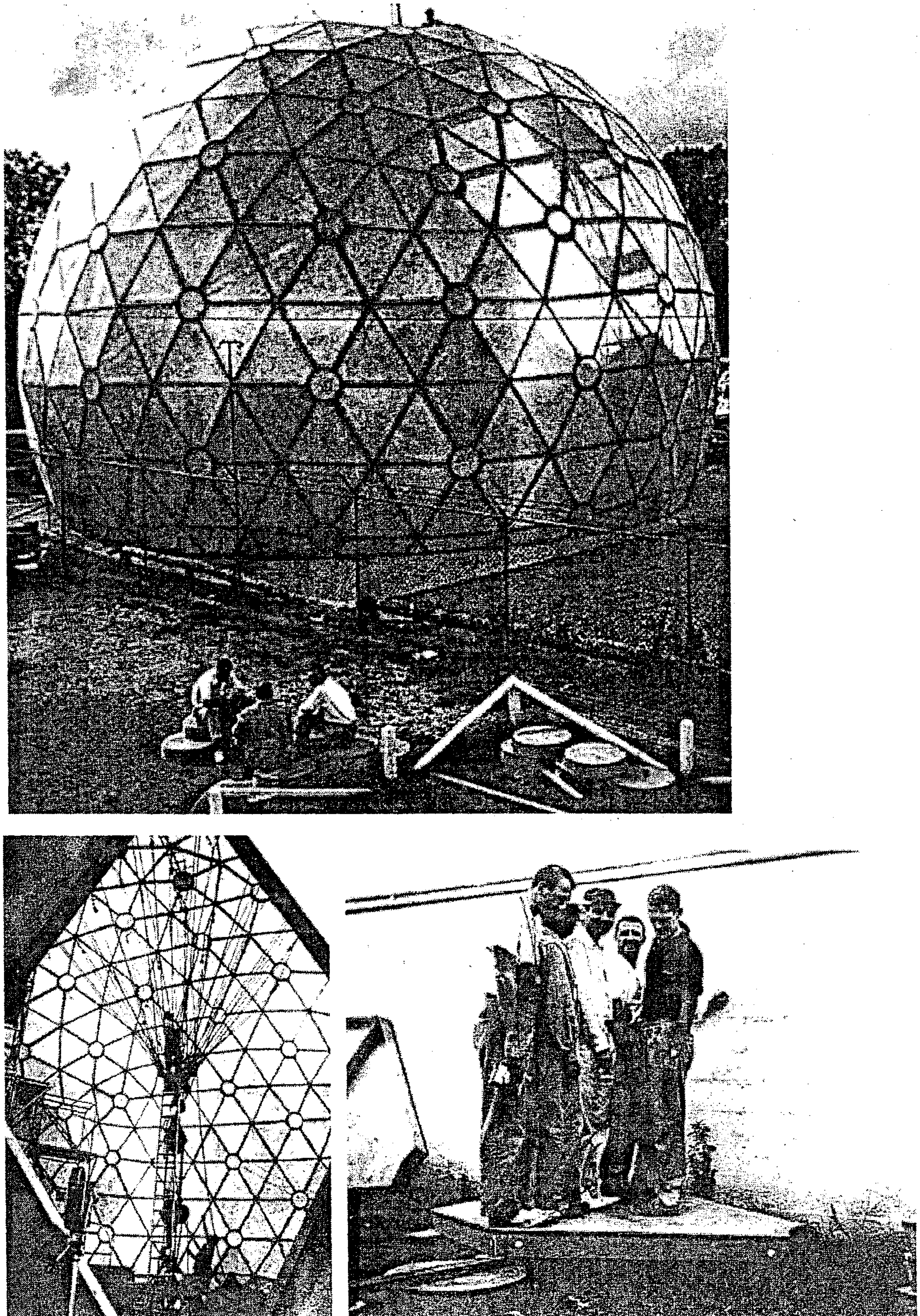
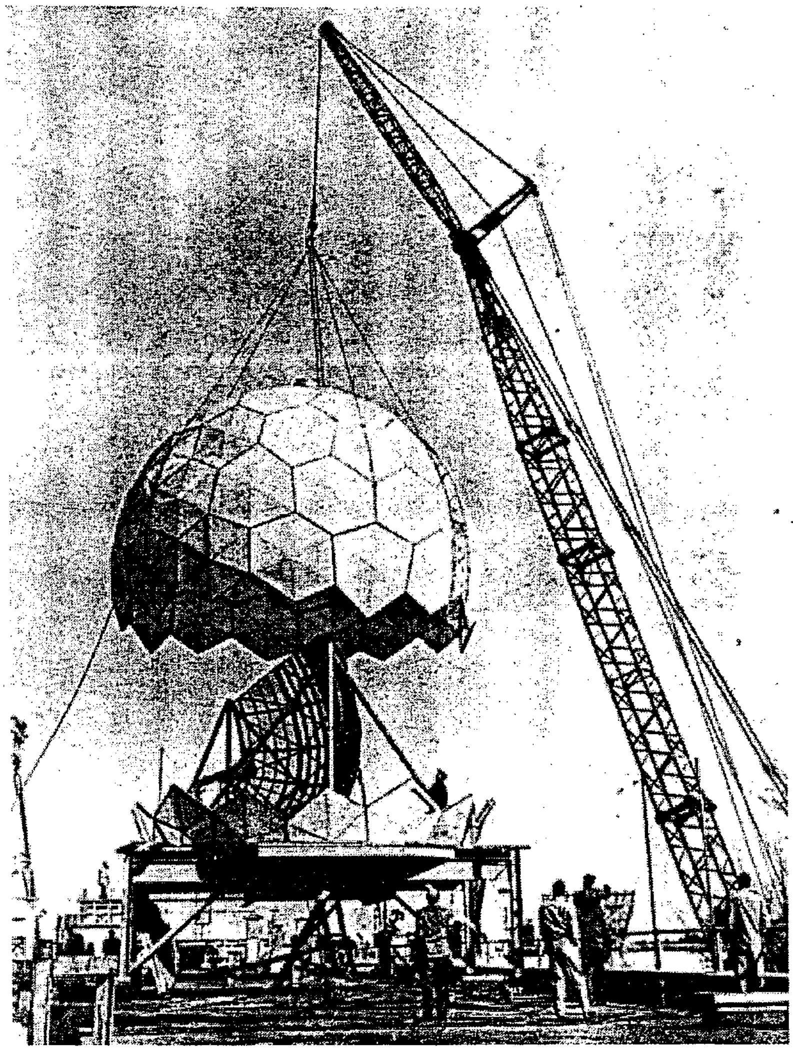


Fig.3.33a 31-D Hex-Pent Radome on top of Lincoln Laboratories, Cambridge-Mass., August 1955.
Source: BFI-Photo #L-5-8.



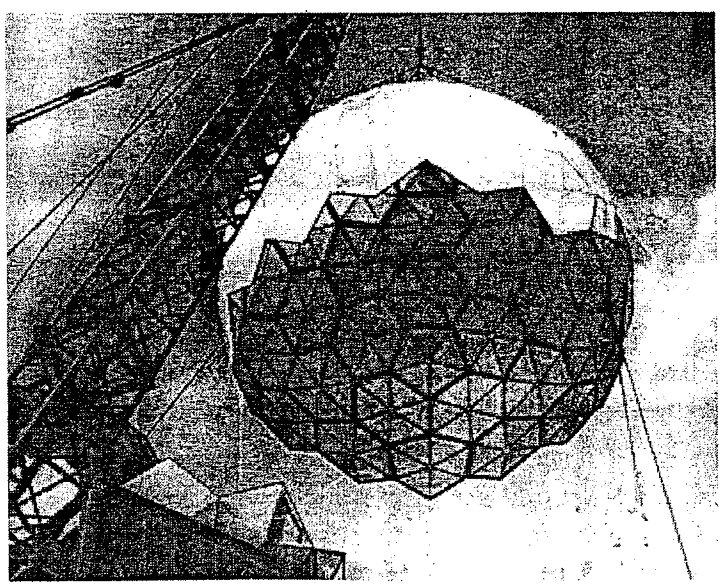


Fig.3.33b 3/4 sphere 31'-D Radome testing by Group 71, Lincoln Laboratories, Cambridge-Ma., 15 April, 1954. Source: BFI-Archive Box2.

GROUP 71

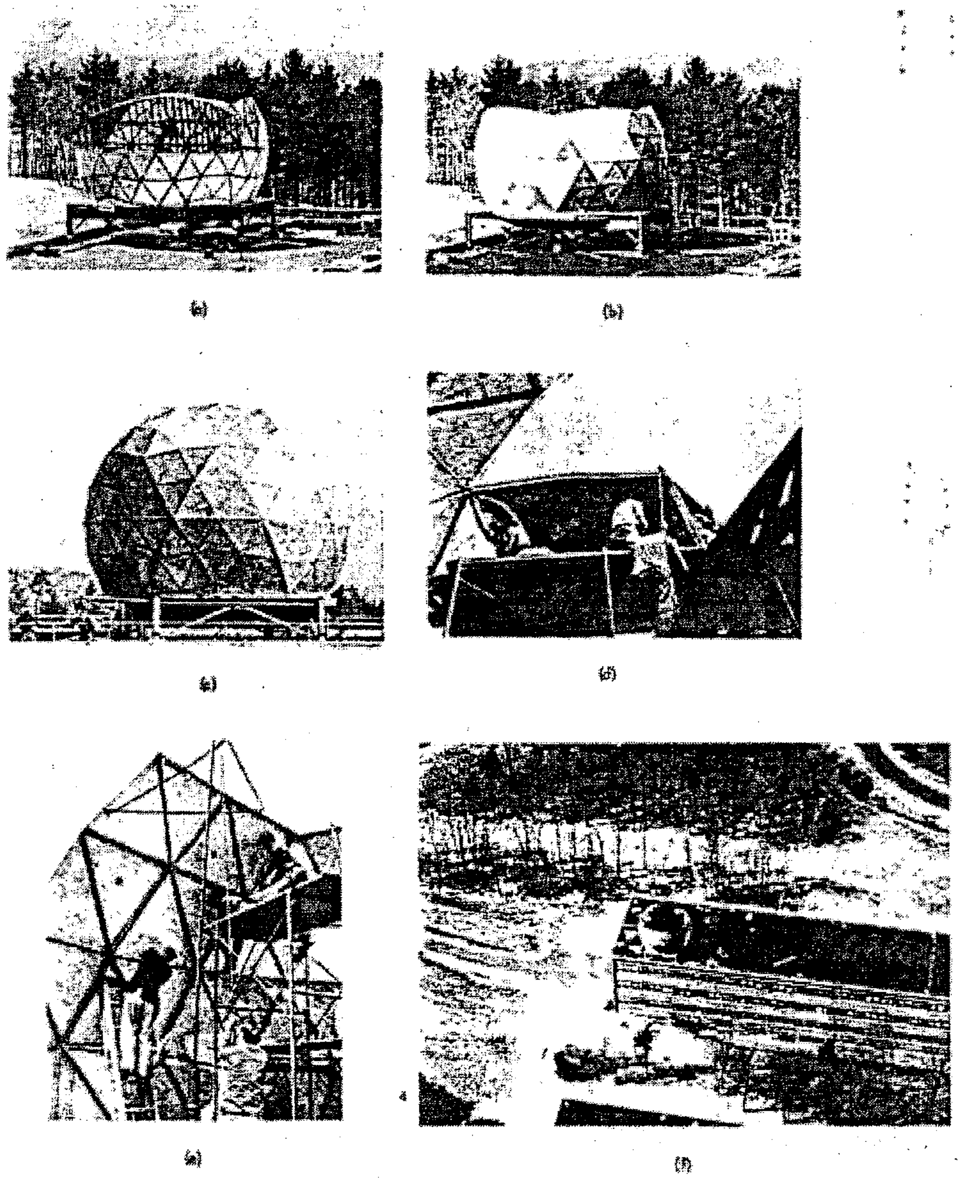


Fig. 71-1(a) – (f). Progress shots taken during erection of rigid radome on roof of Building C.

Fig.3.34 "New Radar Sky-watch to Guard Arctic Frontier" (Western Electric advertisement).
Source: *LIFE*, August 1955.

Fig.3.35 McGill University Cardboard Dome, 1956. Source: BFI-Photo [?].

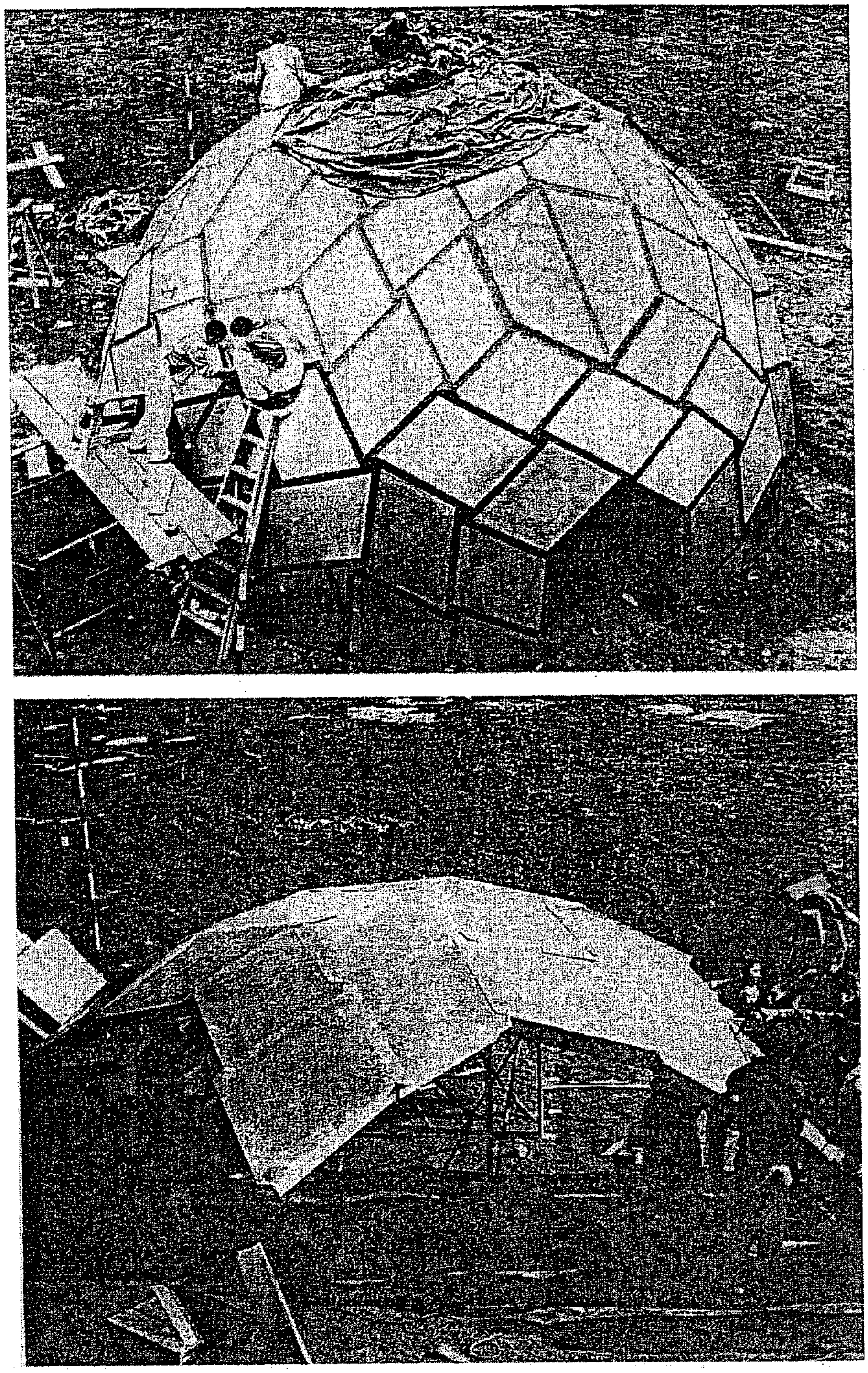


Fig.3.36a Testing of 26'-D Pease Dome (Static and Air Stream testing). Source: BFI-Photo #P-19-3 & 7.
Fig.3.36b Testing of 26'-D Pease Dome (Static loading), Oct. 1958. Source: BFI-Photo #P-19-3 & 7.

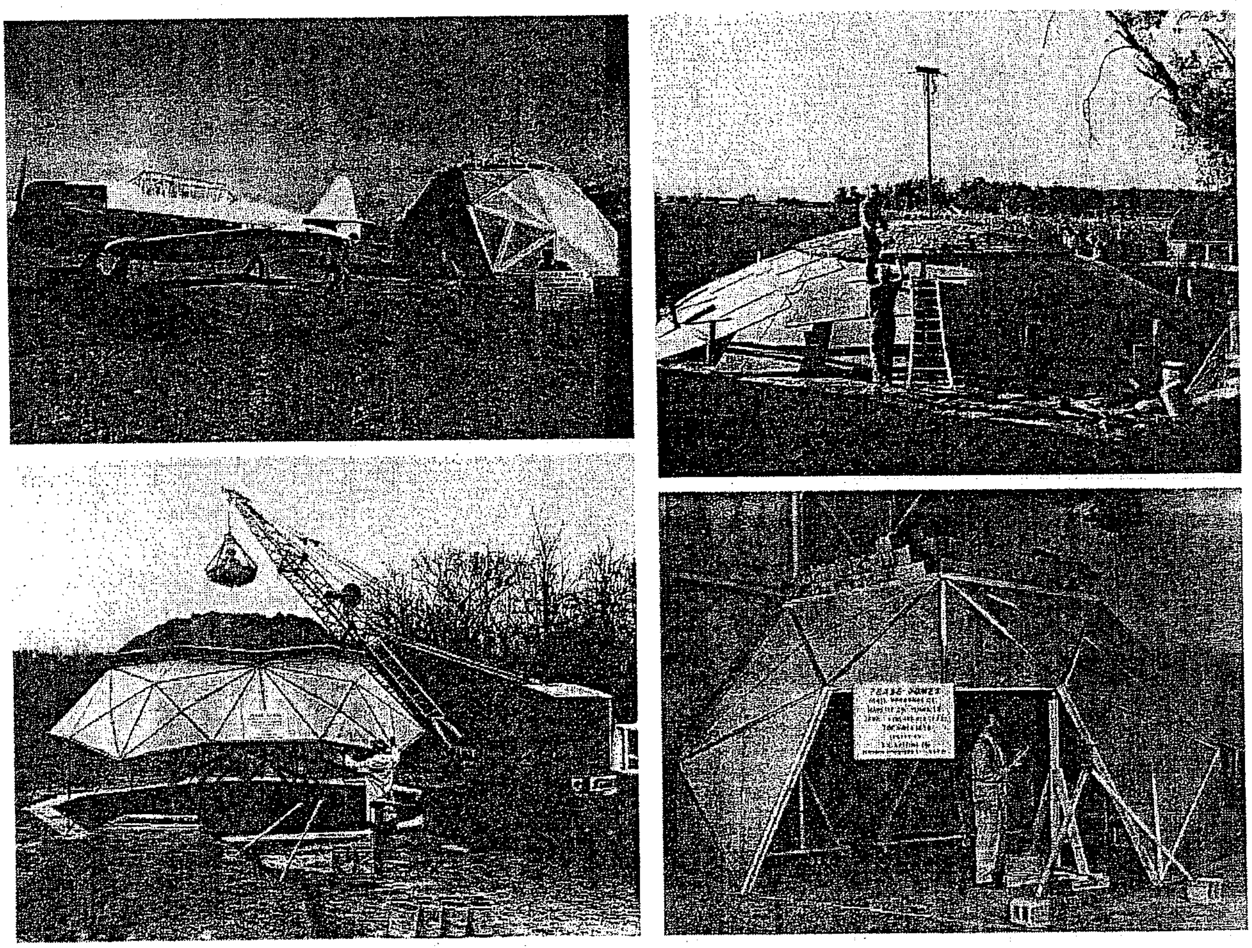


Fig.3.36c Pease Dome, promotional pamphlet, ca. 1960. Source: BFI-[?]

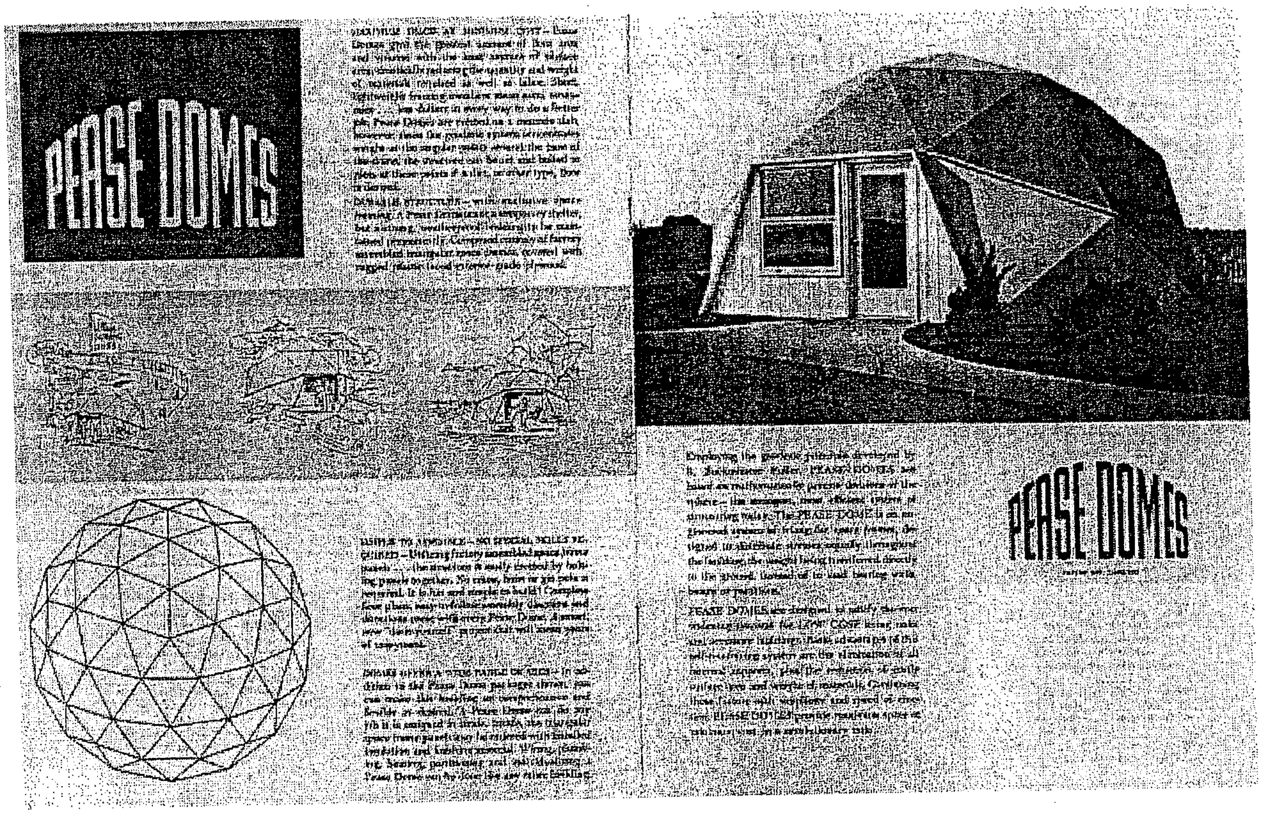


Fig.3.36d Pease Dome-CADCO, promotional pamphlet, ca. 1961. Source: BFI-[?].

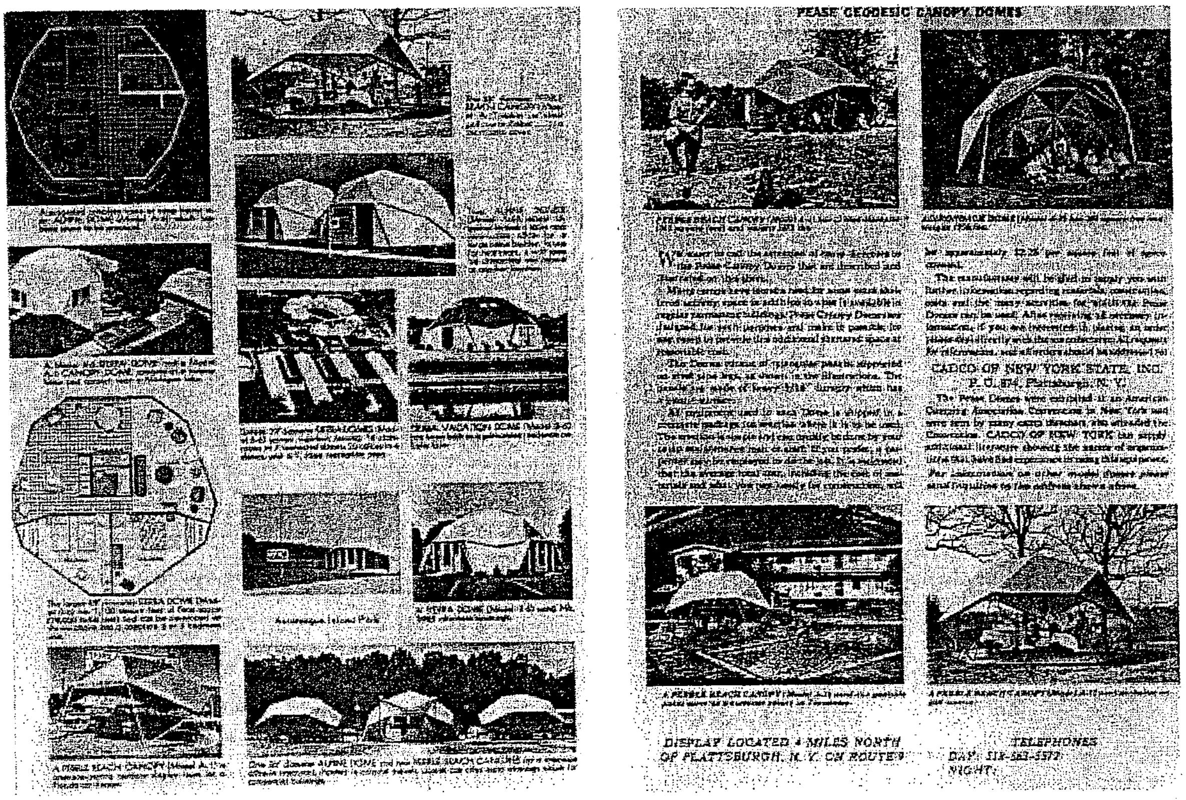
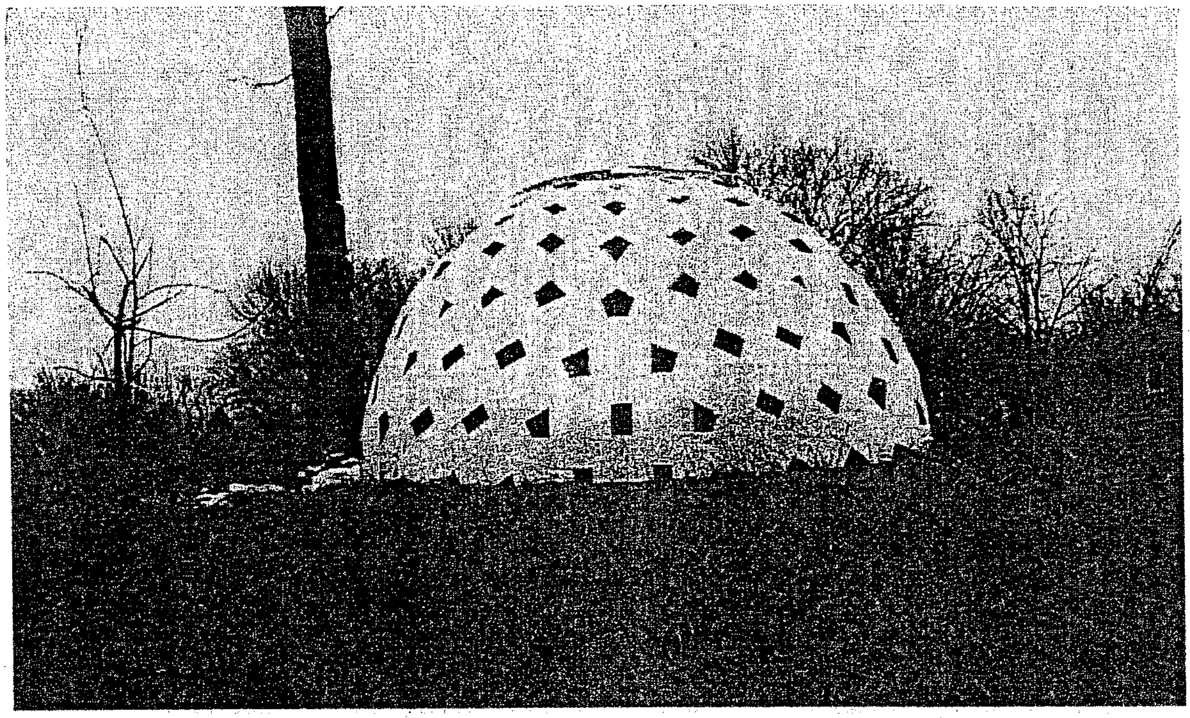


Fig.3.37a 6-Frequency 39'-D Plydome at Van Meter-IA, December 1956. Source: BFI-Photo #B-5-1

Fig.3.37b Construction of 6-Frequency 39'-D Plydome at Van Meter-IA, December 1956. Source: BFI-Photo #B-5-11 & 12



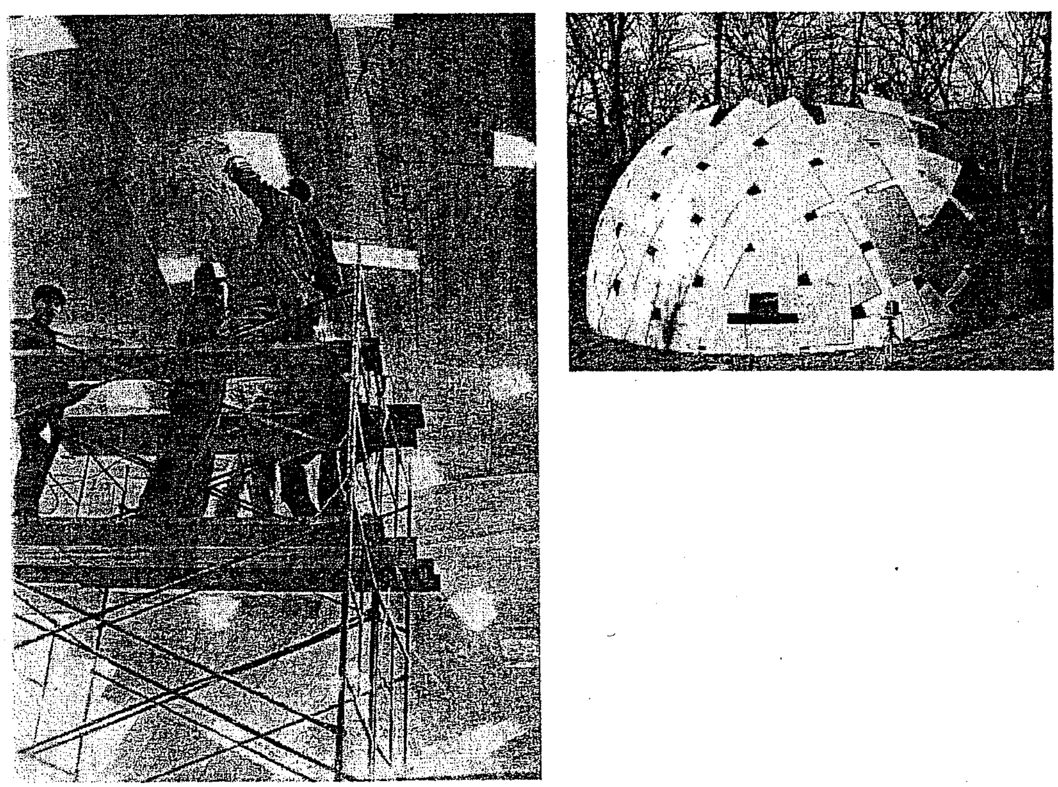


Fig.3.37c Construction of 18'-D Plydome at Des Moines-IA, December 1956. Source: BFI-Photo #B-4-6 & 7.

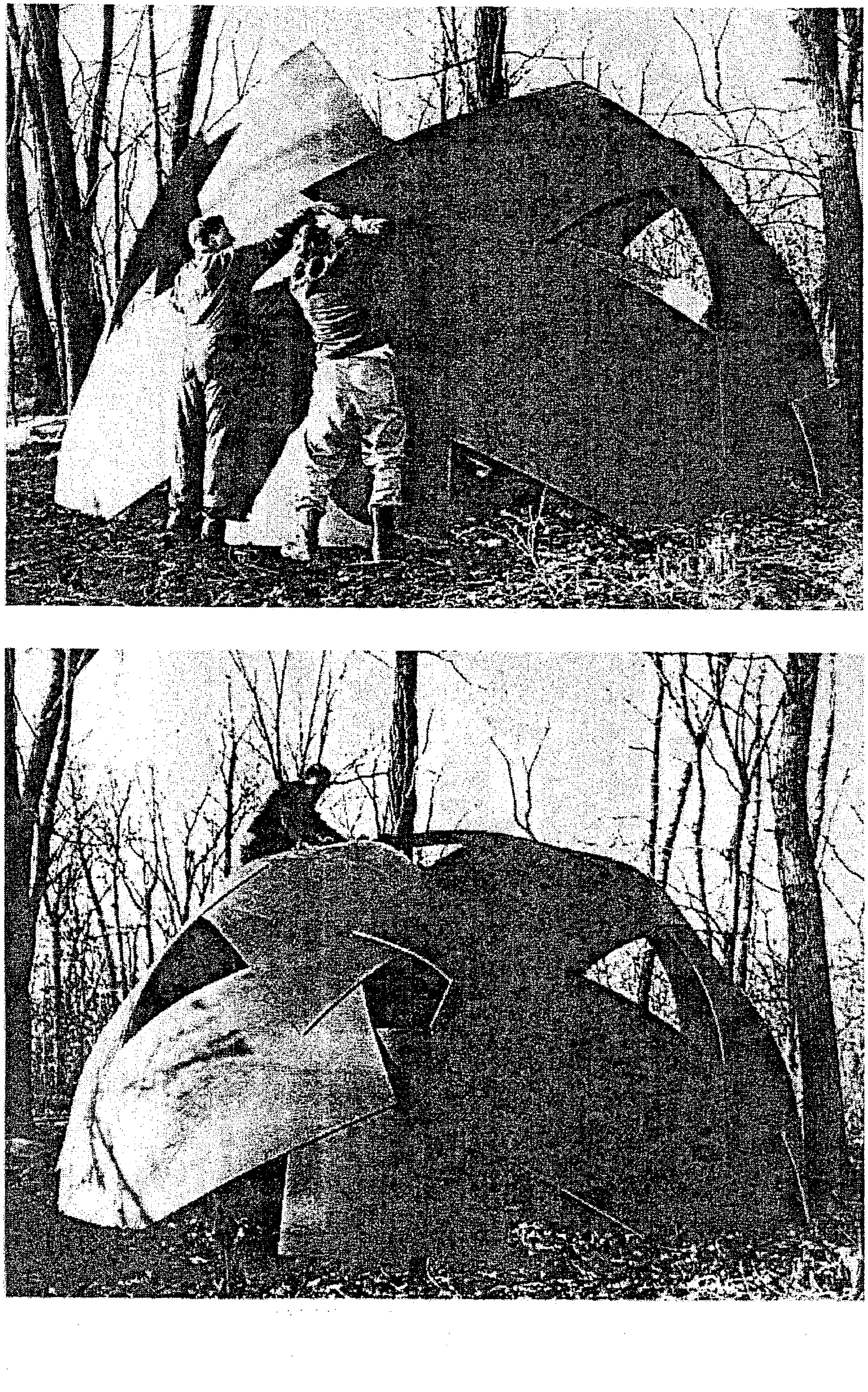
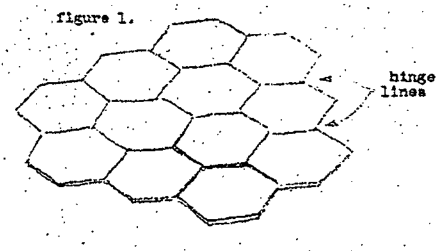


Fig.3.37d 39'-D Plydome at Van Meter-Io. Source: *Better Homes and Gardens,* June 1957.

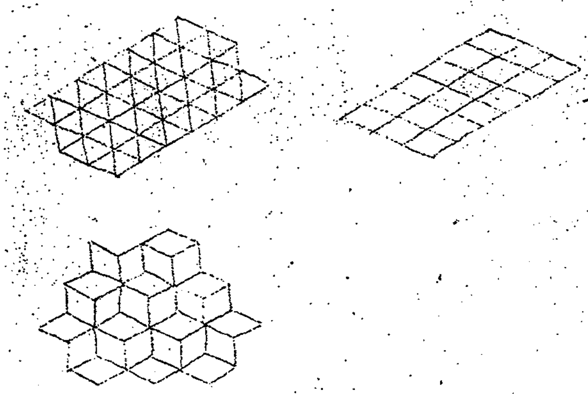
Fig.3.38 Don Richter, Sketches for "Surface Truss Principles," ca.1953. Source: BFI-CR141.

figure 1.



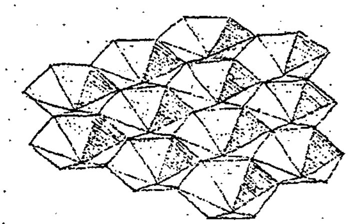
The hexagon is the only single polygon which can be hinge joined without having at least two hinges in line to fold. (ref. figure 2)

figure 2.



Now assume that each hexagon panel of figure (1) is replaced by a hexagon base pyramid as in figure (3), all apexes on the same side of the base plane.

figure 3



Each pyramid is composed of six congruent isoceles triangles joined together along their two long and equal length edges making each edge of each triangle a fold line. All fold lines with a common vertex have less than 180° of angle between them, thus cannot fold, or hinge.

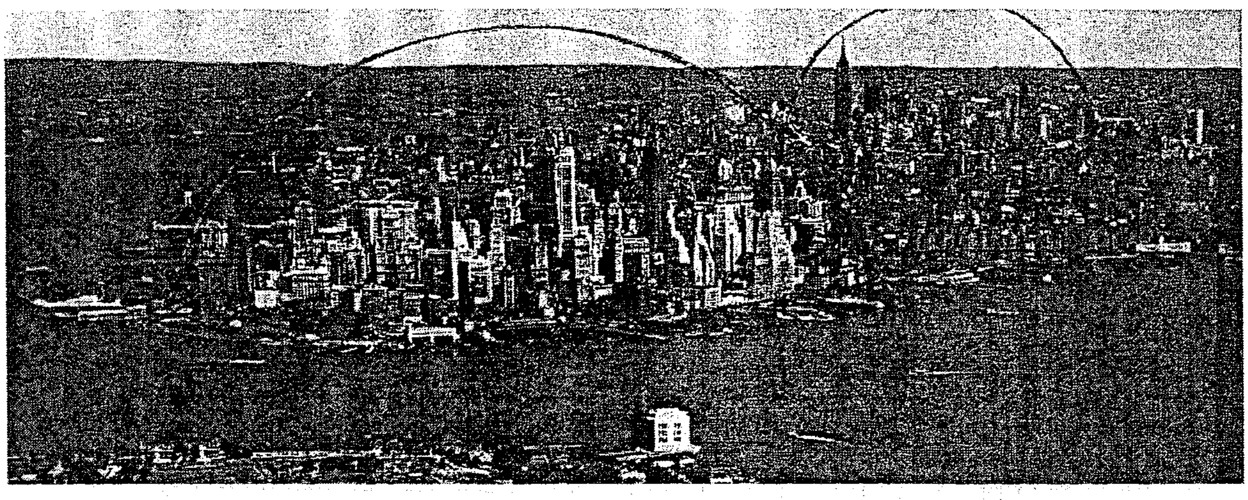
We now have a single surface without flanges that behaves as a truss. This surface thuss can be formed, from one sheet, cast, molded etc. or built up out of components using any suitable material such as metals of plastics.

If the truss is made redundant by having the joints between triangles transmit moments and shear, the "fold lines" can be faired and rounded, the pyramid truncated. By slightly varying the triangle edge lengths this surface truss can be warped to many desirable contours, such as sections of sphere, cylinder etc.

For simplicity of illustration lets now assume the surface truss is built up out of struts, one strut replacing each fold line between every two triangles.

The struts in compression will be represented by ▬ and those in tension by a _ _ _ for each loading system under consideration.

Fig.3.39a R. B. Fuller's sketch of two city-domes over Manhattan, undated. Source: BFI-EJA Green Trunk.



SL-105

AIR VIEW OF NEW YORK CITY WITH ITS SKYSCRAPERS

Completely surrounded by water, Manhattan presents unusual docking facilities for a great city. The largest ships from all over the world have their docks less than one mile from the midtown area. Hudson River Palisades can be seen in the distance.

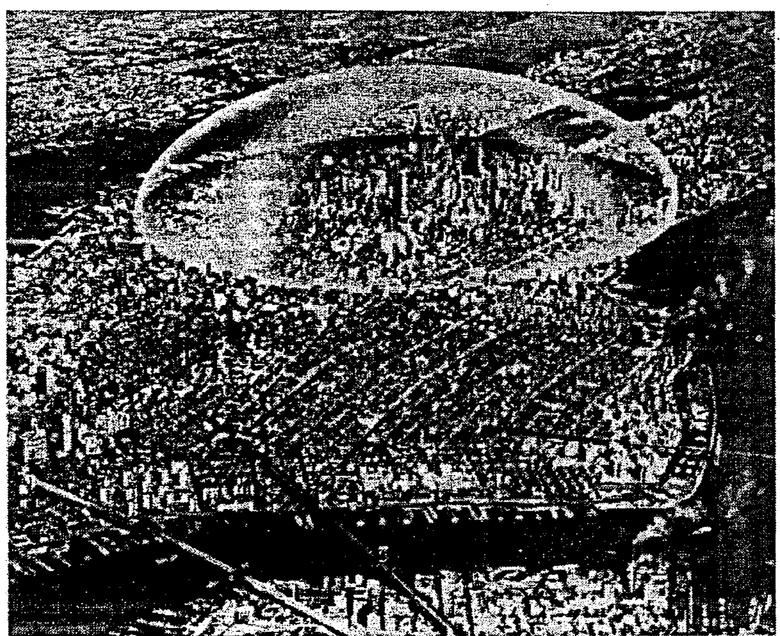
IN FOREGROUND 3/4 MILE DIAMETER 1/3 ~~THIRD~~ SPHERICAL GEODESIC DOME OVER LOWER MANHATTAN ALTITUDE AT ZENITH 2234 FEET

address

place stamp here

IN BACKGROUND 1 1/4 MILE DIAMETER 1/4 ~~QUARTER~~ SPHERICAL GEODESIC DOME OVER MIDTOWN MANHATTAN FROM 28th ST. TO 55th ST. AND FROM NINE AVE TO SECOND AVE INCLUDING ALL LARGE BUILDINGS AS WELL AS PENNSYLVANIA STA AND GRAND CENTRAL - MADISON SQUARE GARDEN BROADWAY THEATER DISTRICT AND NEW MADISON AND THIRD AVE AND PARK AVE SKYSCRAPERS. ALTITUDE

Fig.3.39b Fuller's 2-mile dome over mid-Manhattan. Source: "The Case for a domed City." *St. Louis Post-Dispatch*, 26 September 1965, Special Supplement.



The Fuller dome, as it would appear if installed over central Manhattan island

Fig.3.40a Fuller's House in Carbondale-IL. by Al Miller (Pease), ca. 1960. Source: J. Ward., ed., The Artifacts of R. Buckminster Fuller, Vol.4, p.35.1

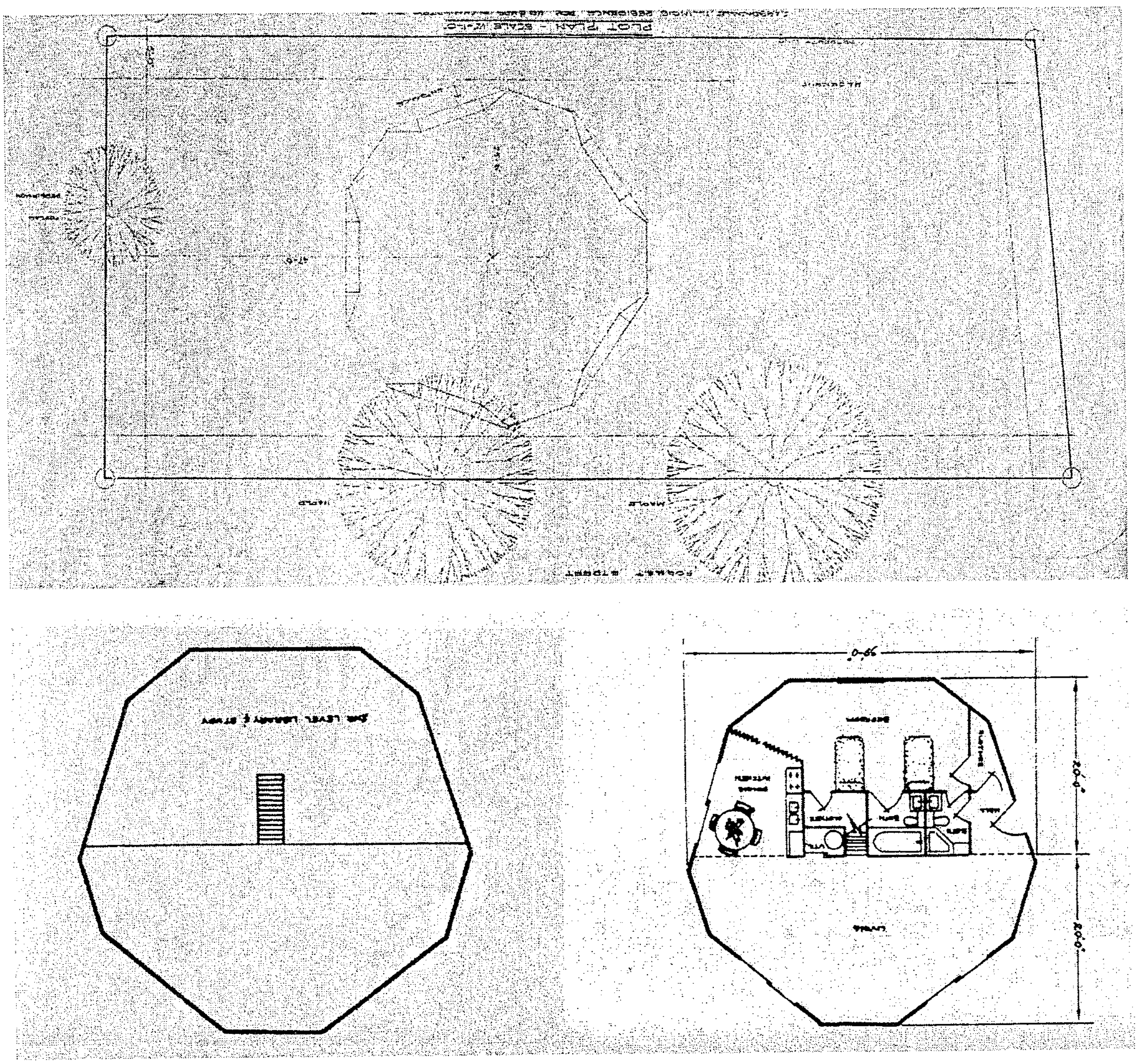


Fig.3.40b Fuller's House in Carbondale-IL. by Al Miller (Pease), ca. 1960. Source: J. Ward., ed., The Artifacts of R. Buckminster Fuller, Vol. 4, p.34.1-4.

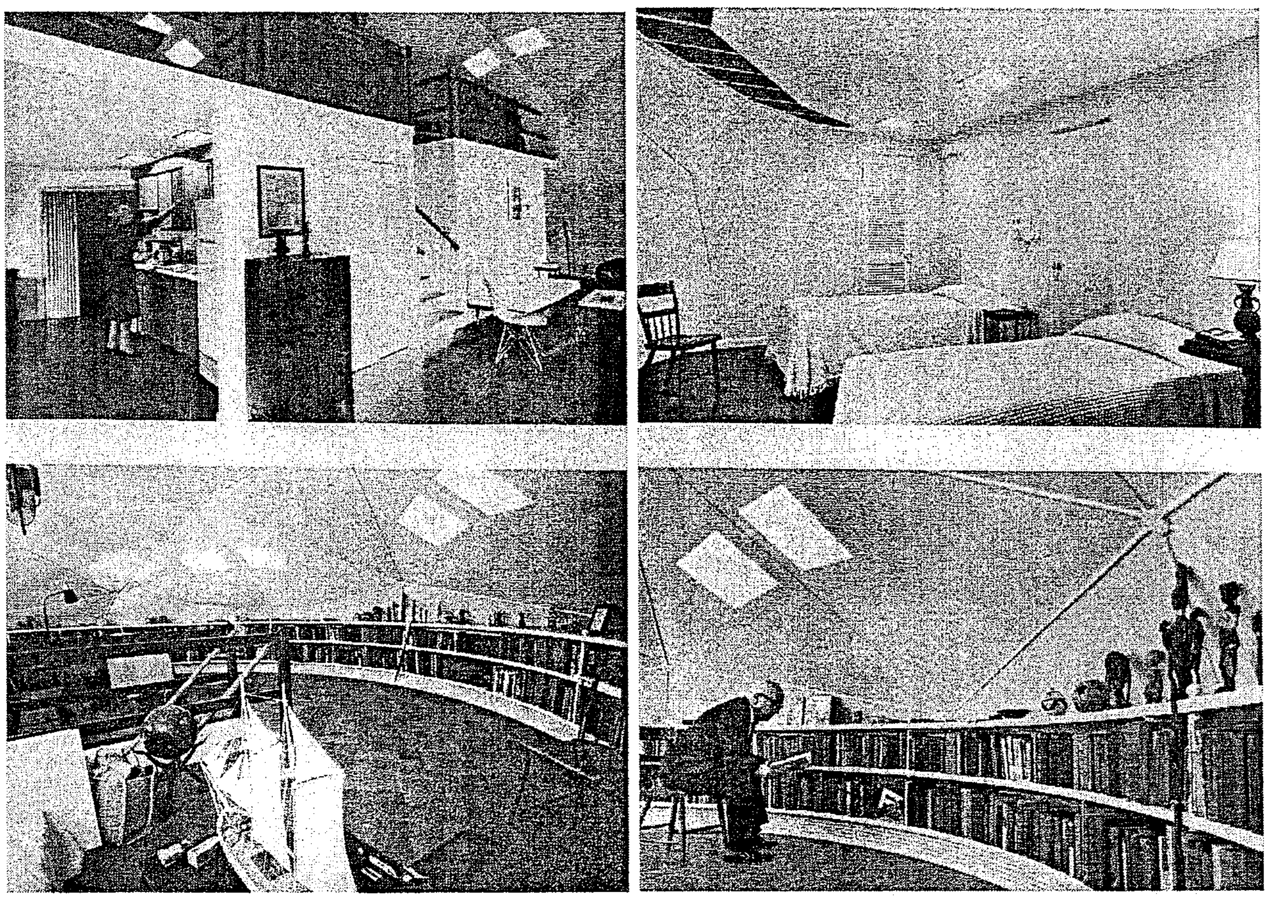
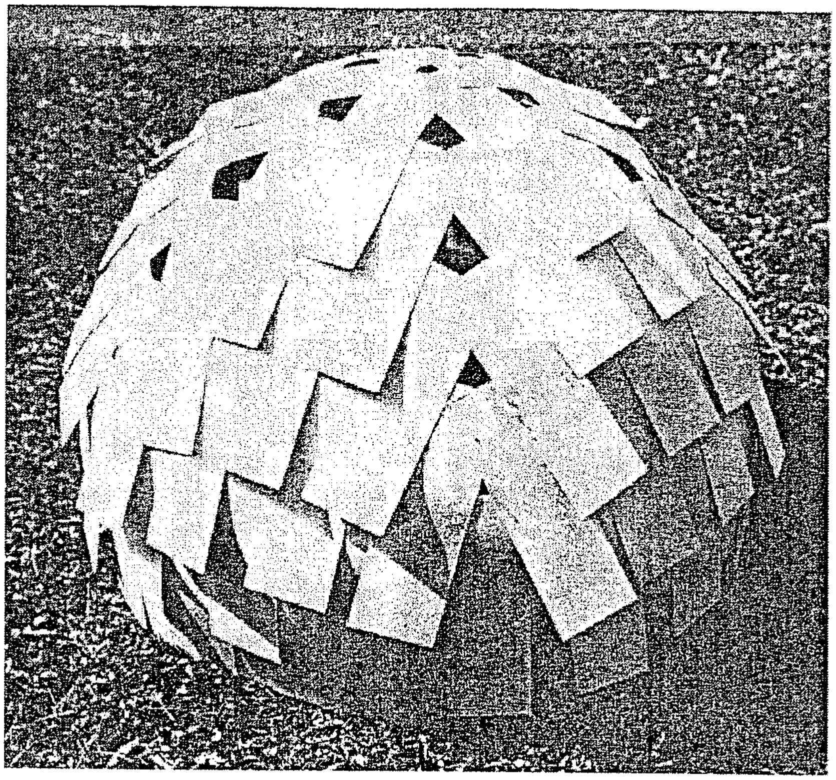


Fig.3.41 40'-D, 5/8 sphere, Shingled Dome. Source: BFI-Photo #B-10-3 & 11-4.



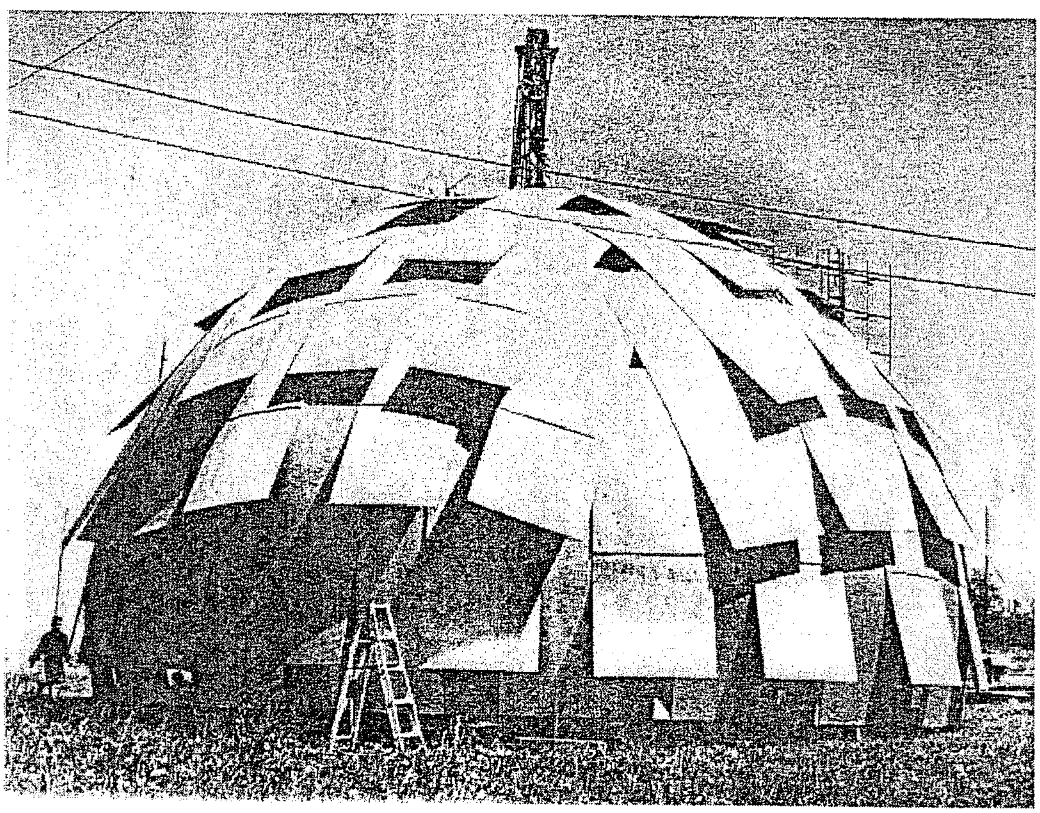


Fig.3.42a 29'-D Plydome as Carwash, Hartford-Io. Source: BFI-Photo #P-15-8.

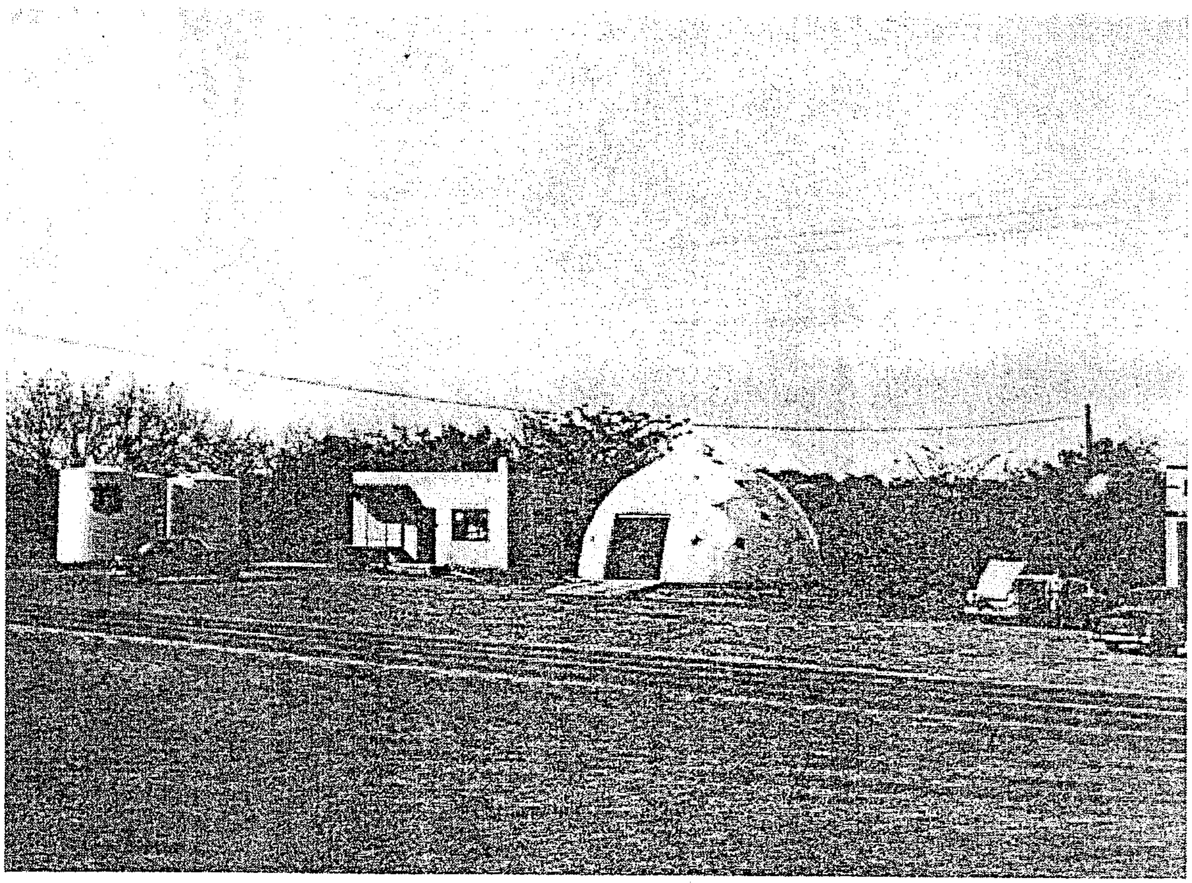


Fig.3.43 40'-D Columbian Father for Far-eastern Chapel, Hartford-I0. <u>Source:</u> BFI-Photo #P-11-1.

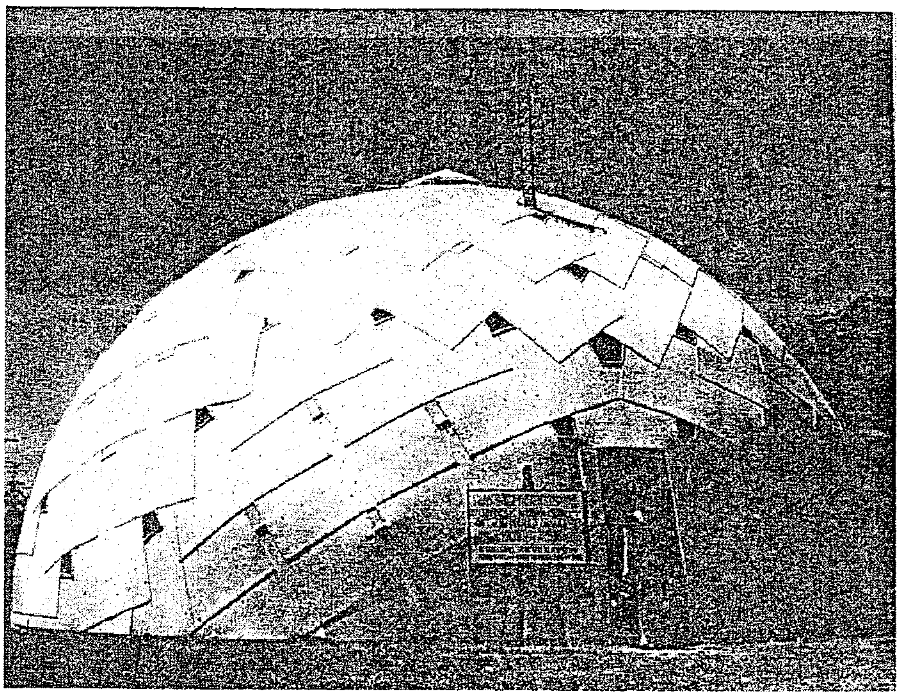
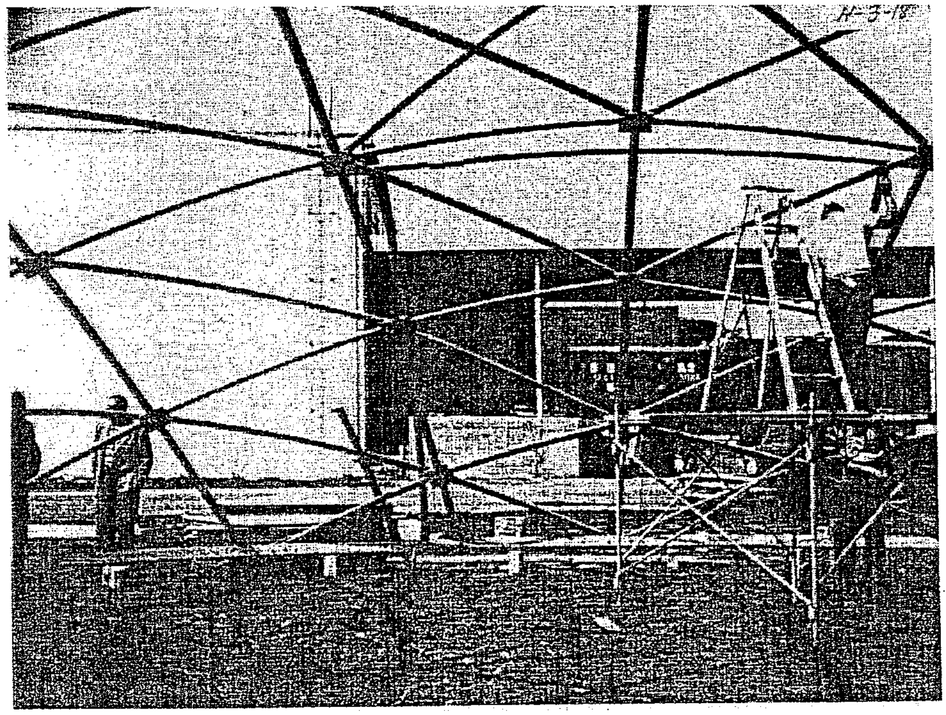


Fig.3.44 Synergetics Inc., Homasote Domasote Prototype, Sept. 1957. Source: BFI-Photo #H-3-23.



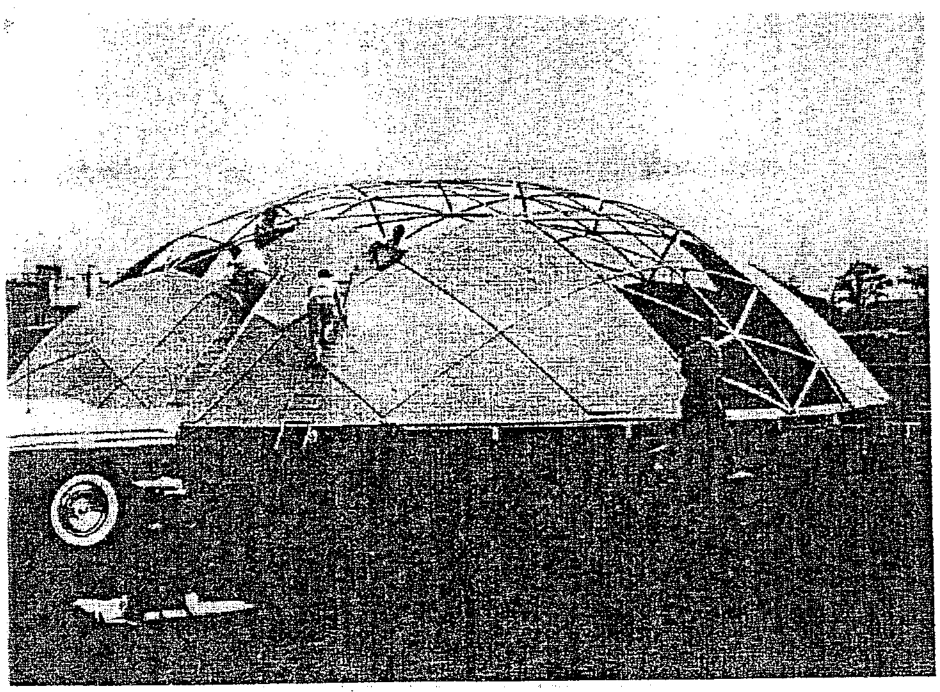
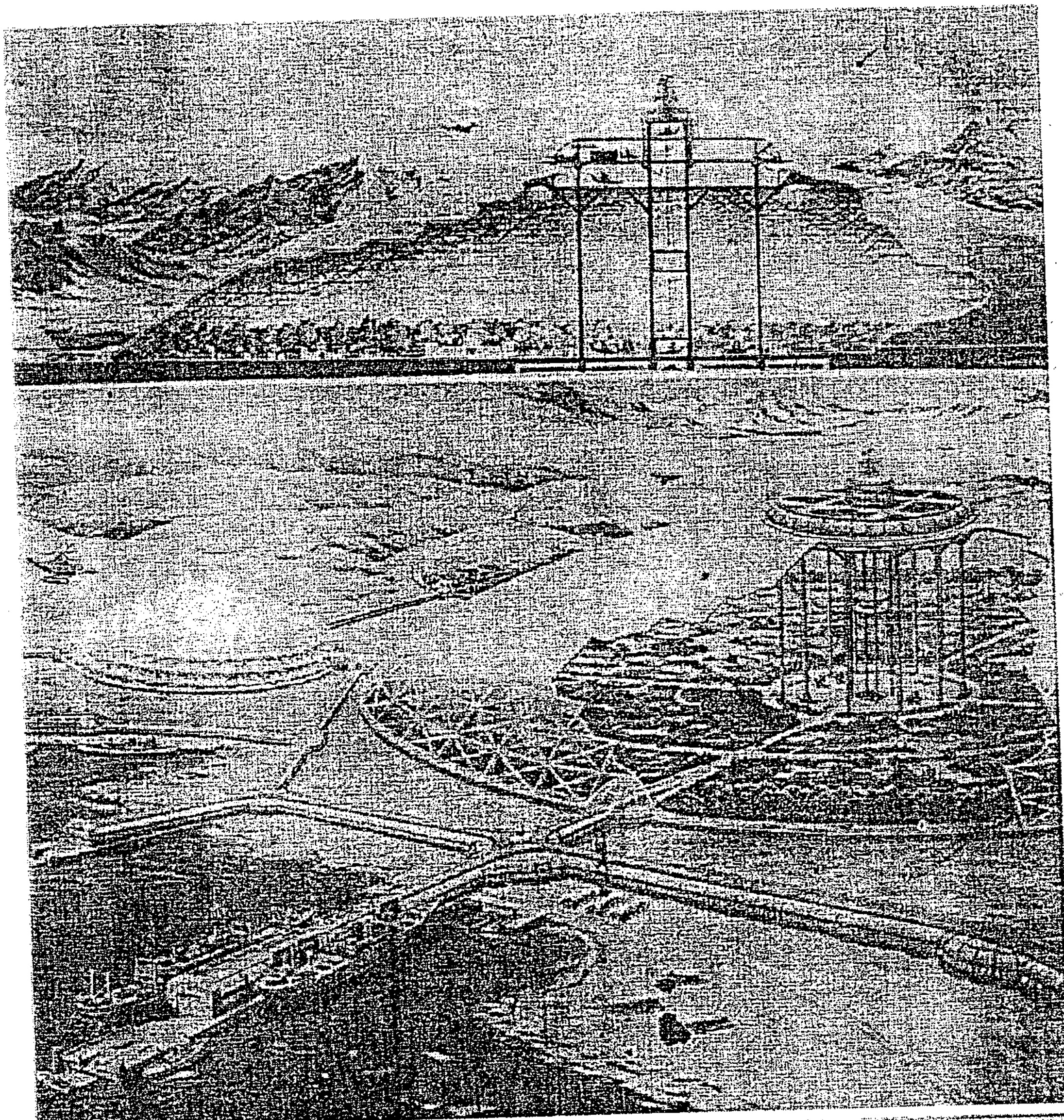


Fig.3.45 "Warm Bubble in the Arctic." Source: *The Boston Daily Globe*, 3/30/55, Oct. 1958.



(United Press-Boston Globe Photo)

WHAT NEXT?—A climatized Arctic airbase, housed in huge plastic domes and heated by portable atomic fission units, is envisioned in the April issue of Mechanix Illustrated Magazine. The magazine says that small plastic shelters recently demonstrated by the Marine Corps could be scaled up to almost any size. One 2000 feet in diameter could house military installations, living quarters and the heating unit. Smaller domes nearby, bottom left, could be used for service facilities, storage space and even gardens. Air operations from the giant plastic shelter would be centered on huge turntable platforms atop the dome (top). One platform would launch fighter planes and atomic bombers, the other, guided missiles. An elevator would carry planes and pilots up and down.

Fig.3.46a USMC Heliflight of Dome to USS Leyte, 12 July 1957. Source: BFI Photo #M-27-22.

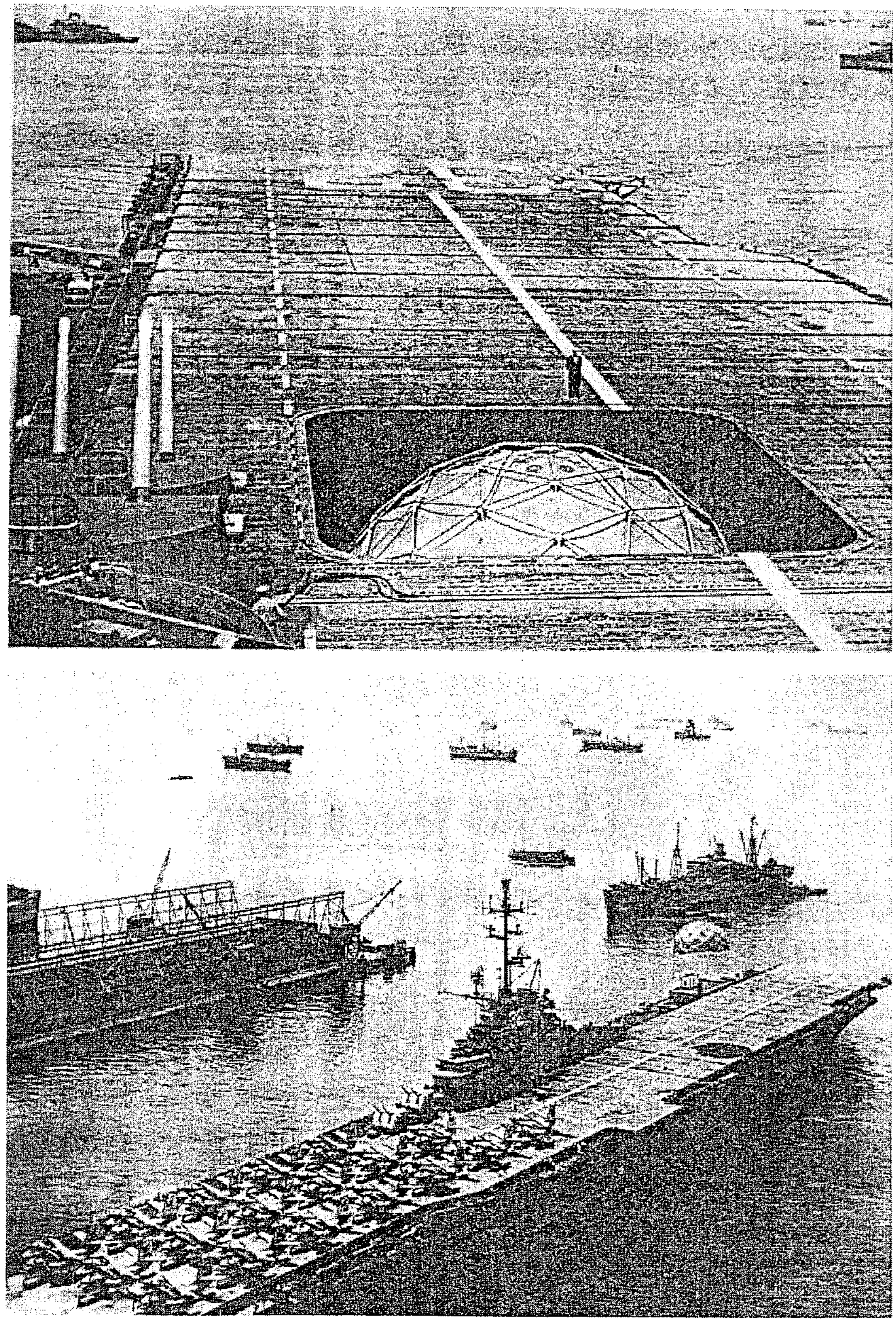
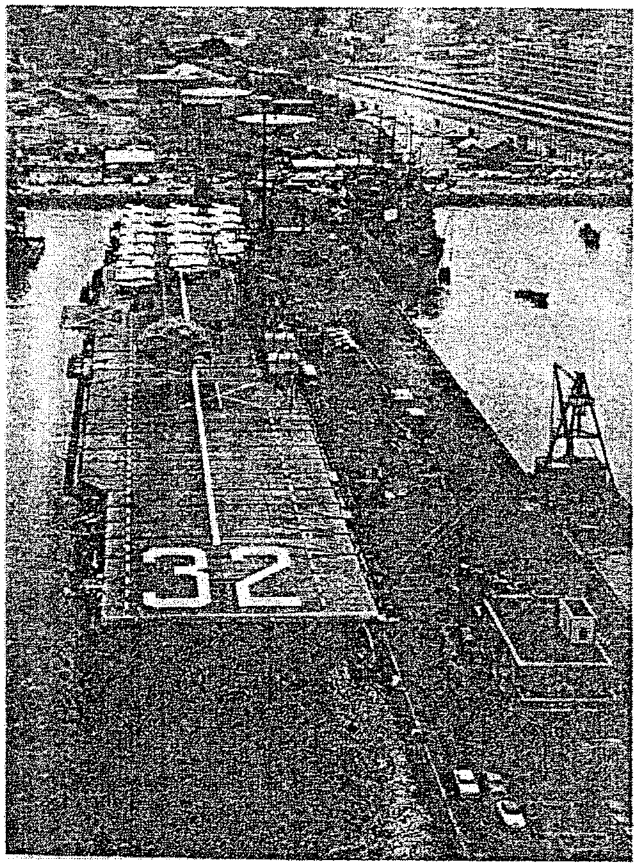


Fig.3.46b Testing of USMC 57-ft diameter geodesic Air Hangar produced by Magnesium Products of Milwaukee (MPM). Source: BFI Photo #M-28-1.



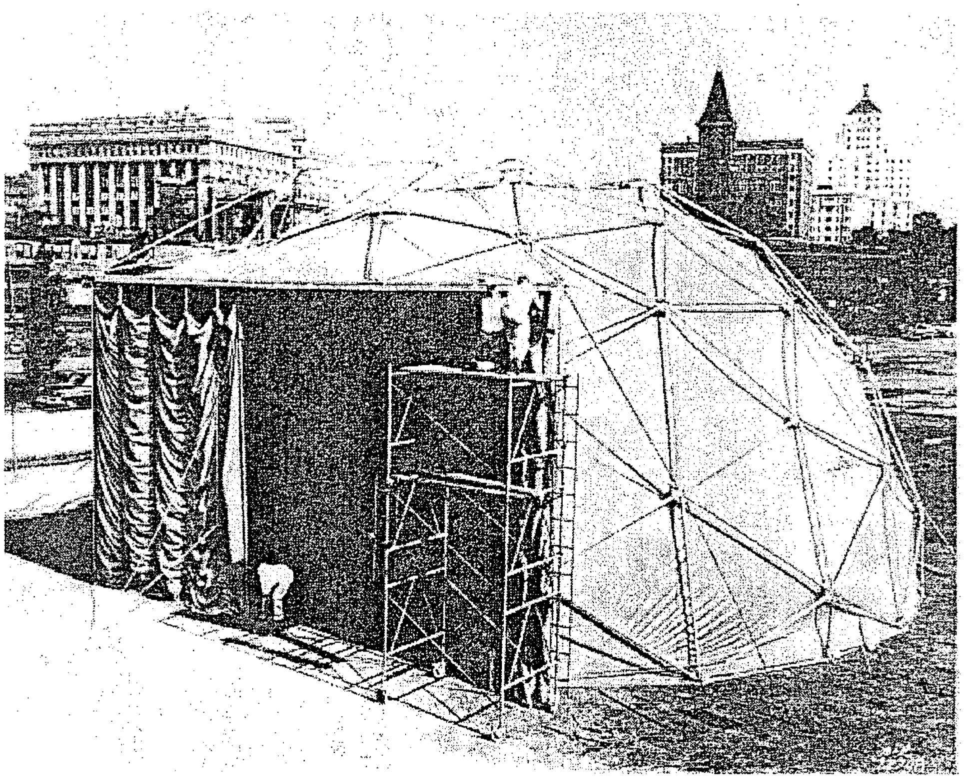


Fig.3.48 "Low Cost Sun Domes You can Build Easily." Source: *Popular Science*, May 1966.

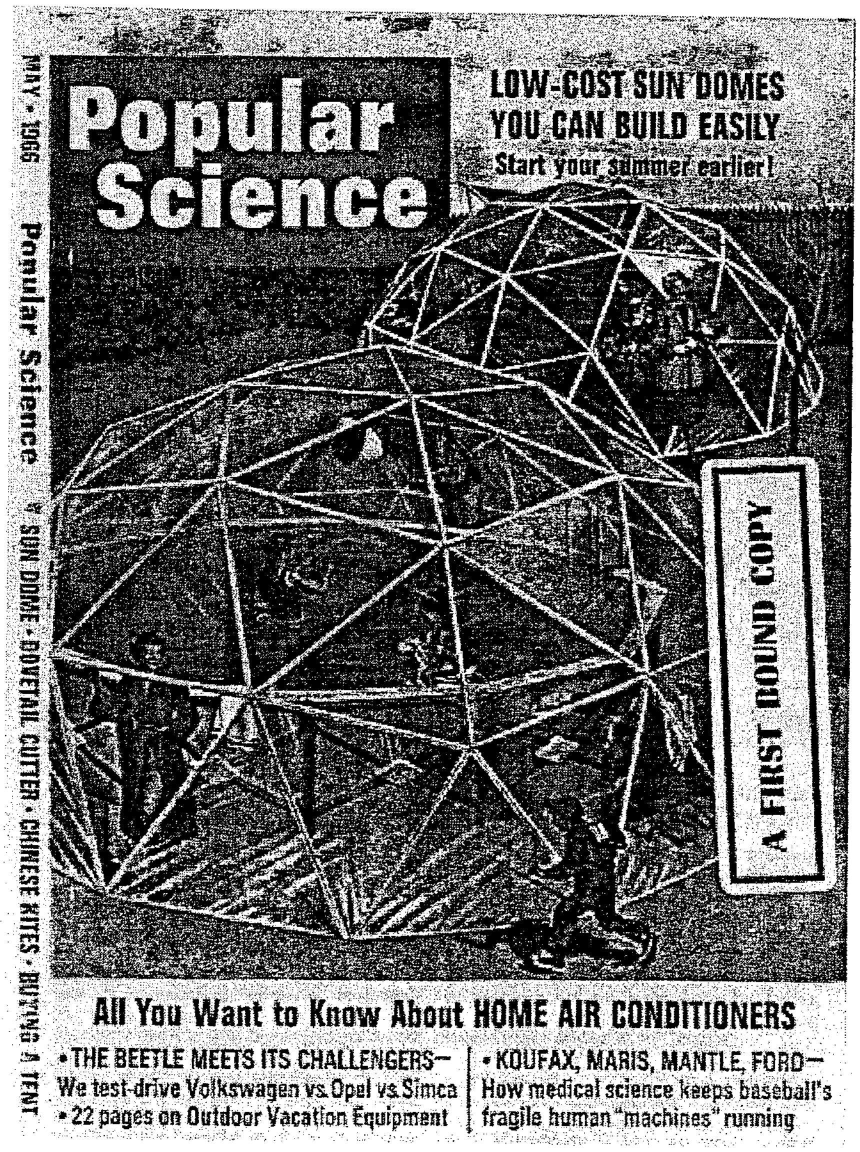
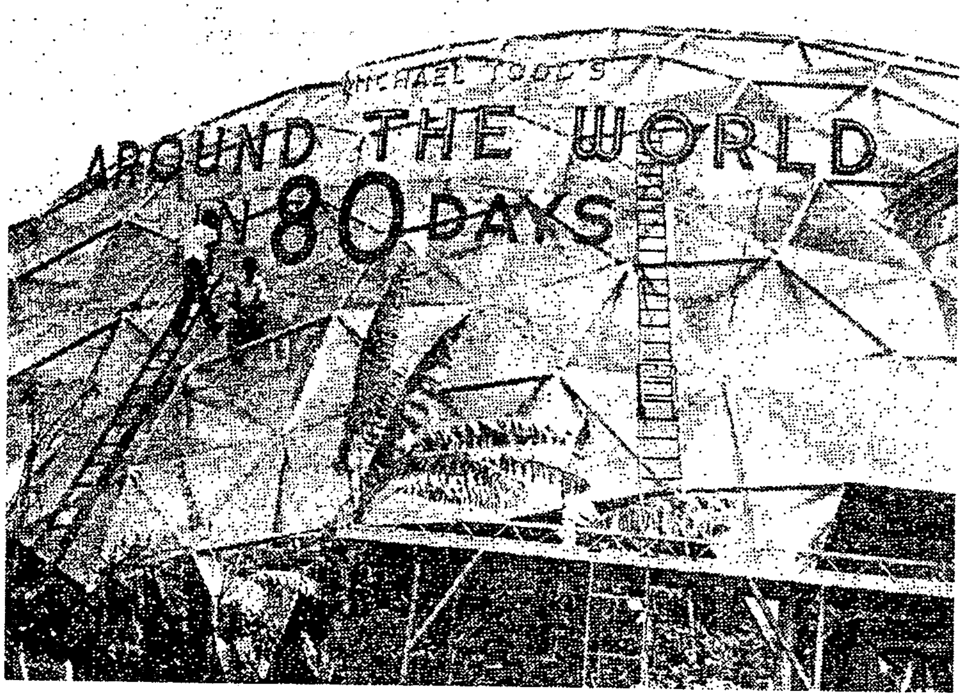


Fig.3.49 **1**: Michael Todd's "Around the World in 80 days" premiere opening at Kaiser's Dome. Source: The Honolulu Advertiser, 30 October 1957; **2**: Henry Kaiser. portrait. Source: NY World Telegram & Sun, 10 February 1958, p.27; **3** Three partners of the Dome Enterprises. Source: "Weaver, Kaiser, Todd Take on New Venture." Broadcasting Magazine, 11 November 1957, p.39.



Top Figure

Kaiser, 75, Builds Hotel After He Can't Get a Room

By PETER EDSON,

WASHINGTON, Feb. 10.—Industrialist Henry J. Kaiser was back in Washington the other day blooming as ever.

Since he moved to Honolulu in 1953 and began building his 200 room Hawaiian Village Hotel on Waikiki Beach, he hasn't frequented these parts as much as he did in war times.

But more or less regularly now, he flies from Honolulu to Oakland, checks up on operations of his 57 enterprises at his headquarters there, flies on to New York to see his bankers, down to Washington to see how things are here—and is back in Hawaii within 72 hours from the time he left. [illegible] find a site and buy 16 acres of beach front property. He [illegible]

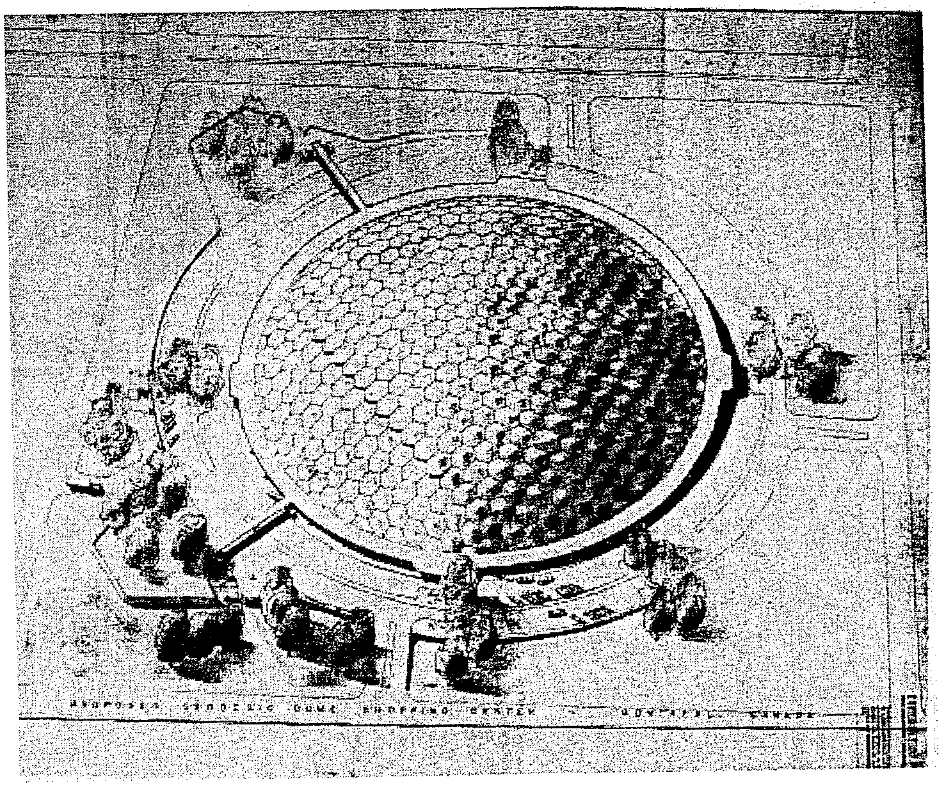

HENRY J. KAISER.

—all eight feet planted firmly off the ground.

The product of Dome Enterprises is a hemispherical roof made of diamond-shaped curved aluminum panels. They are fastened together and raised on a central mast until they are built out to the circumferential foundations. Then the mast is taken down and out, leaving a pillarless dome which can be used as a pavillion, auditorium, theater, dance hall or whatever it is you need.

The first one was built at Hawaiian Village Hotel. Many of the Kaiser engineers thought the idea was crazy and that the dome would cave. Mr. Kaiser didn't think so. When it stood up all right, they said the acoustics would be terrible. Mr. Kaiser didn't think so.

Fig.3.50 Geodesic Dome Shopping Centre (aka Montreal Shoppersville), by Synergetics Inc., ca. 1960. Source: J. Ward ed., The Artifacts of R. Buckminster Fuller, Vol.4, pp.1-2.



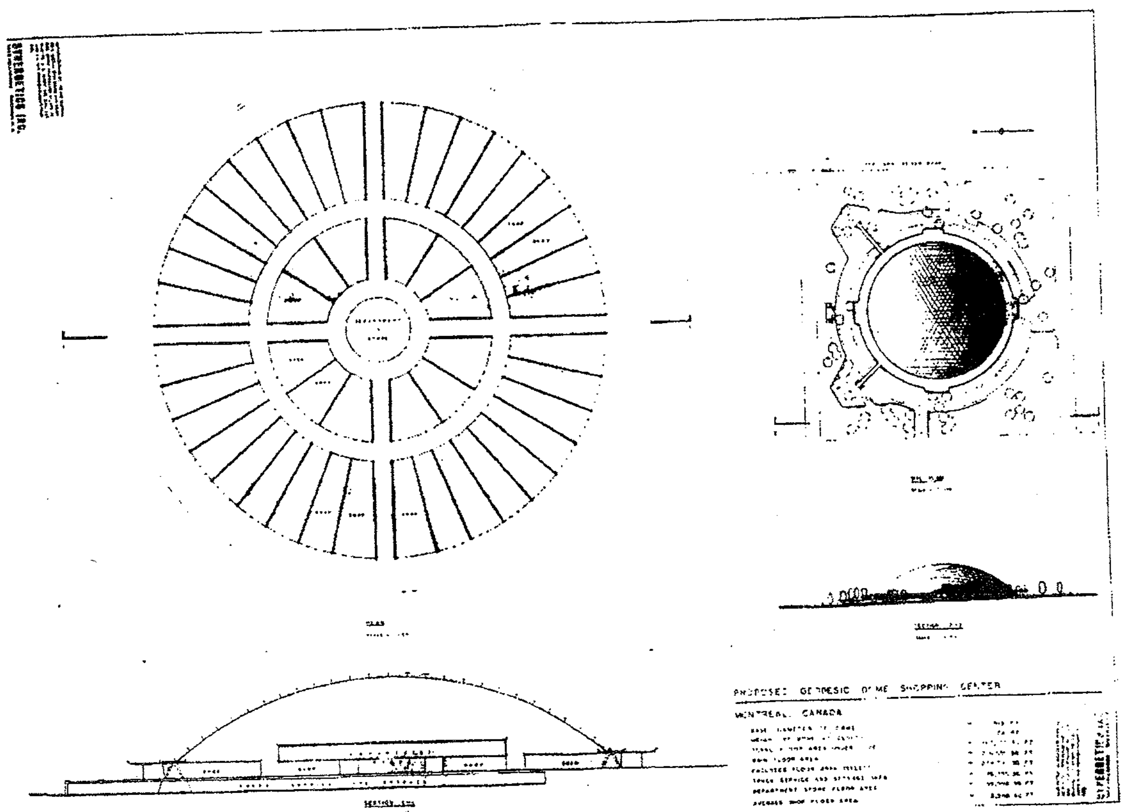


Fig.3.51 ALCOA (Aluminum Company of America), Proposed "Yonkers Raceway" for William Zeckendorf, ca. 1958. <u>Source:</u> BFI-Photo #Z-2-1.

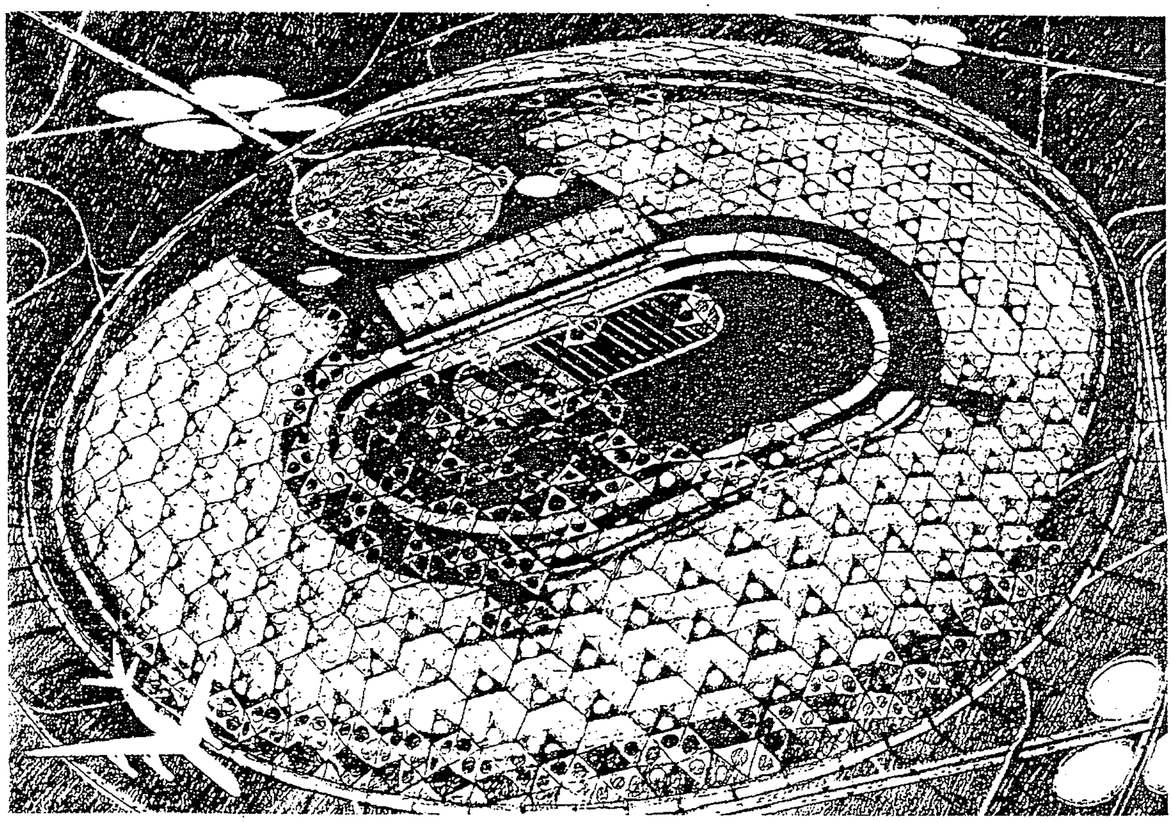


Fig.3.52 Geometrics Inc./R.B. Fuller, Model of Shoriki Tower, next to a scale model of Eiffel Tower, ca.1962. Source: BFI-Photo #J-2-1.

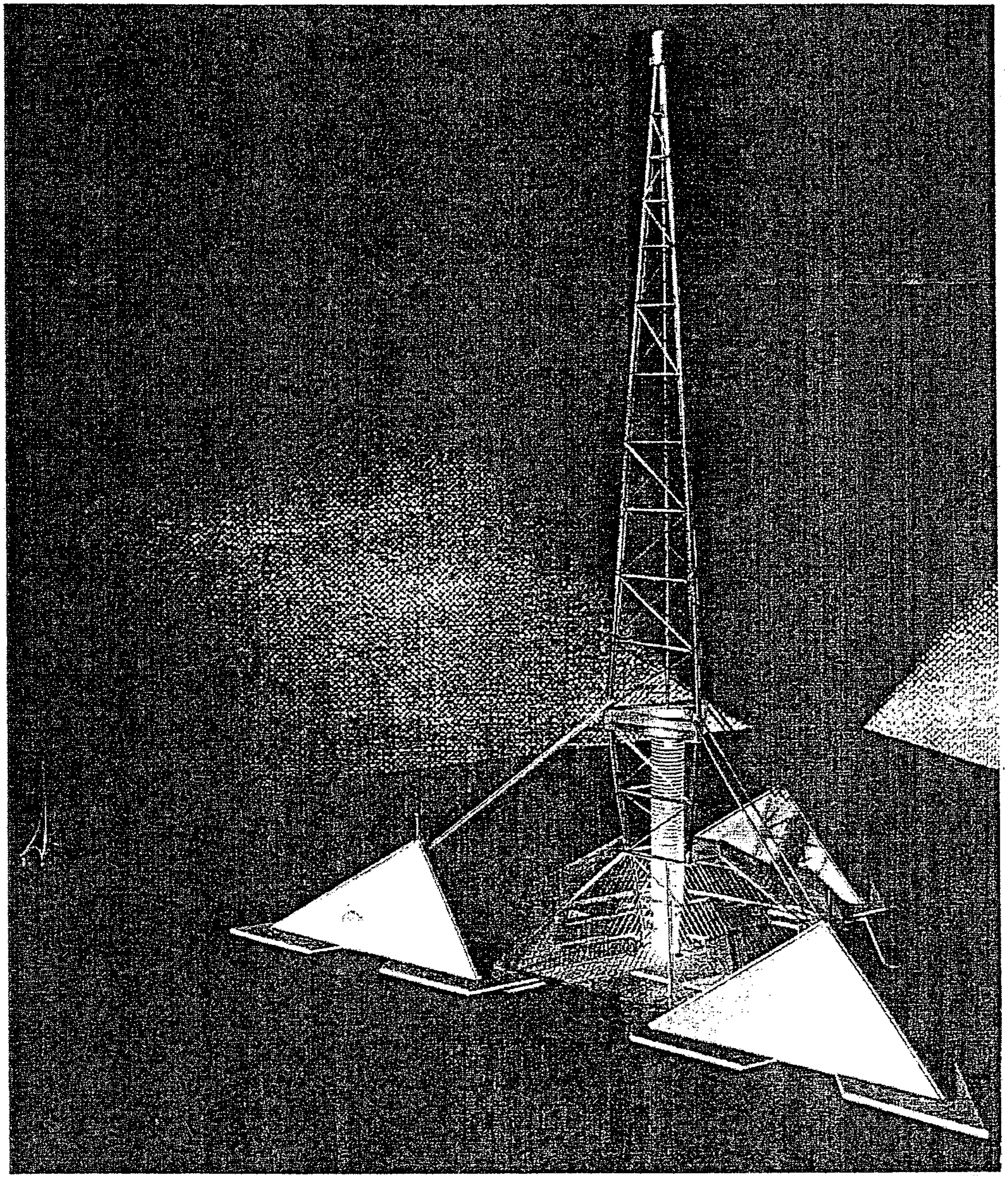
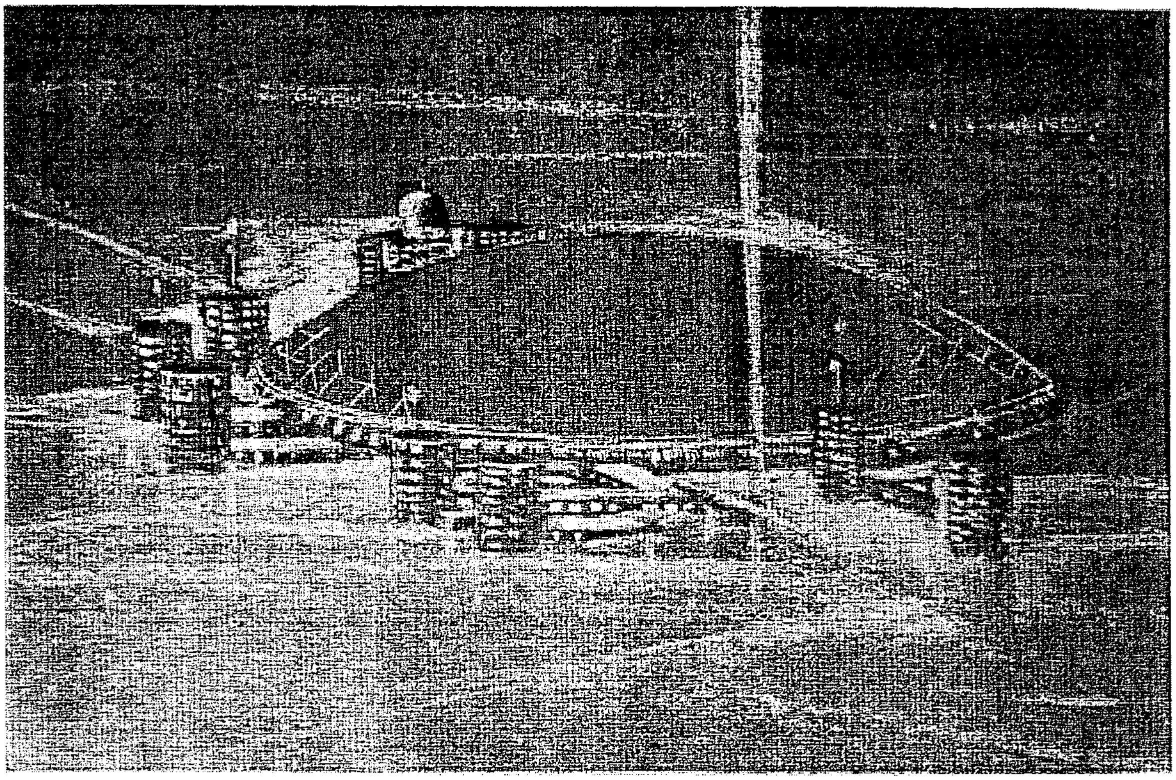


Fig.3.53 J.W. Fitzgibbon, 2300'-D "Town-enclosure" for Frobisher Bay -Canada, ca.1958. Source: M. Fitzgibbon's Collection.



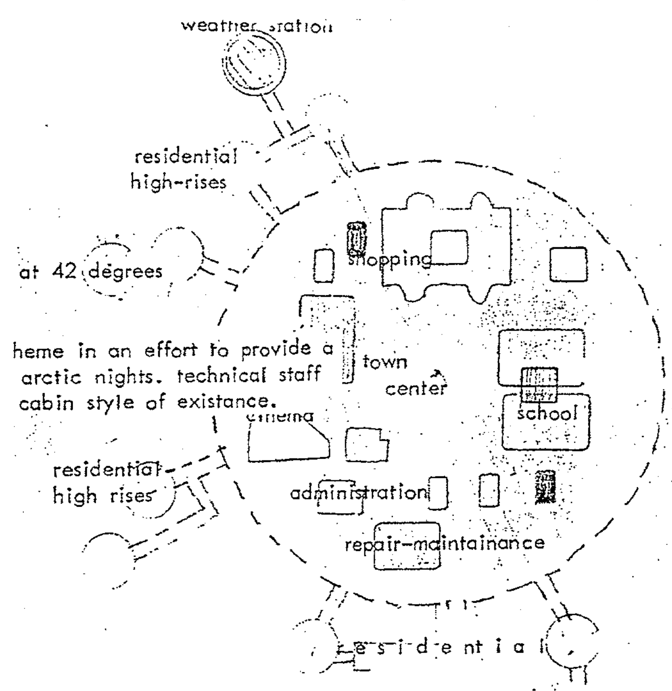


Fig.3.54 J.W. Fitzgibbon, Interior of Town Umbrella (13,500' x 7100') for Kuwait City, ca.1958.
Source: M. Fitzgibbon's Collection.

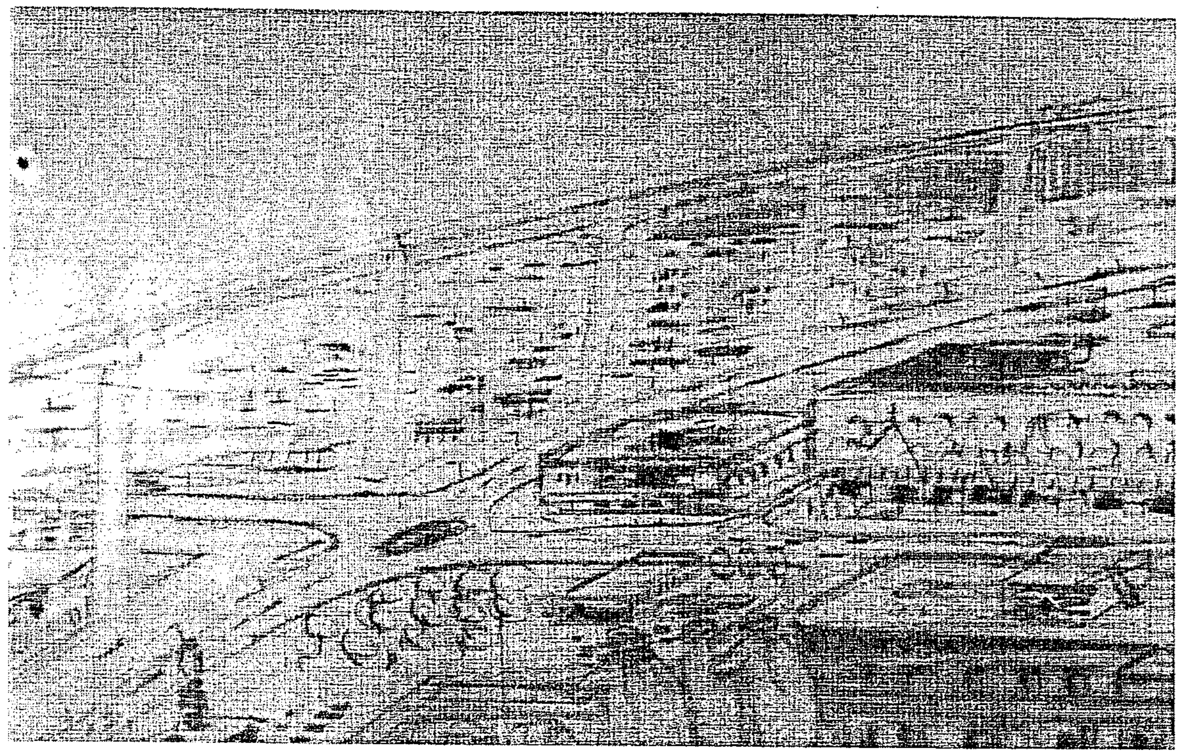


Fig.3.55a R.B. Fuller & Princeton University, Model of O'Malley Dodgers' Dome. Source: BFI-Photo #D-7-11.

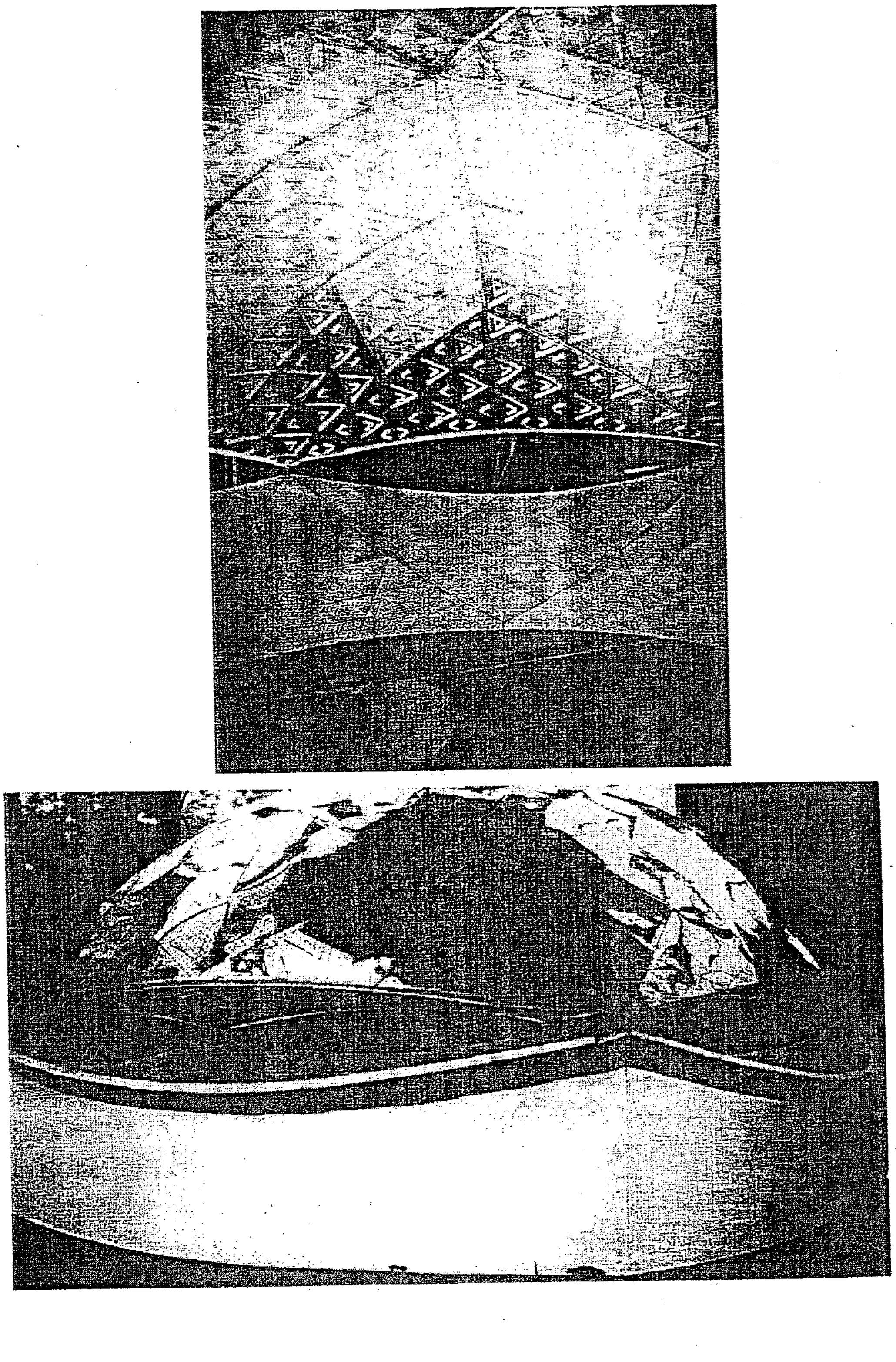


Fig.3.55b An cut away section of the O'Malley Dodgers' Dome. <u>Source:</u> *Mechanix Illustrated*, July 1956.

Fig.3.55c Cartoon commentary on the proposed Brooklyn City Sports Center, *Journal American (New York)*, 2 February 1956.

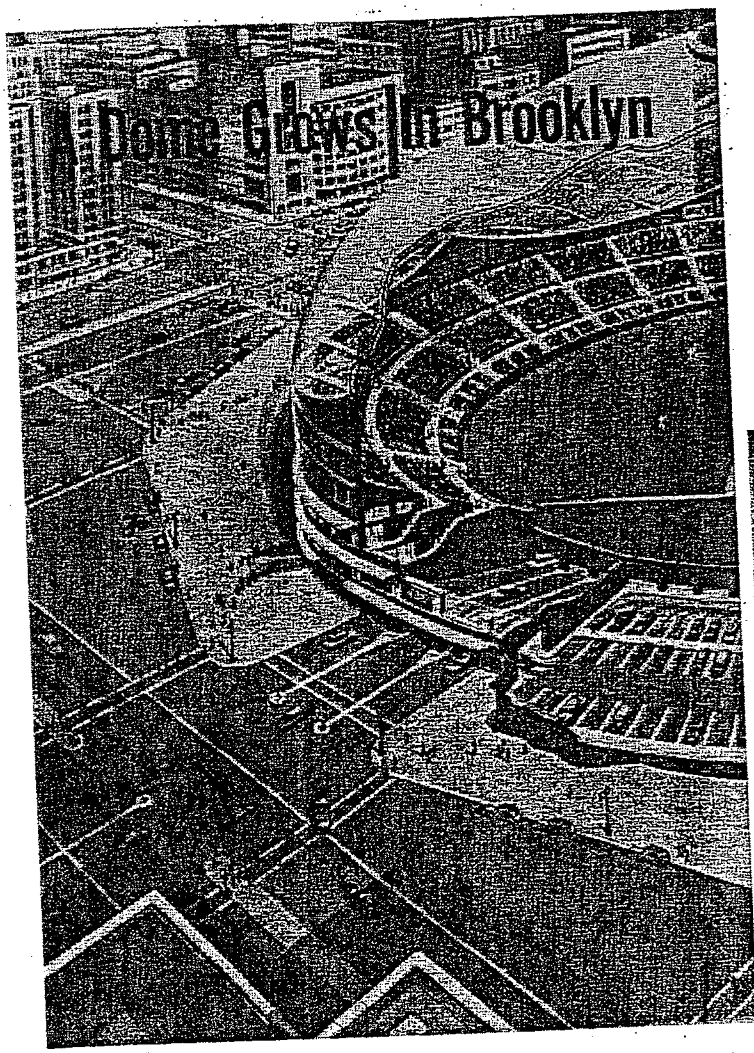


Fig.3.56 R. B. Fuller's sketch of "Rollin-doughnut shaped circulation of heated air", December 1951. Source: BFI-CR134.

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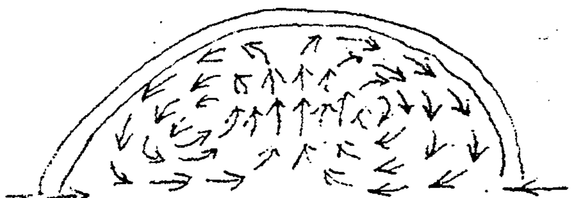
domes, condensations and frosting on interior surface is reduced or eliminated. The interior dome provides favorable internal aeronautical space shaping, resulting in self-protecting internal laminar flow enclosing the rolling-doughnut shaped circulation of heated air.



The exterior dome reduces externally dissipated energy by exposing the minimum structural surface per enclosed volume as well as minimum heat loss as caused by internal-external atmospheric pressure differential, as induced by exterior low pressure drag area inherent in structural shape relationships. The hemisphere presents the optimum omni-directional wind drag reduction shape.

Drawing #2 (A) shows the basic spherical components identification and repetitive pattern. The hangar shipment includes a rolled up, coded parts-identifying assembly jig for basic four-strip subassembly outlined in blue crayon, two of which comprise one basic diamond, fifteen of which basic diamond complexes complete the hemisphere. Parts are individually numbered, color coded and lettered to match faces, edges and vertexes of assembly jig and the basic equilateral diamonds can go together in only one way.

Fig.3.57a Bird's eye-view of the Climatron, Missouri Botanical-Garden, ca. 1962. Source: T. C. Howard Collection.

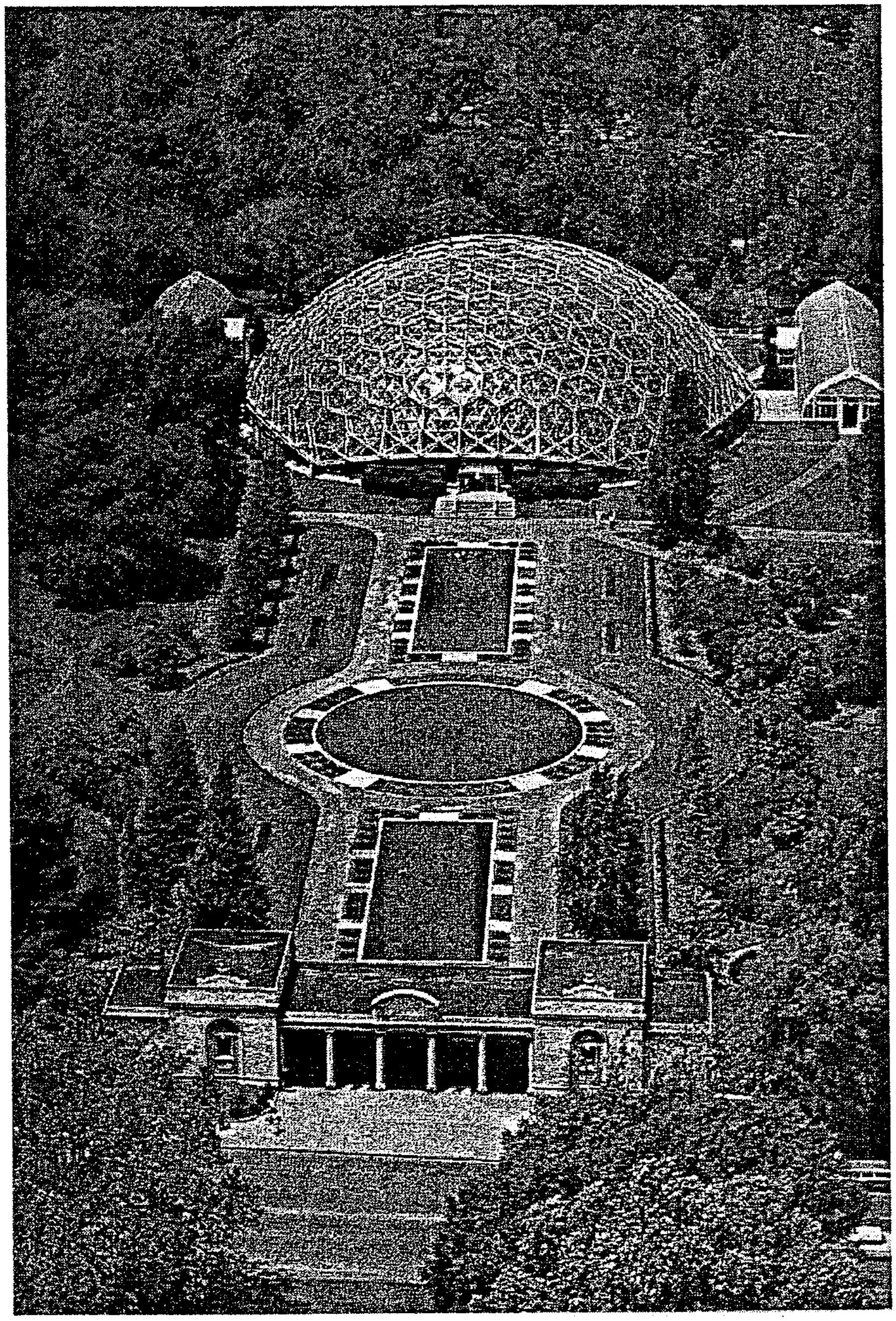


Fig.3.57b Climatron, Missouri Botanical-Garden, ca. 1962. Source: T. C. Howard Collection.

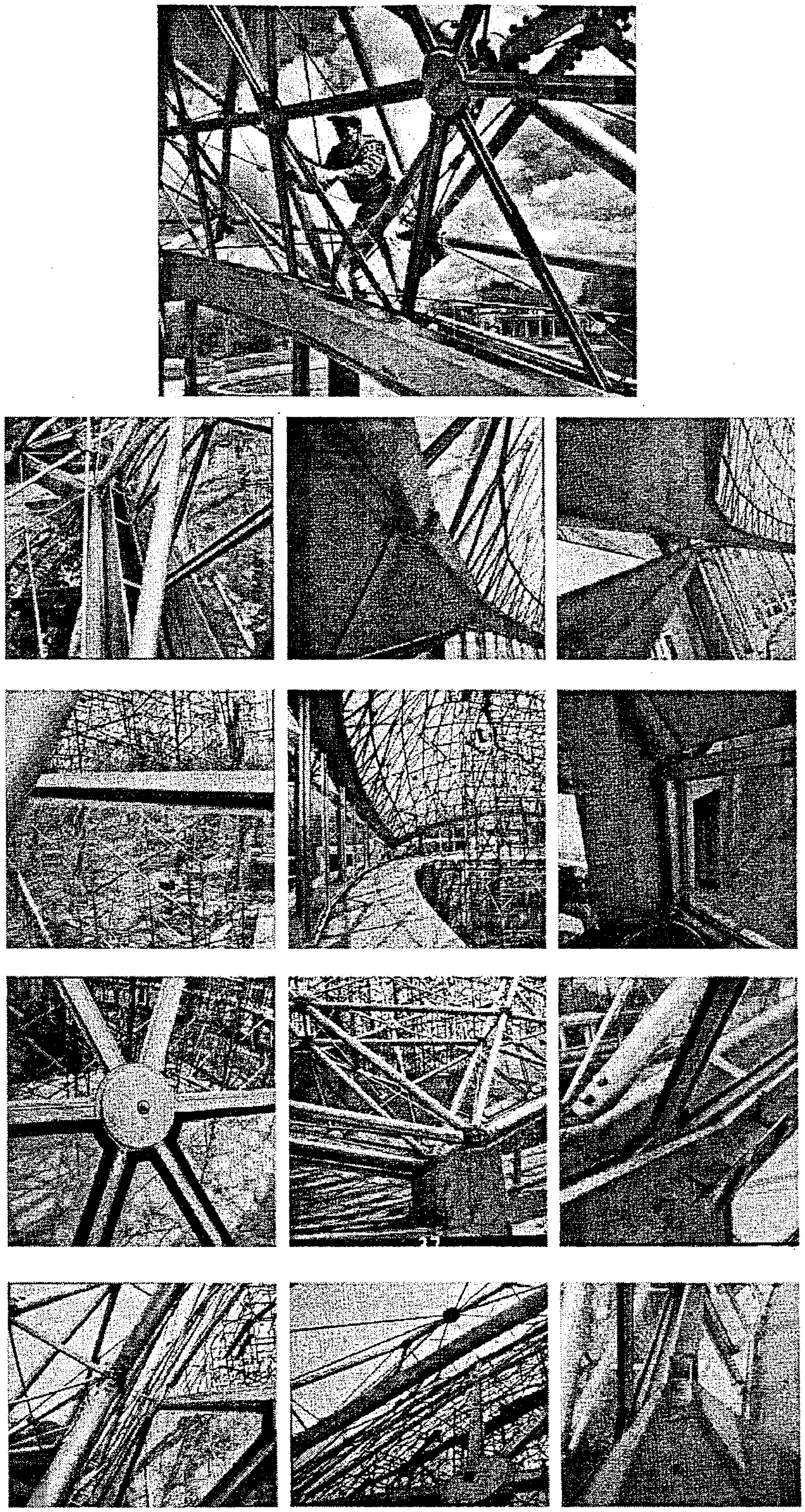


Fig.3.58a Site Plan for Redevelopment of Shaw's Garden, Missouri Botanical Garden, December 1958 by Layton, Layton & Rohrbach. <u>Source:</u> MBG Archives, Dwg. 770374 "Staging" 12/4/58.

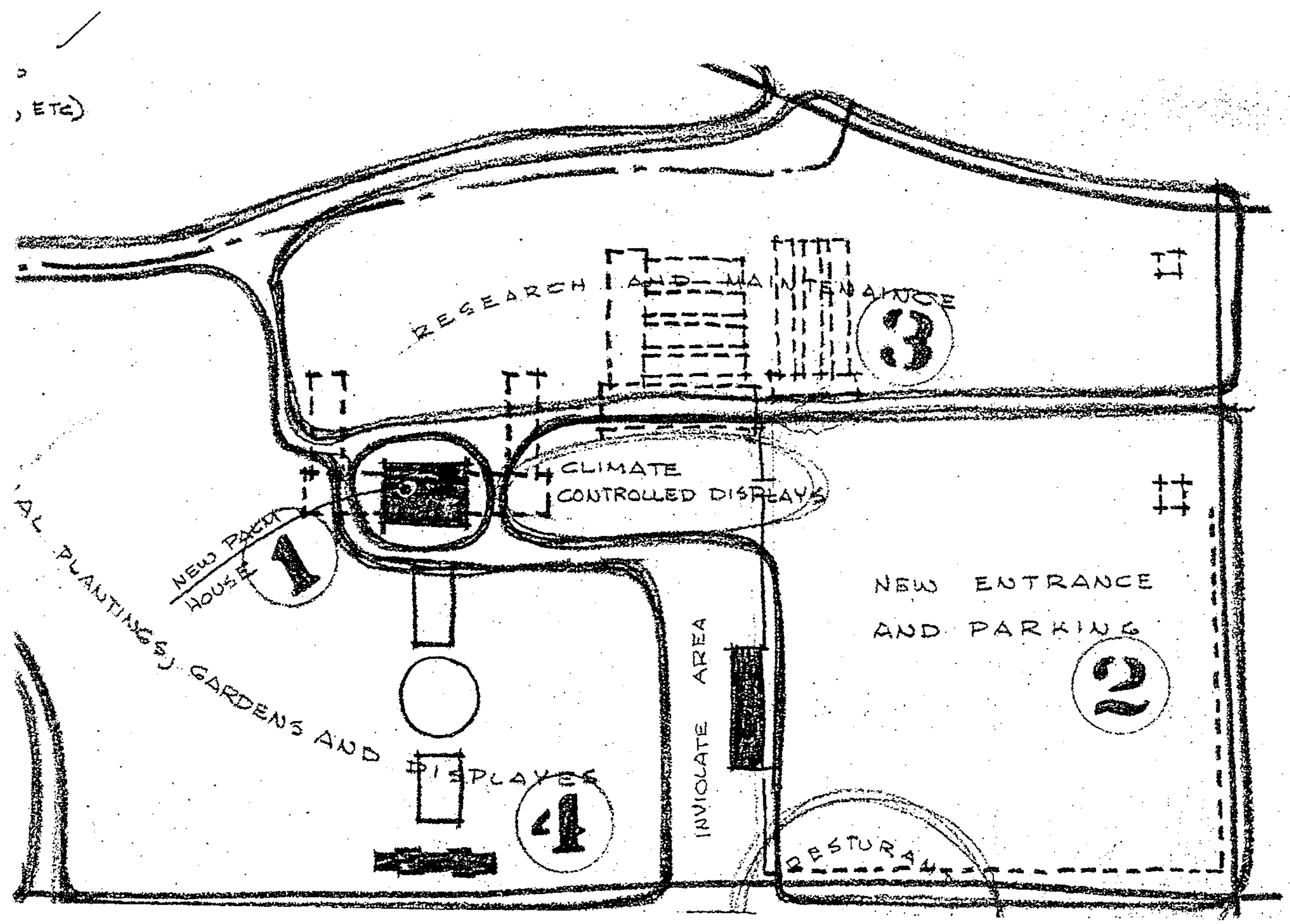


Fig.3.58b Site Plan for Redevelopment of Shaw's Garden, Missouri Botanical Garden, December 1958, by Layton, Layton & Rohrbach. Source: MBG Archives, Dwg. 770374 "Proposal" 12/4/58.

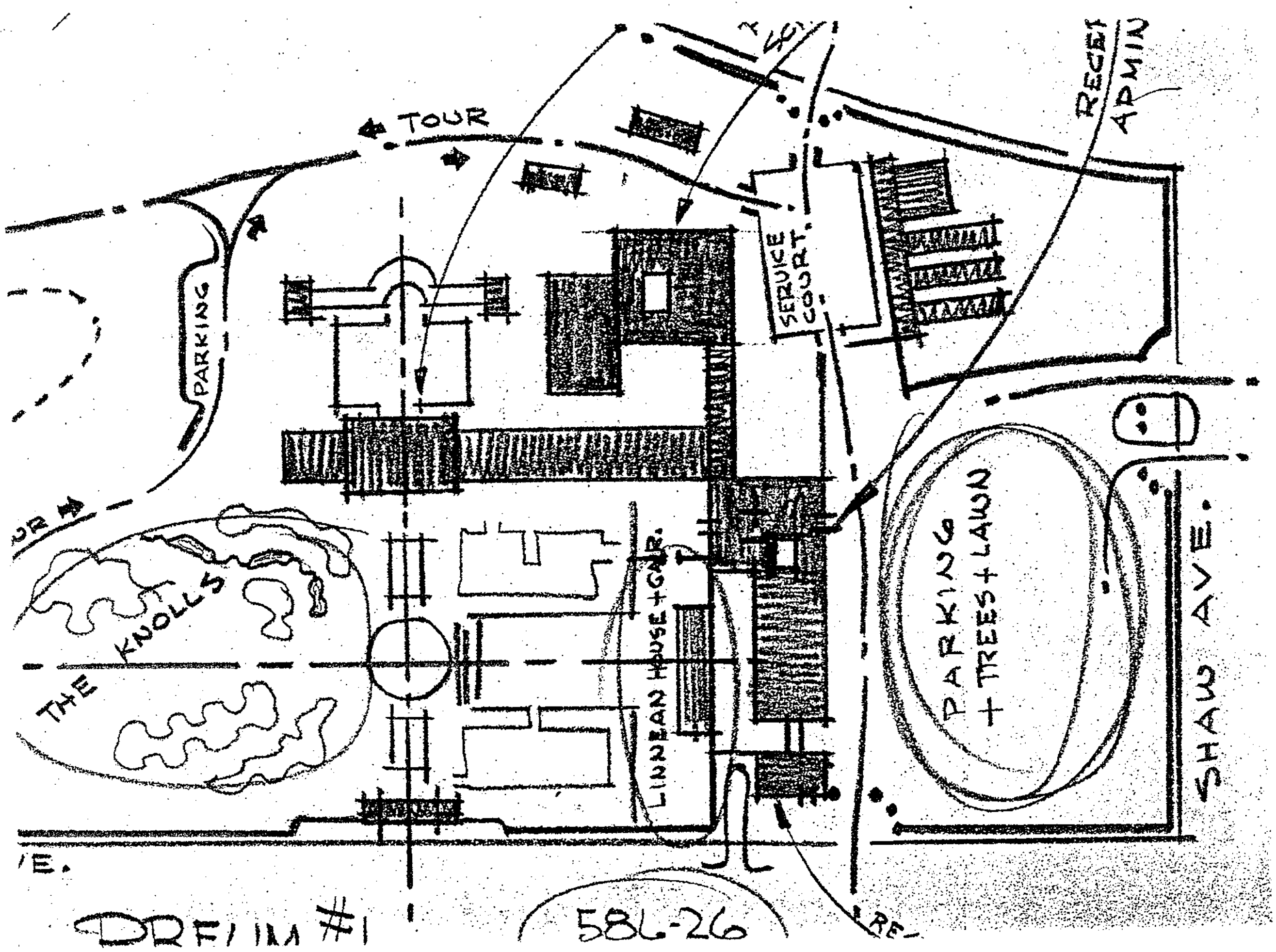


Fig.3.59a The old Palm House, Missouri Botanical Garden (demolished), undated. Source: MBG Archives, Layton, Layton & Rohrbach, "Master Plan Report" 1960.

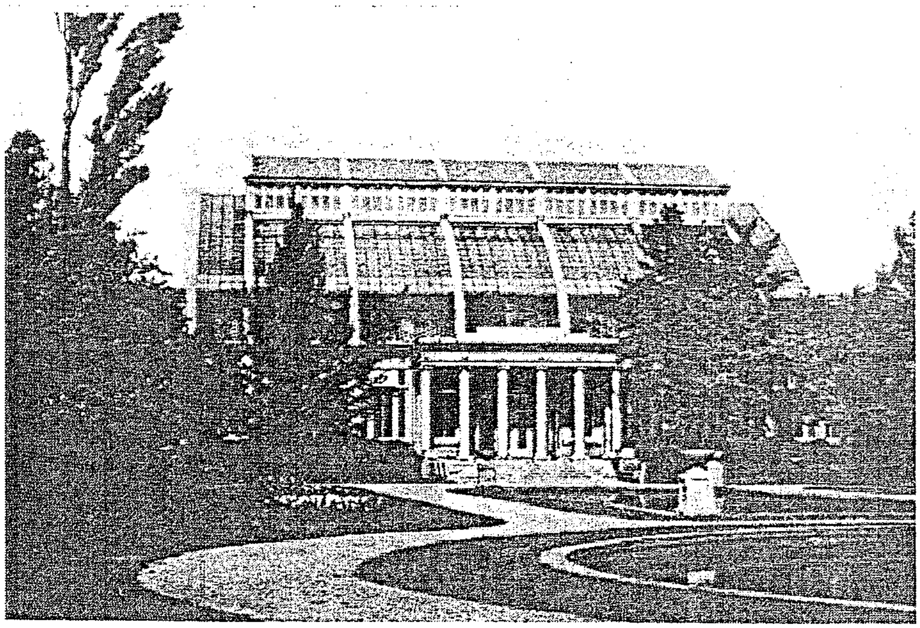


Fig.3.59b Site-plan Sketch for the New Greenhouse, December 1960 by Murphy & Mackey. <u>Source:</u> MBG Archives, Dwg. 91.00.89, 1958 December, "1st. Stage Construction".

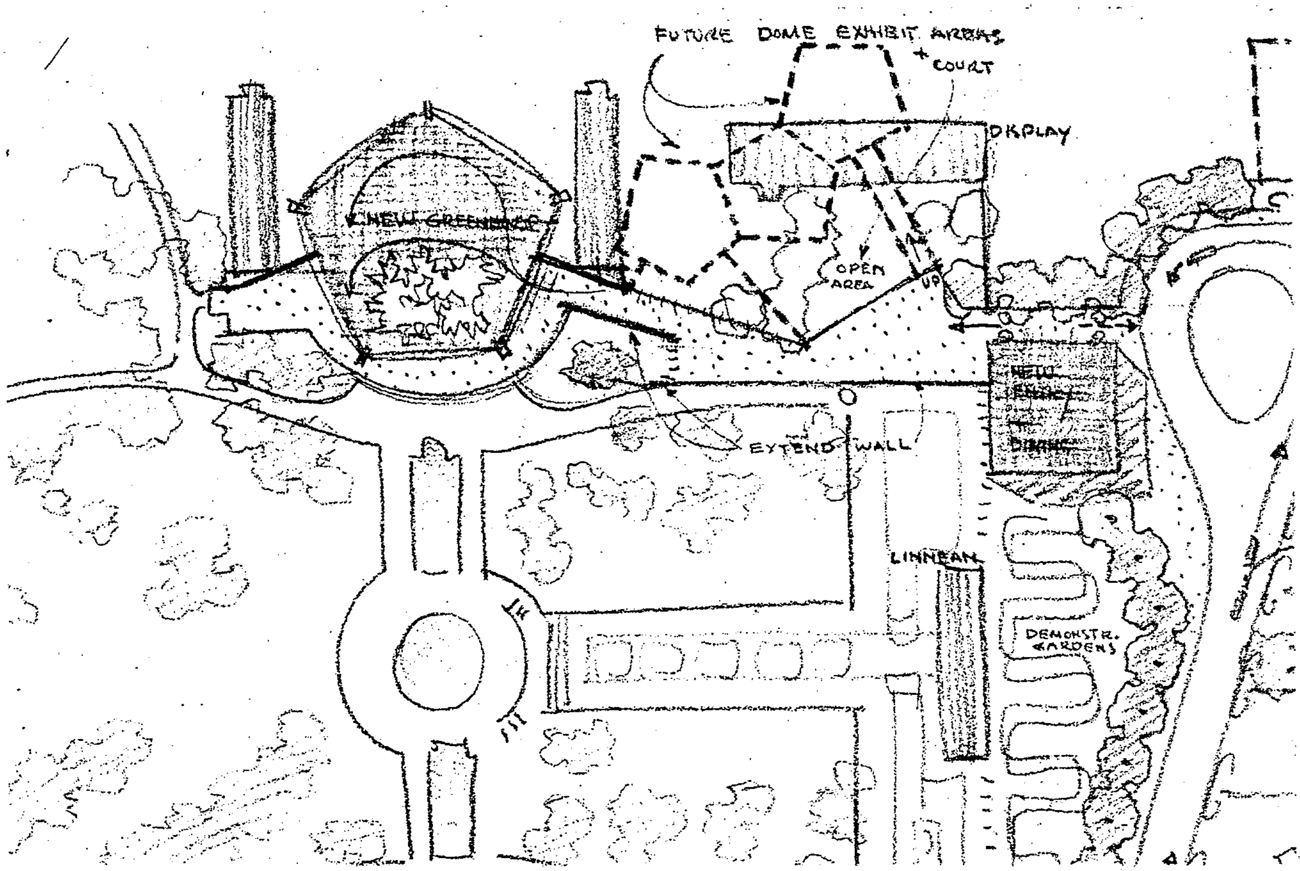


Fig.3.59c Murphy & Mackey, Site-plan Sketch for the New Greenhouse, December 1960. Source: MBG Archives, Dwg. 77.00.281, 12/30/58, "Proposed Development Plan & New Structures".

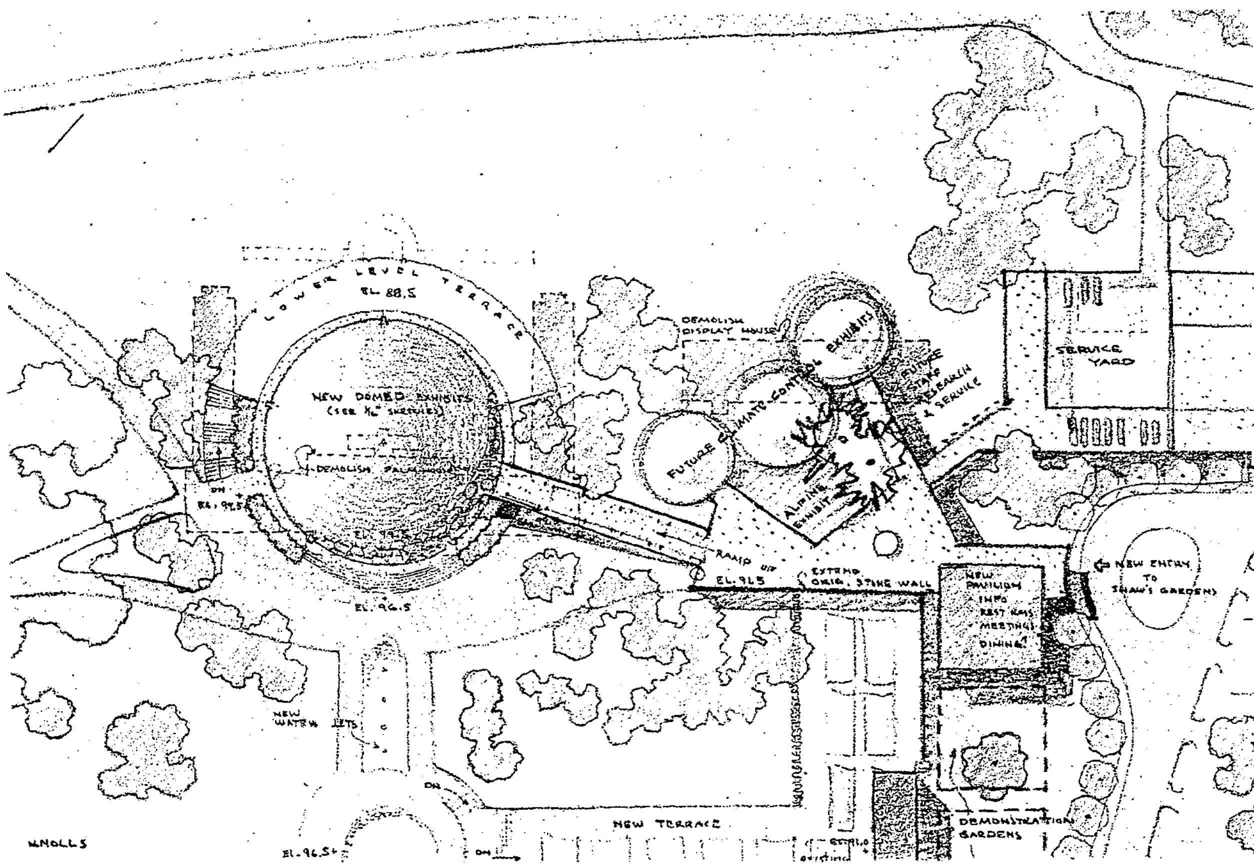


Fig.3.59d Preliminary Study - Missouri Botanical Garden Master by Layton, Layton & Rohrbach. Source: MBG Archives, Dwg. 91.0067, 17 February 1959, Drawer 69/2.

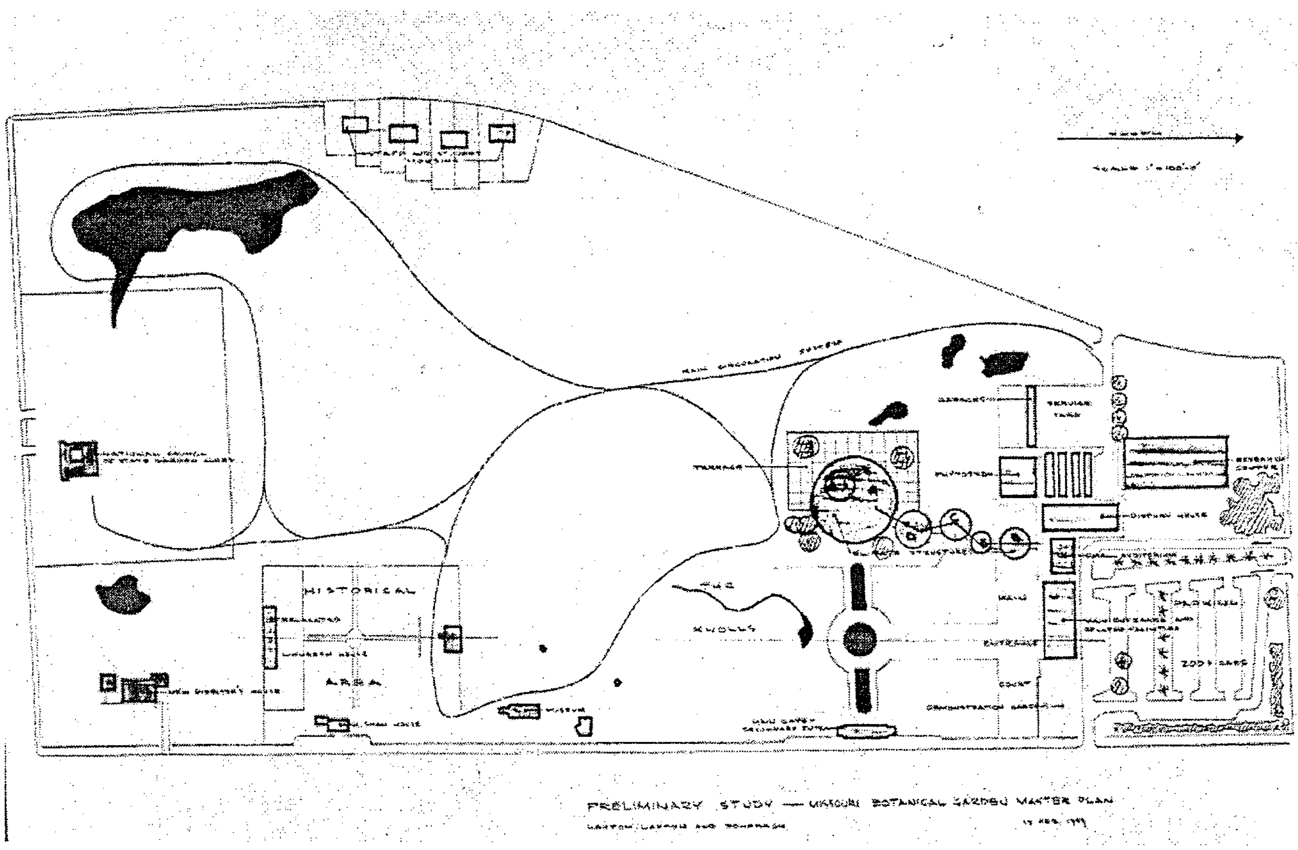


Fig.3.59e Master Plan Study - Missouri Botanical Garden Master by Murphy & Mackey. Source: MBG Archives, Dwg. 770.375, 1959, 24 March 1959.

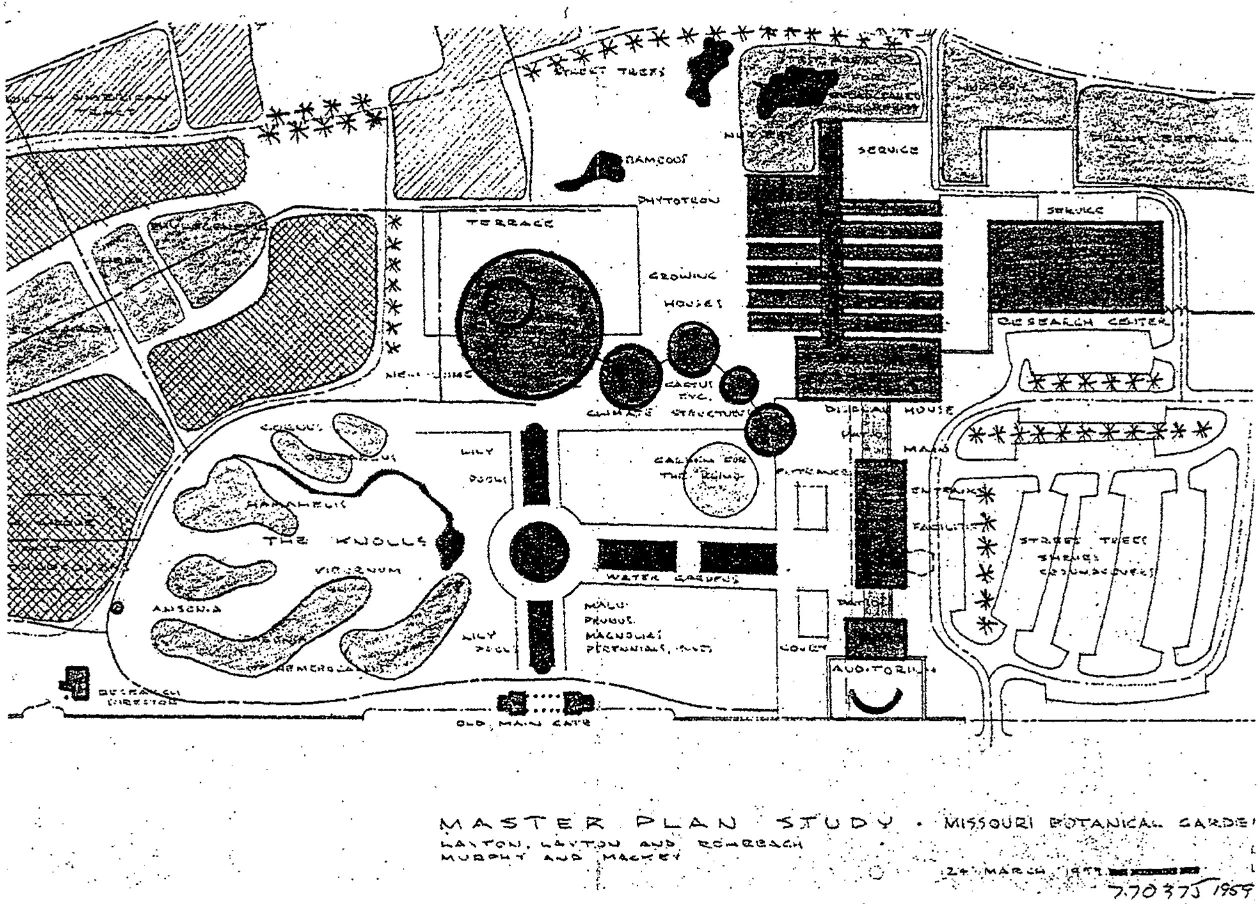


Fig.3.60 Fuller as "designer of the (Climatron) dome," *St. Louis Globe-Democrat*, November 12, 1959.

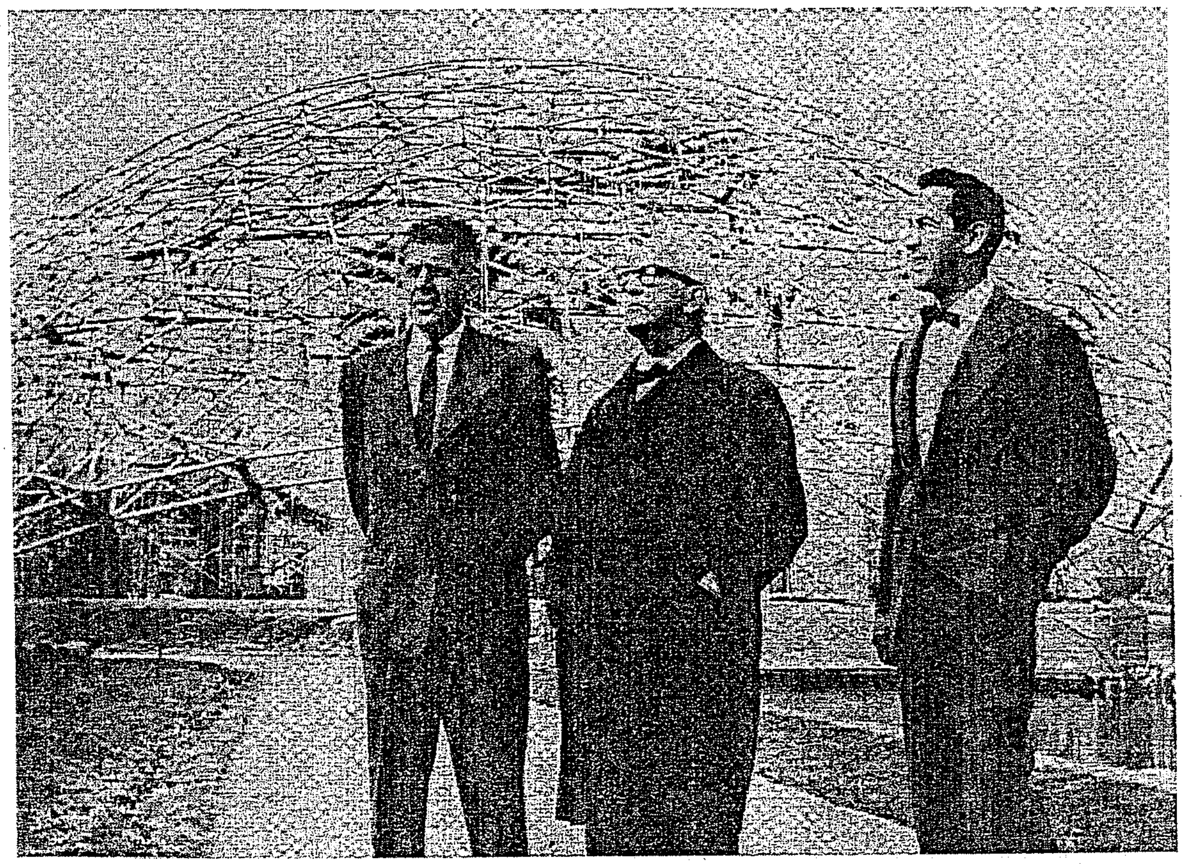
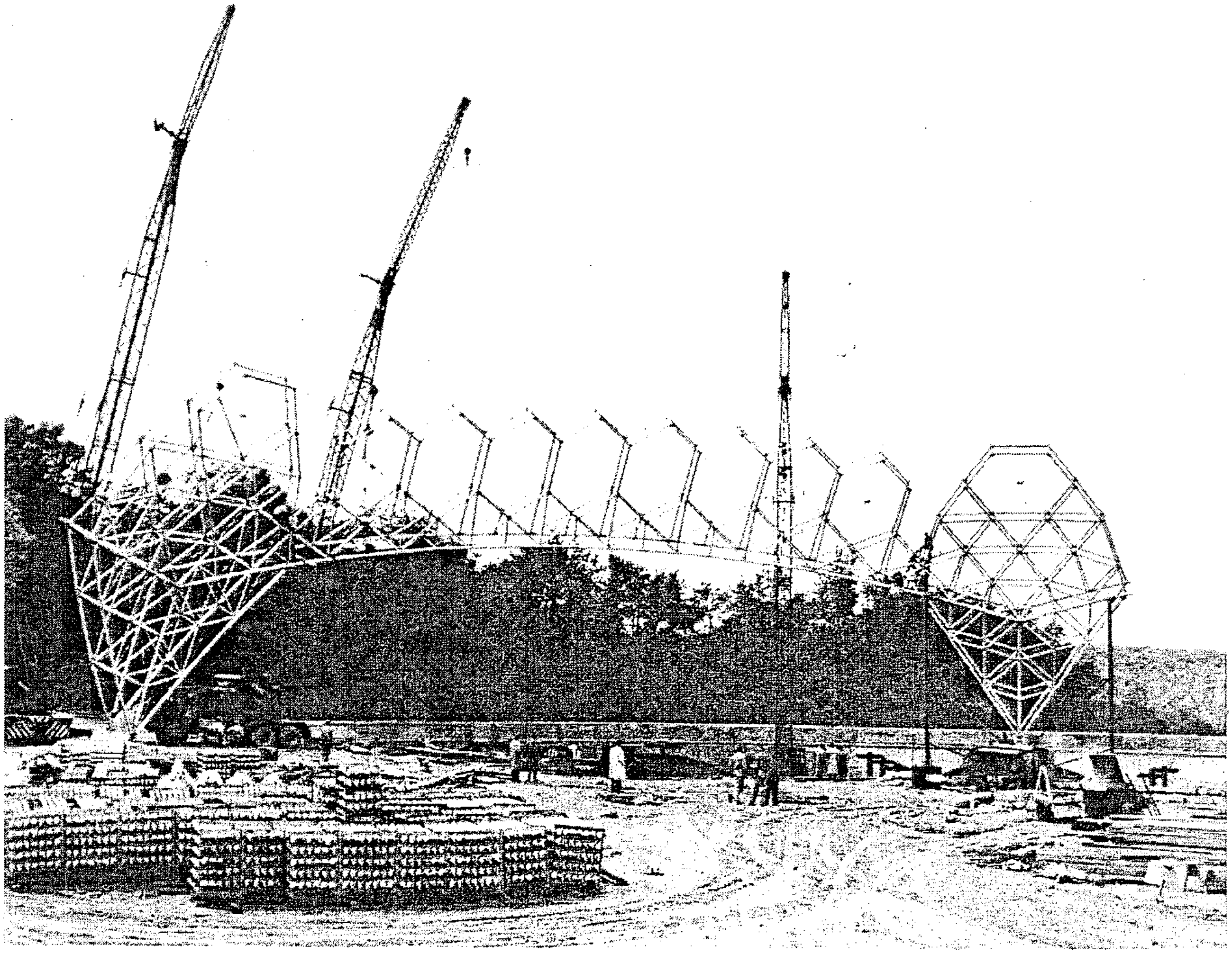


Fig.3.61 Synergetics Inc., American Society of Metals(ASM) Building in Metals Park-Ohio. <u>Source:</u> M. Fitzgibbon's Collection.



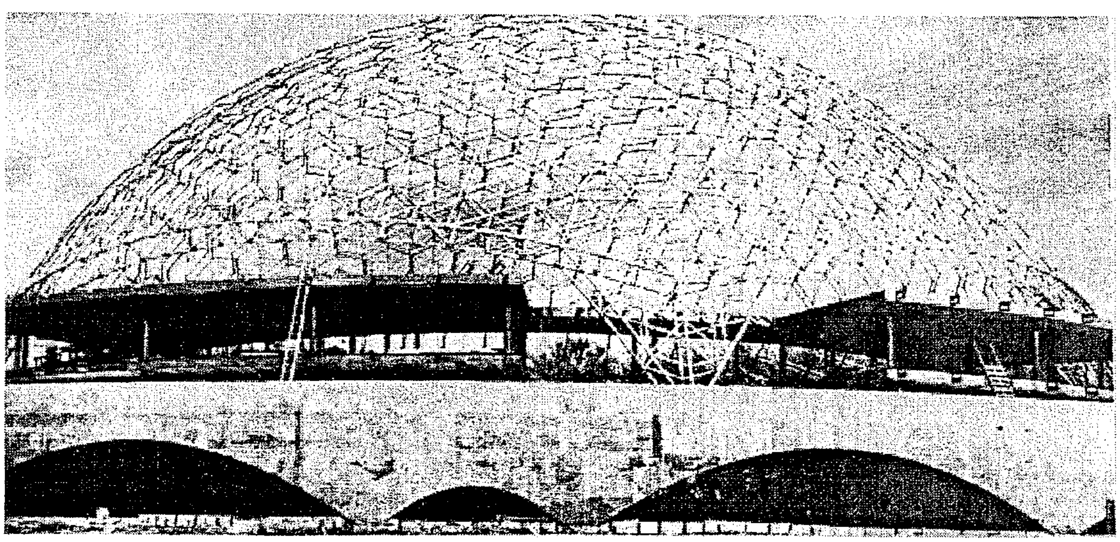


Fig.3.62 Synergetics Inc., Exterior View of the American Society of Metals(ASM) Building in Metals Park-Ohio.
Source: M. Fitzgibbon's Collection.

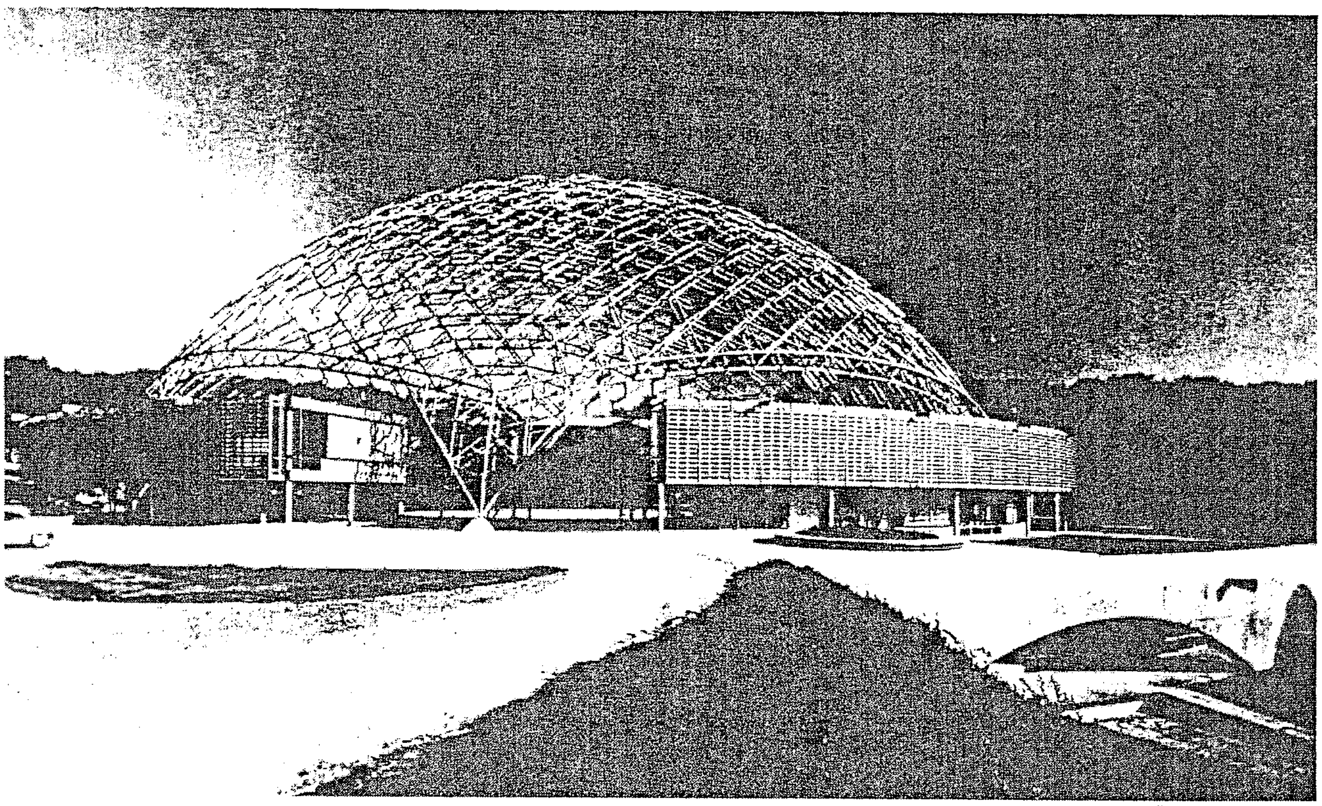
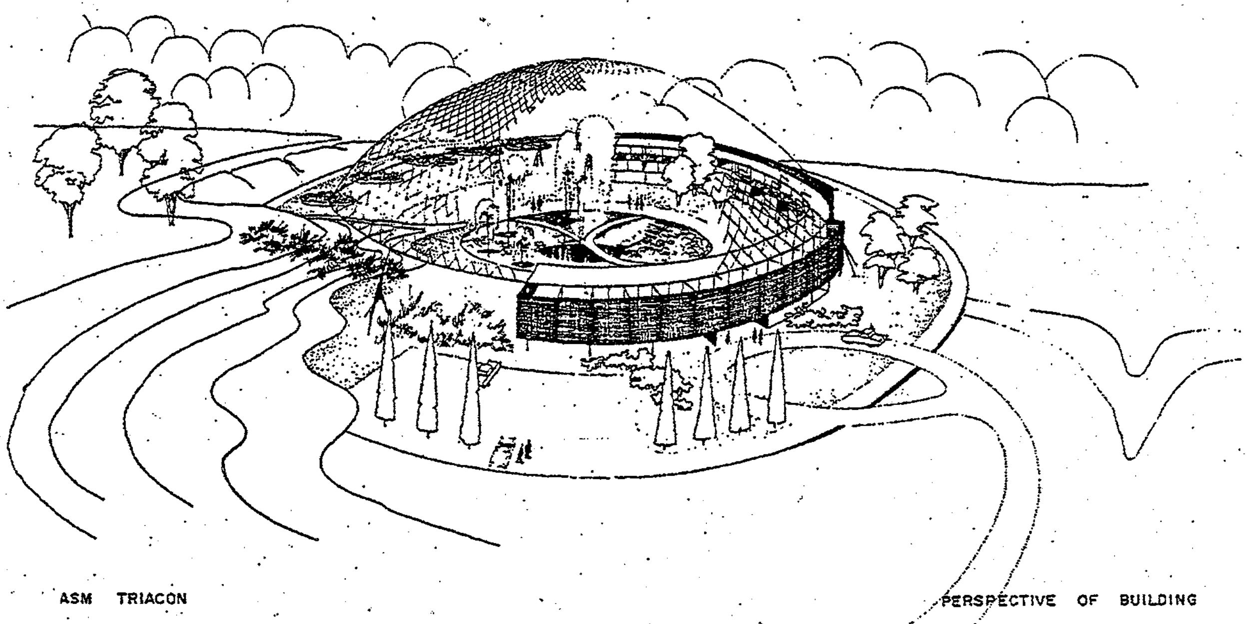
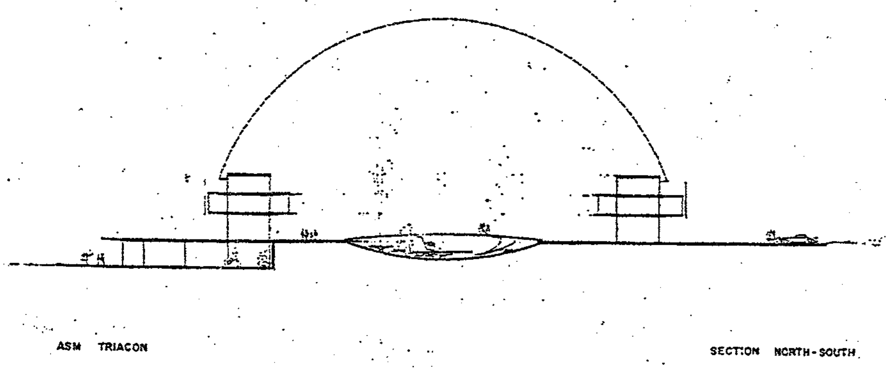


Fig.3.63 John Kelly, Sketch of American Society of Metals(ASM) Building in Metals Park-Ohio. Source: T. C. Howard Collection





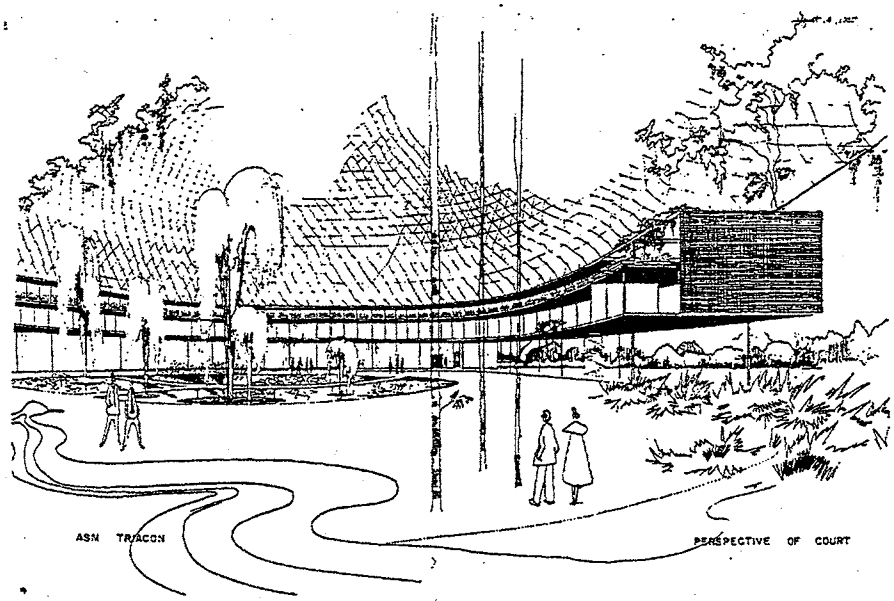


Fig.3.64a Ford Rotunda Building at Great River Forge Plant. Source: BFI-Photo #F-2-1]

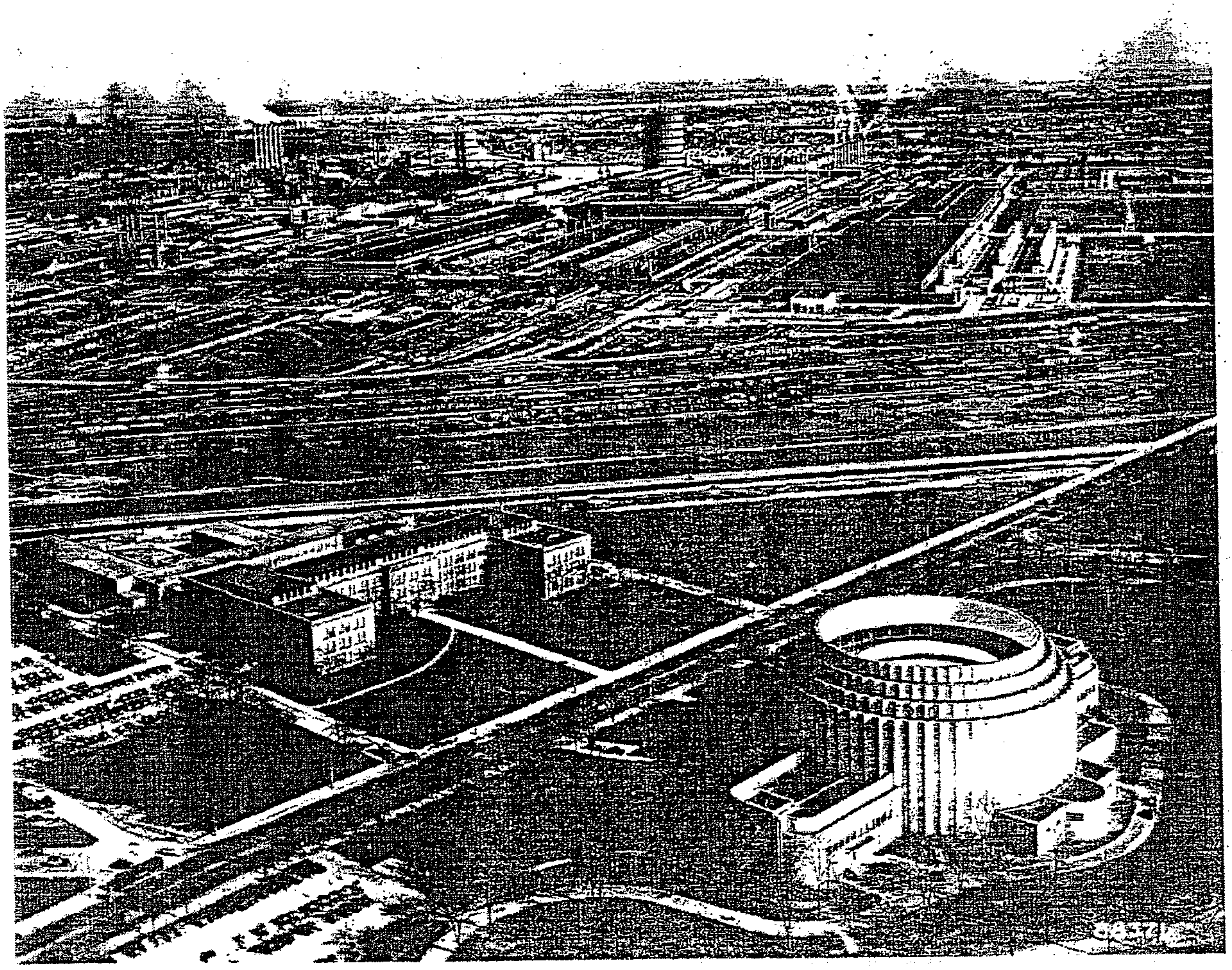
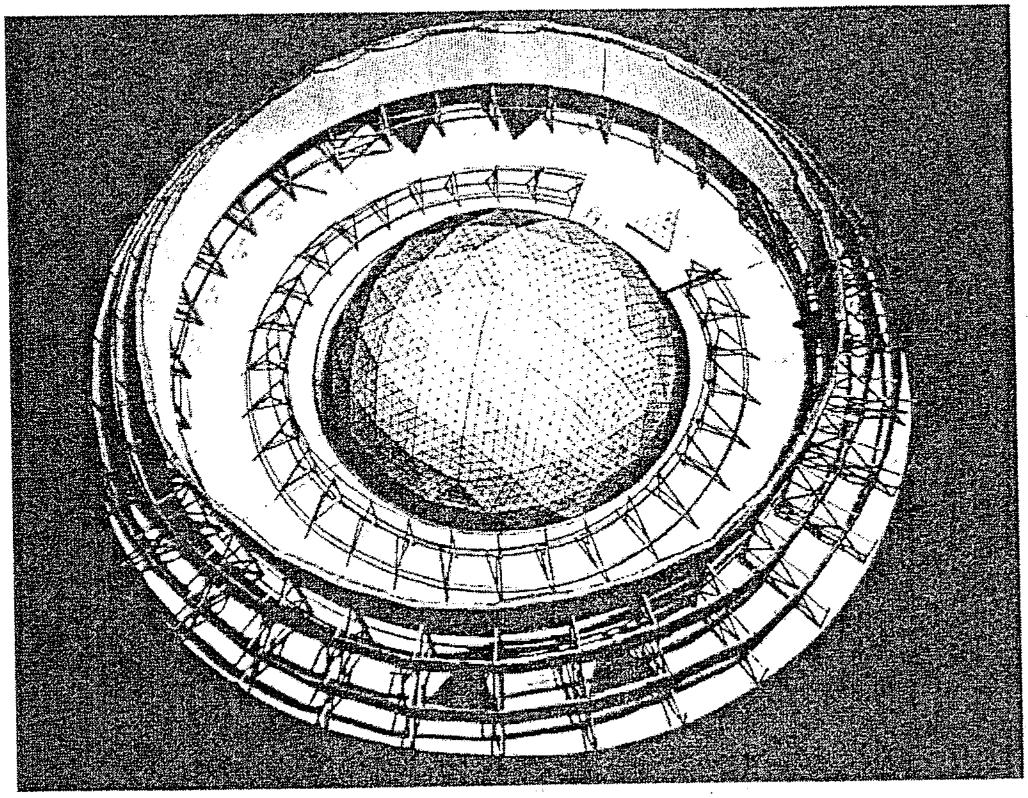


Fig.3.64b Ford Rotunda Building, Model of Fuller's Dome design. Source: BFI-Photo #F-2-31.



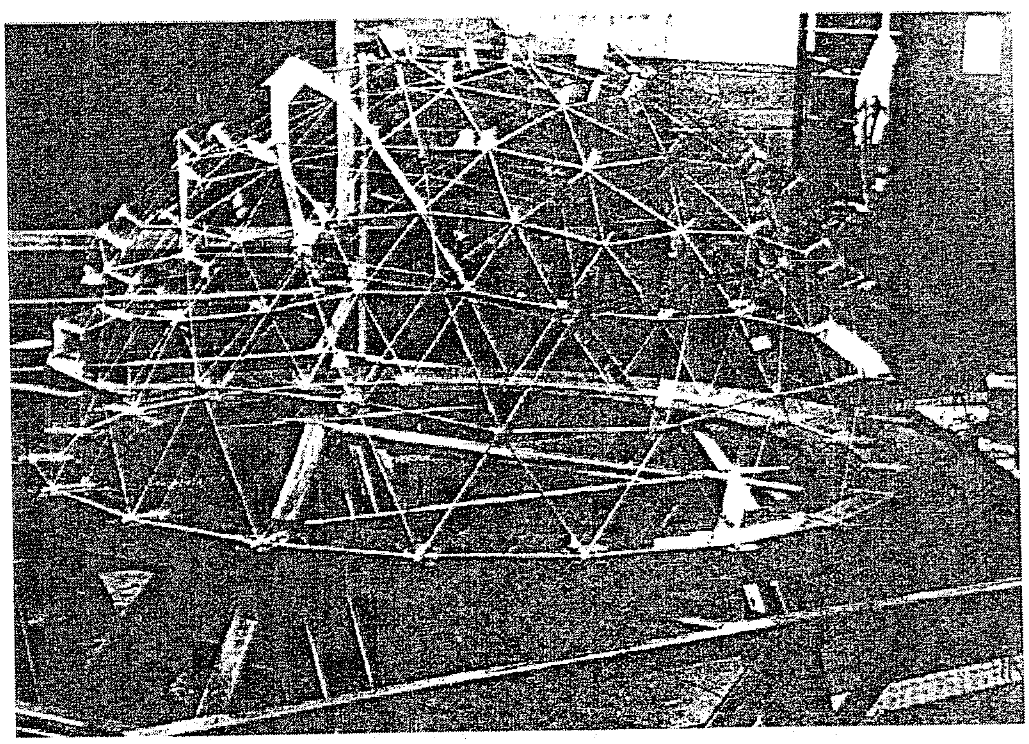
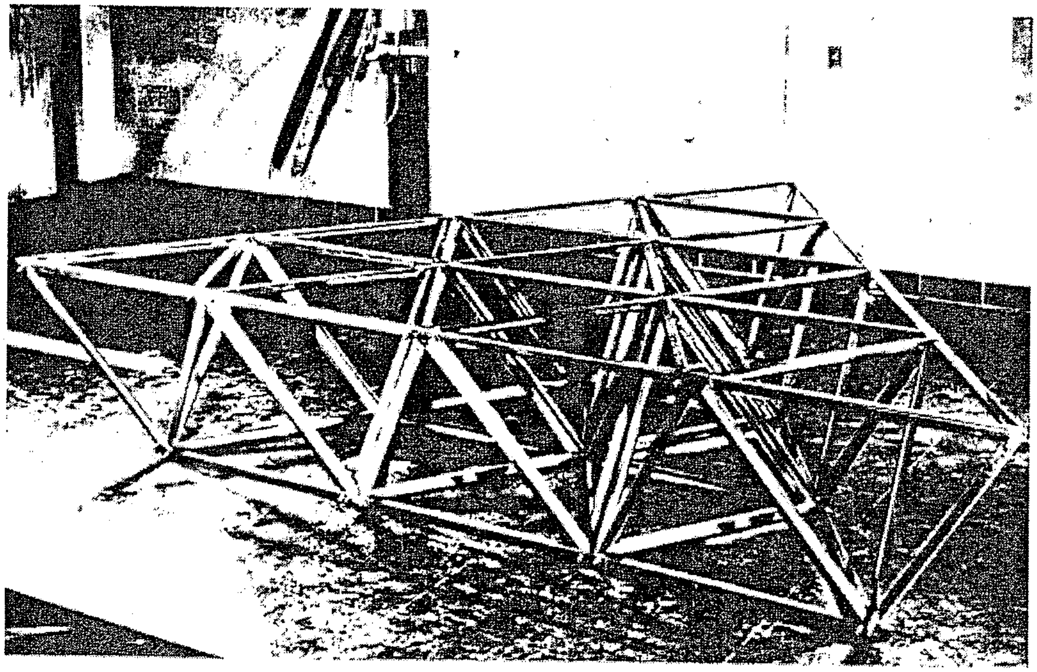


Fig.3.64c Ford Rotunda Building, Octet Section in Laboratory testing. Source: BFI-Photo #F-2-23.



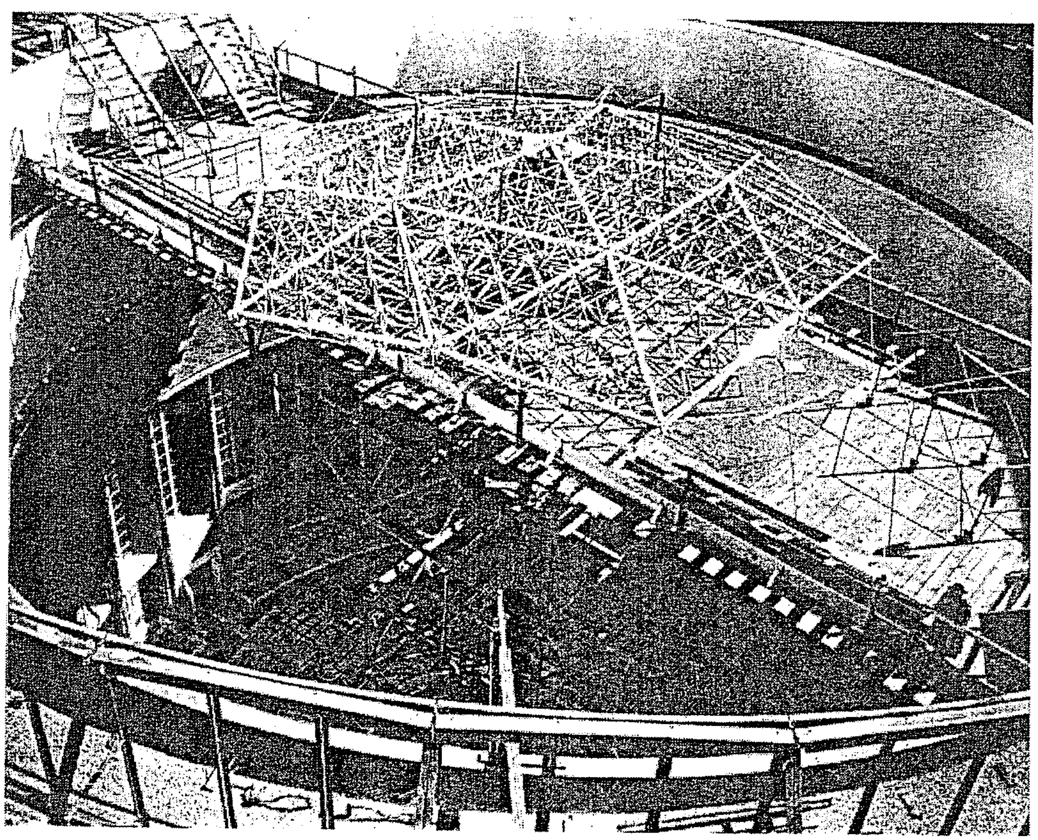


Fig.3.66 Project Time-line, The Climatron, Missouri Botanical Garden, undated. Source: Missouri Botanical Garden Archives, Dwg. MBG 2-83-0022 Climatron.

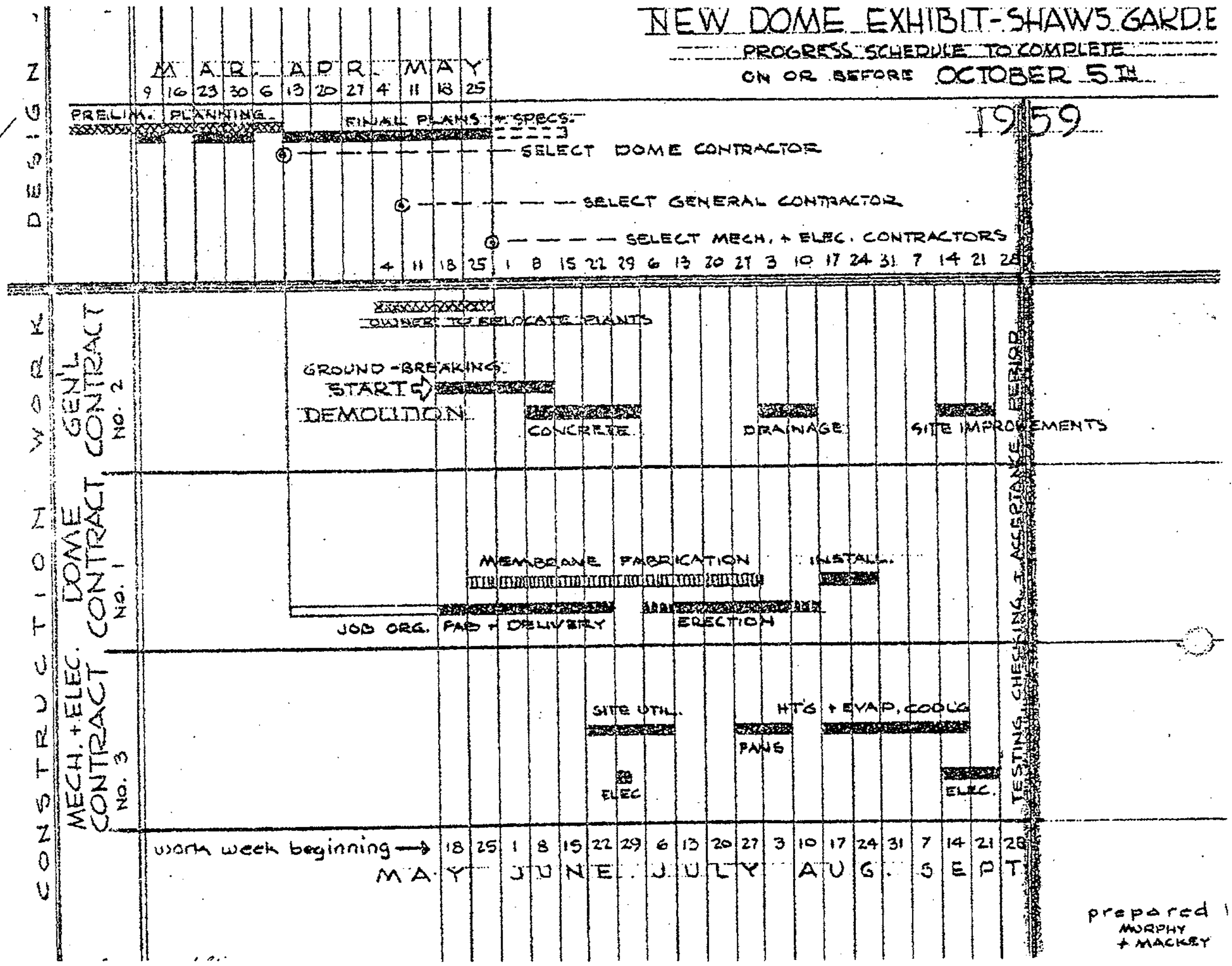
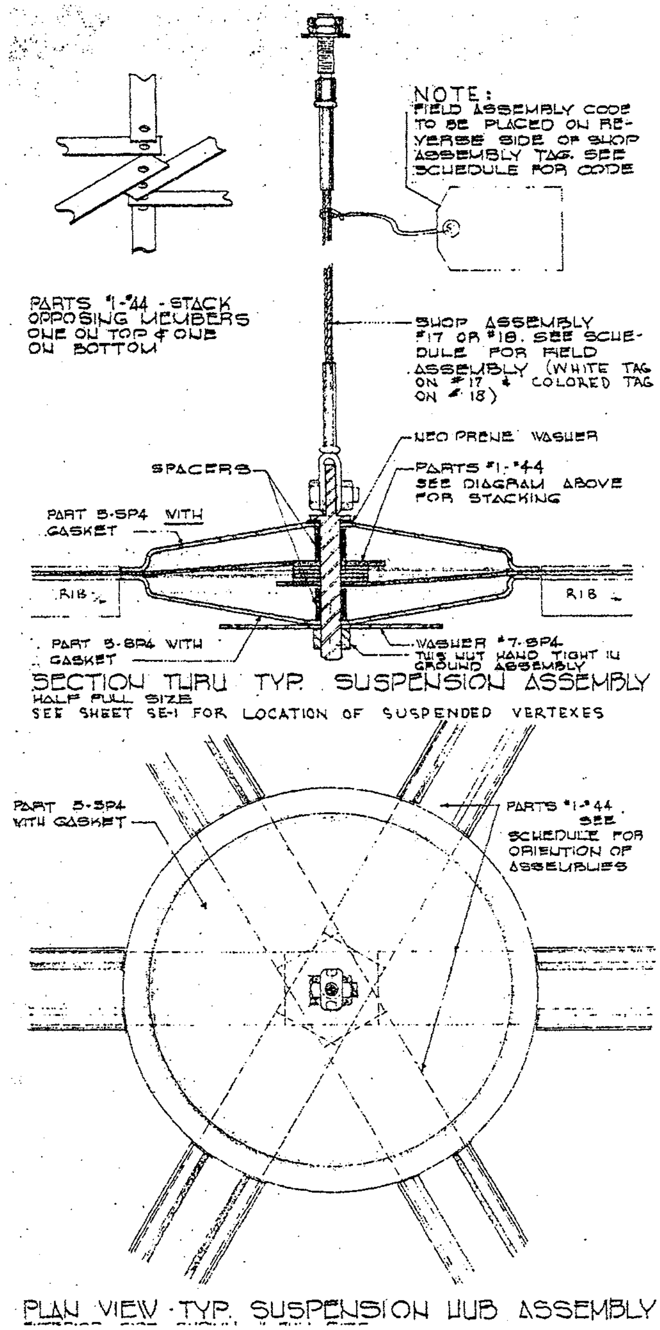


Fig.3.67a Synergetics Inc., (T. C. Howard) "Suspended Skin Frame Relative to Dome Frame" detail , The Climatron, Missouri Botanical Garden, undated. Source: Missouri Botanical Garden Archives.



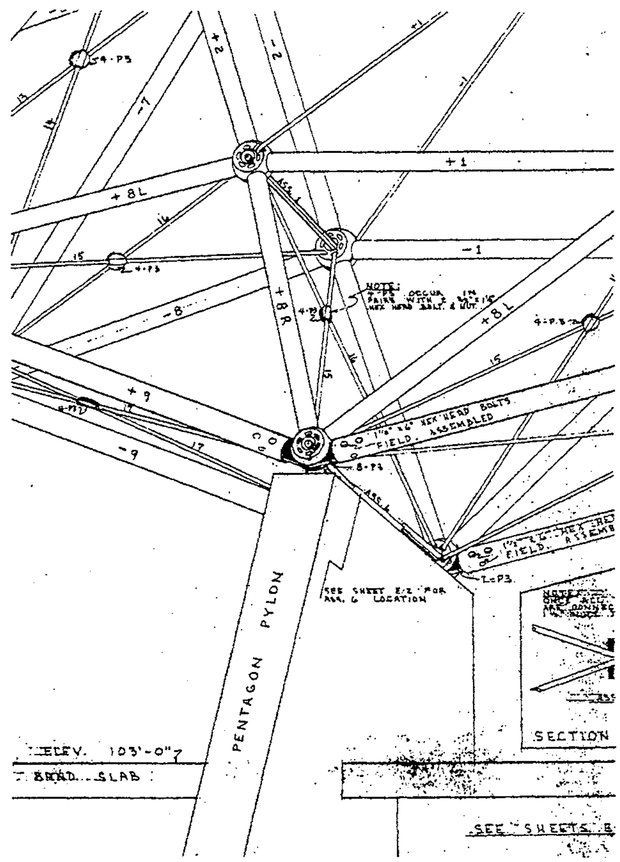


Fig.3.67b Plan, Details of The Climatron, Missouri Botanical Garden. Source: How Building Team Achieved Award Winning Dome, *Building Construction*, December 1961, p.25.

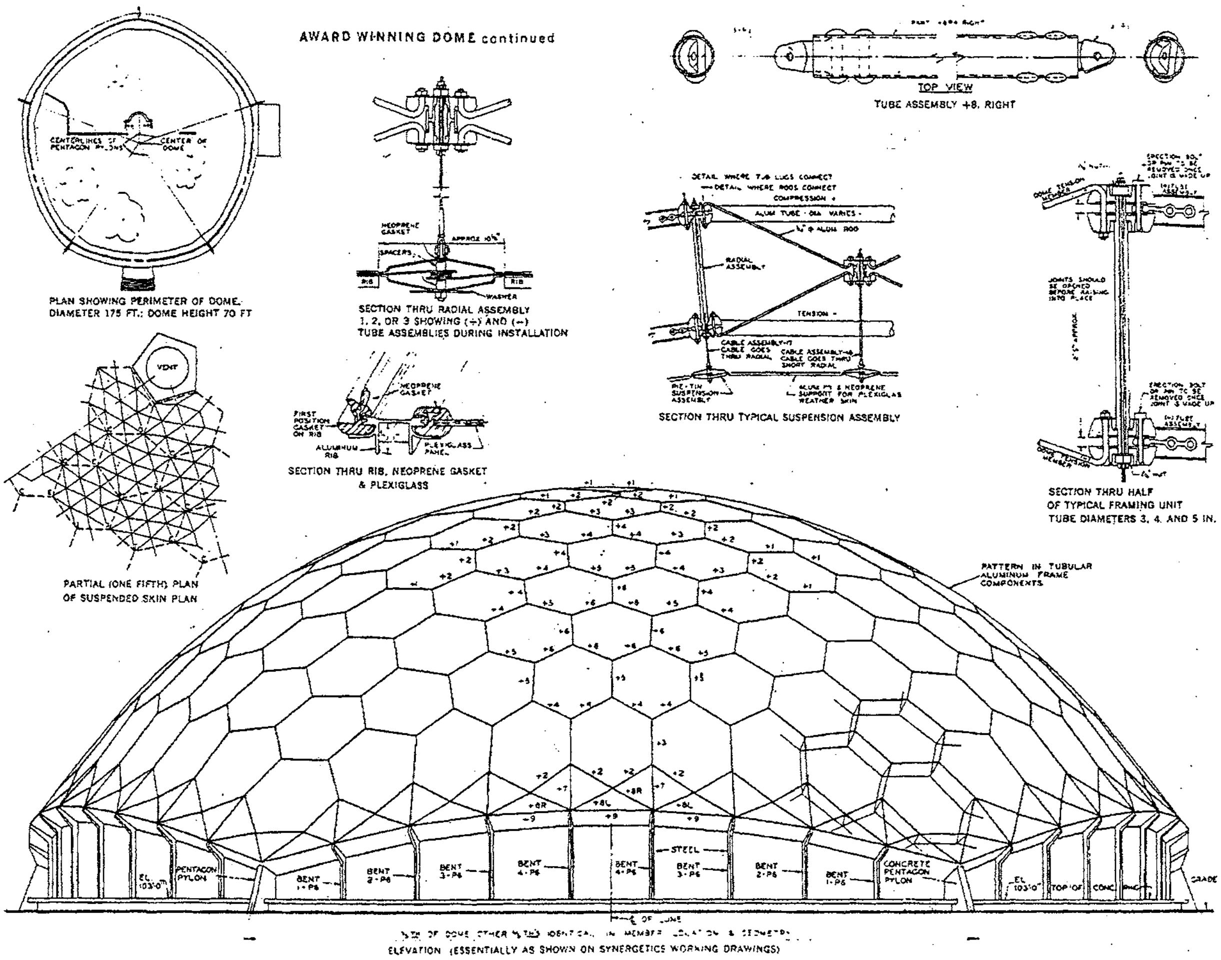
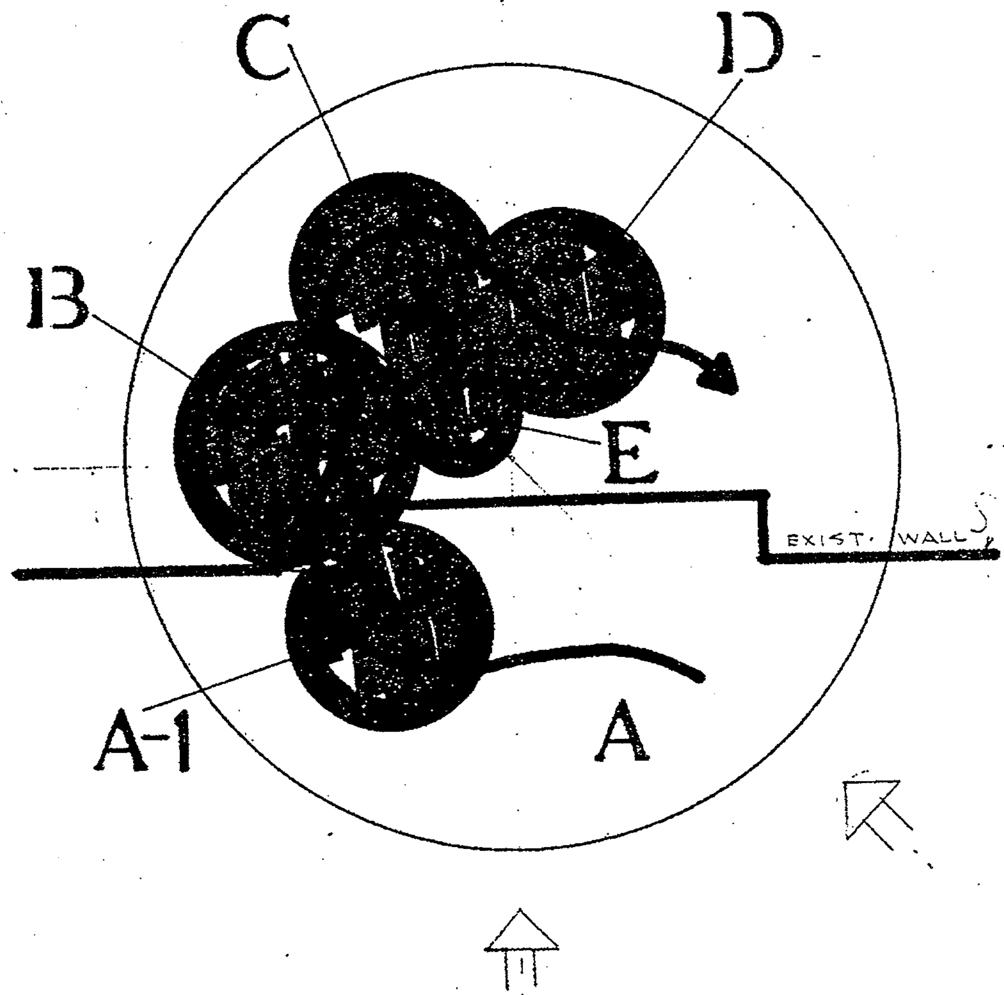


Fig.3.67c Layton, Layton & Rohrbach, 6 Climate zones , The Climatron, Missouri Botanical Garden, February 1959. Source: MBG Archives, Layton, Layton & Rohrbach, "Report Number I, 2/11/59" in MBG 2-83-0083/Climatron.

EXHIBIT 3



CLIMATE
(6 ZONES)

586.36
7-10-59

1" = 30'

Fig.3.68 Murphy & Mackey , "Shaw's 1962 Redevelopment Plan", Missouri Botanical-Garden, c. April 1962.
Source: BFI-CR229.

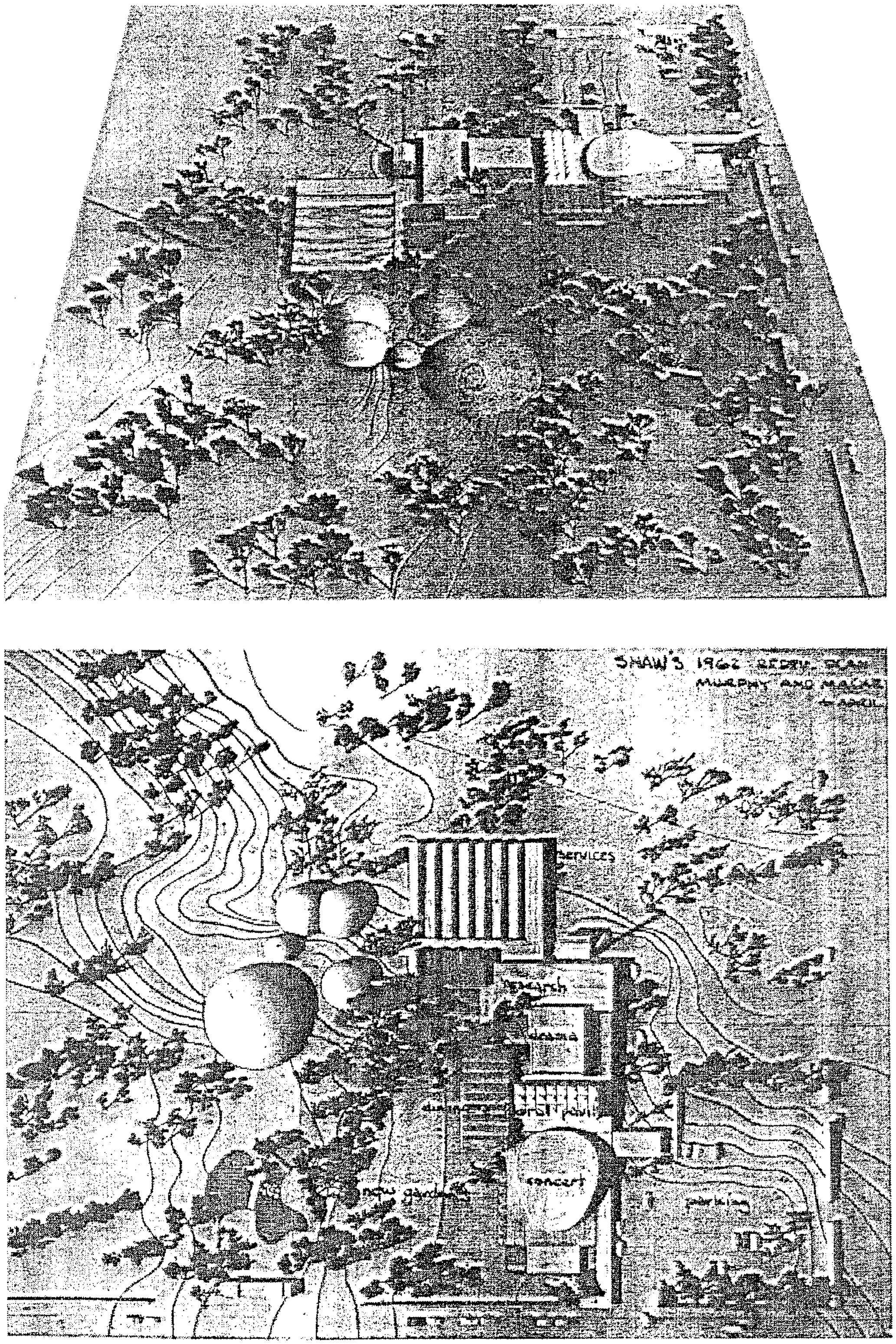
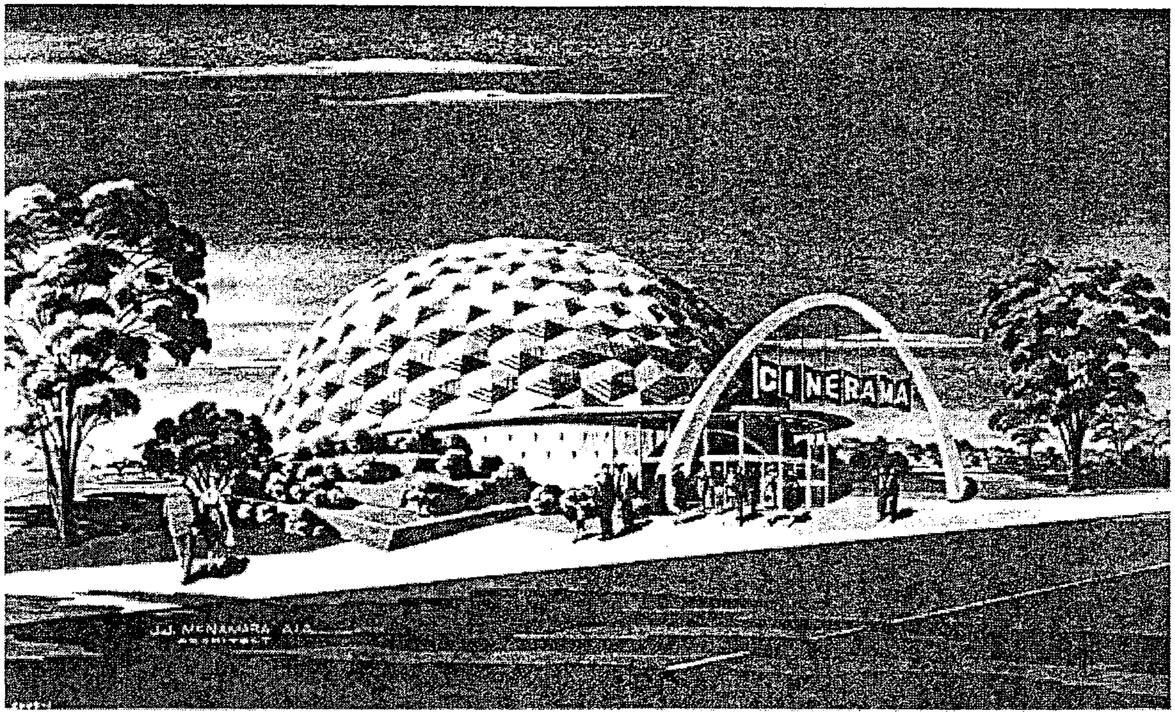


Fig.3.69 Cinerama Theatre, Hollywood-California, 12/1/63. Source: BFI-Photo#C-17-1 & 2.



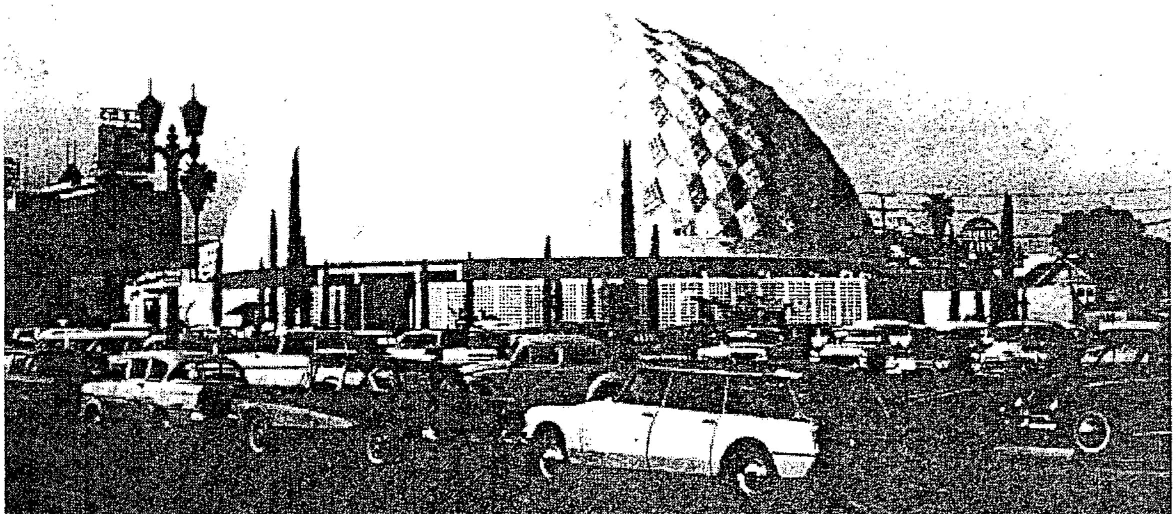


Fig.4.01 "Three Structures by Buckminster Fuller" at the garden of MoMA-NY. Source: MoMA Exhibition Brochure, September 1959.

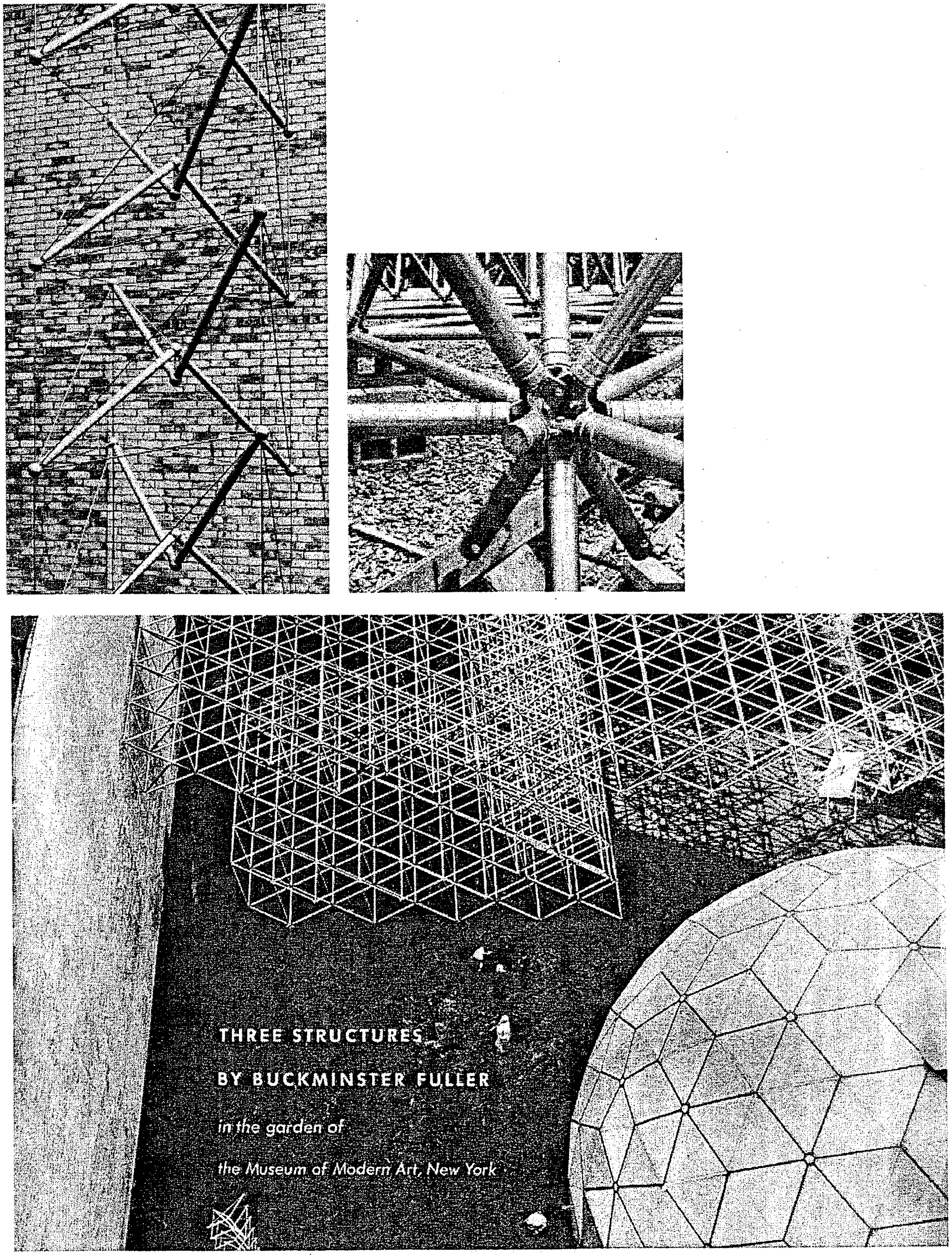
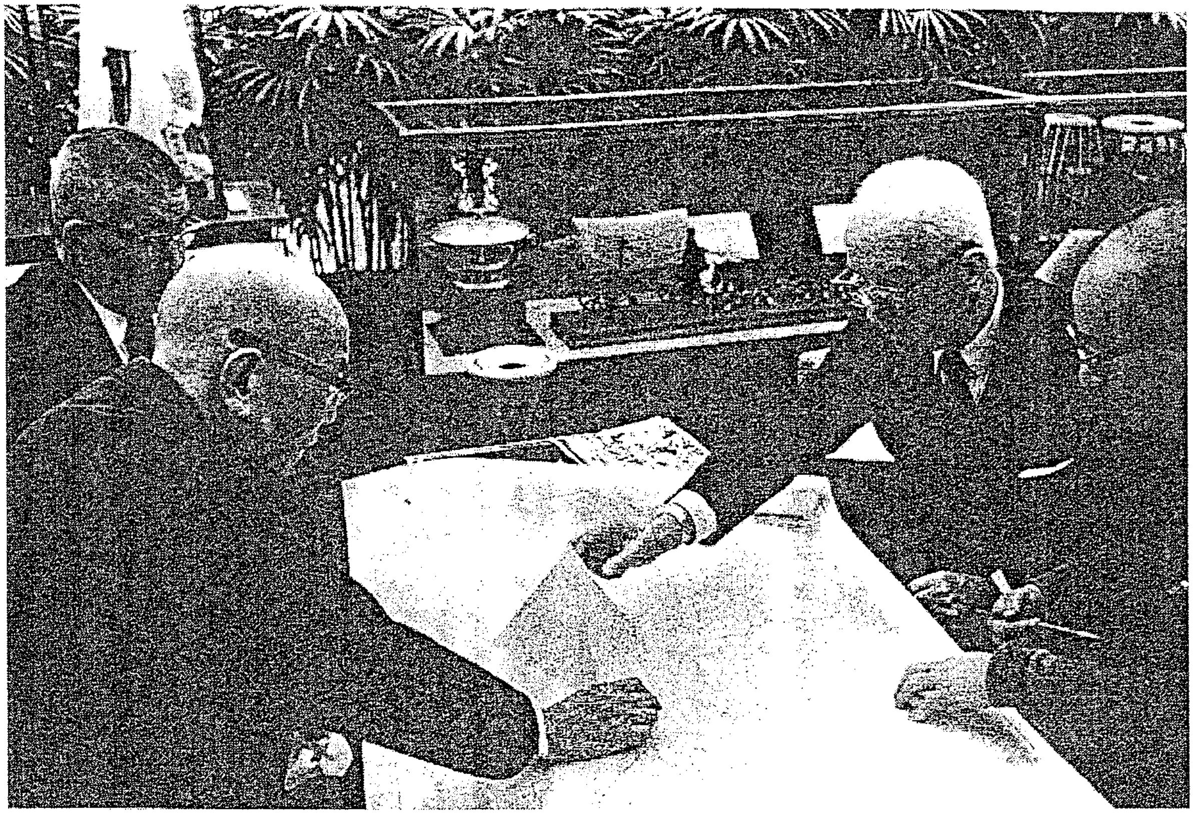


Fig.4.02a Fuller and Shoriki over the Tetrahedronal City Project for Tokyo, 1967 Source: BFI-Photo #F-3-149.
Fig.4.02b Fuller and Shoriki meeting over the fly-eye mono-hex (5/8 sphere) dome in Tokyo. Source: BFI Photo # Y-3-1.



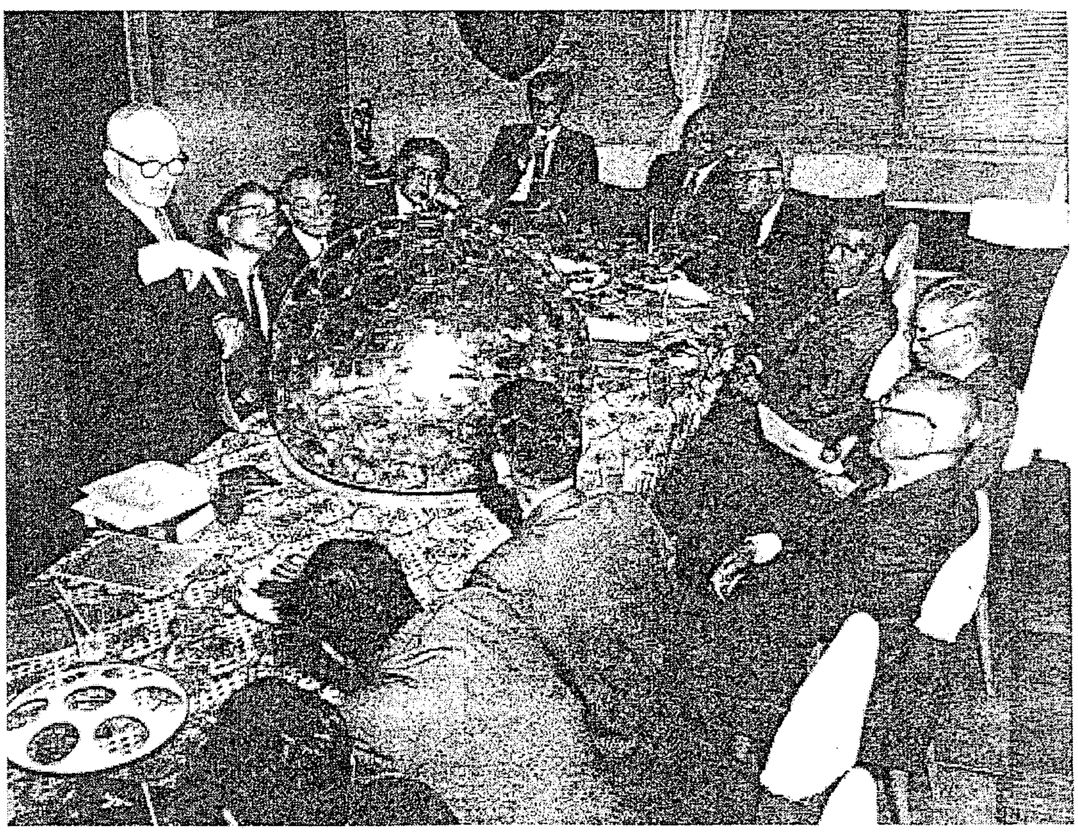
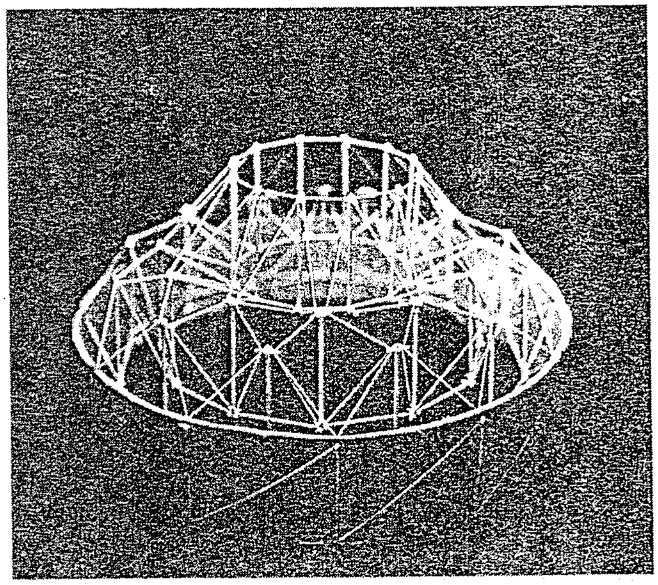


Fig.4.02c Varieties of structural studies for the Shoriki's Yomiuri Golf Club Dome. **.1**:Aspension Dome developed at SIU-Carbondale. Source: BFI Photo #A-10-1; **.2** Rigid compression aspension dome. Source: BFI Photo #A-9-1.



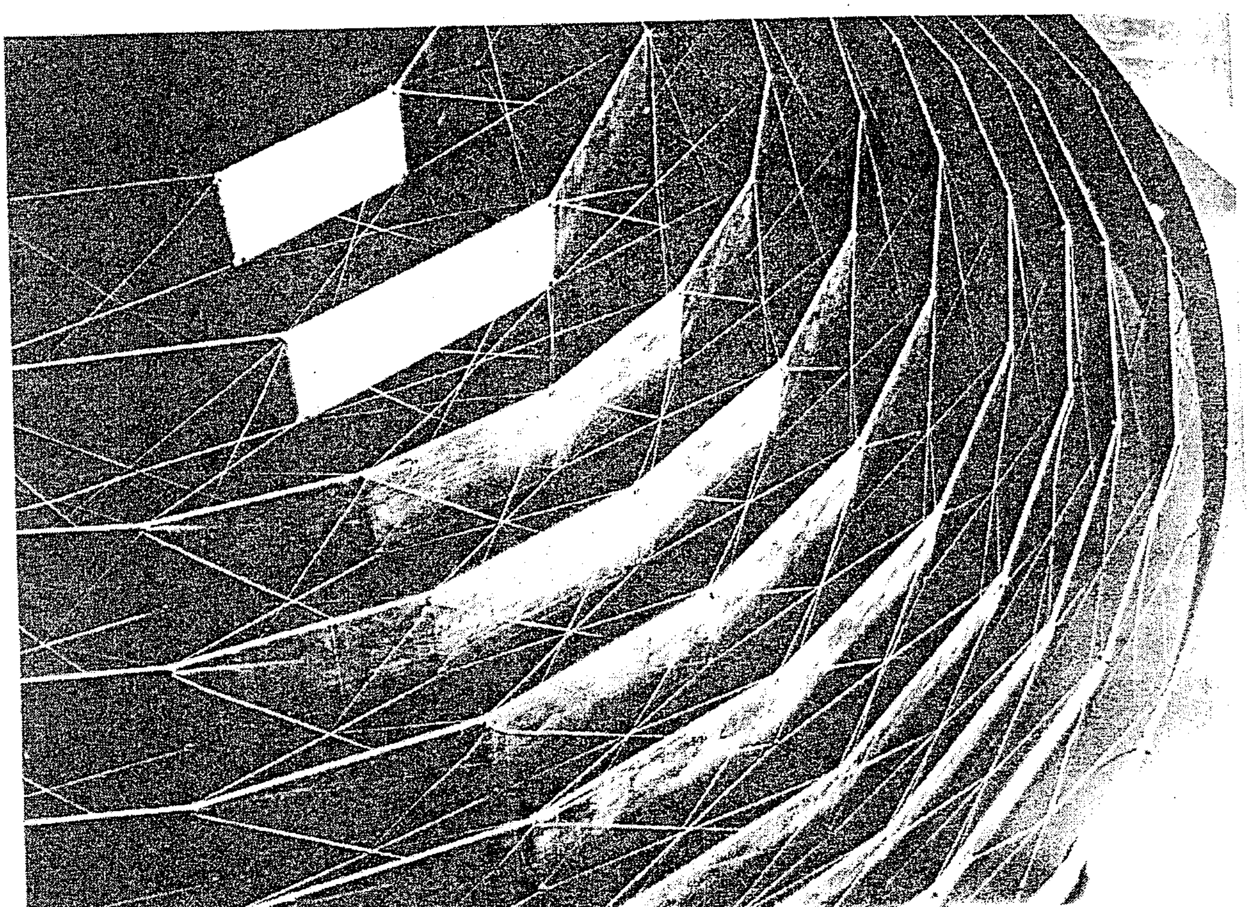
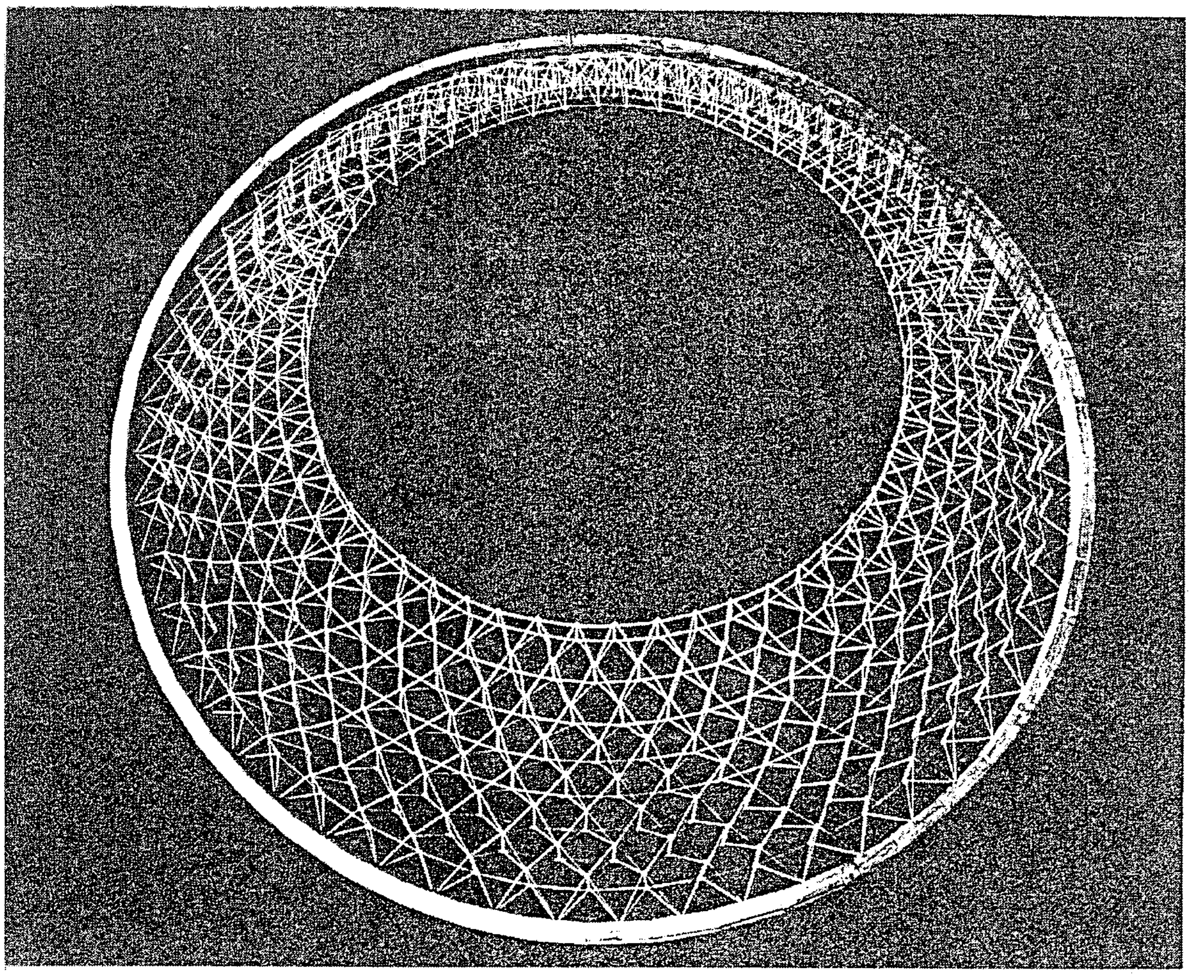


Fig.4.02d Varieties of structural studies for the Shoriki's Yomiuri Golf Club Dome. 8'-diameter model of the 200' aspension dome, ca. May 1961. Source: BFI Photo [?]



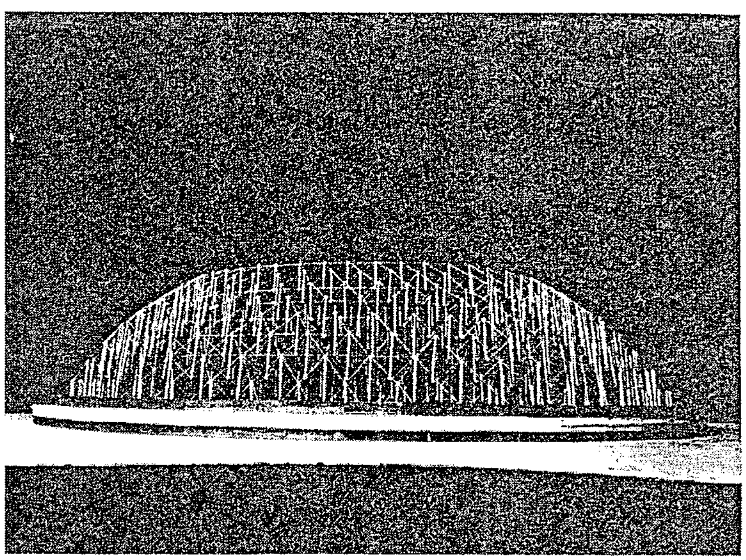
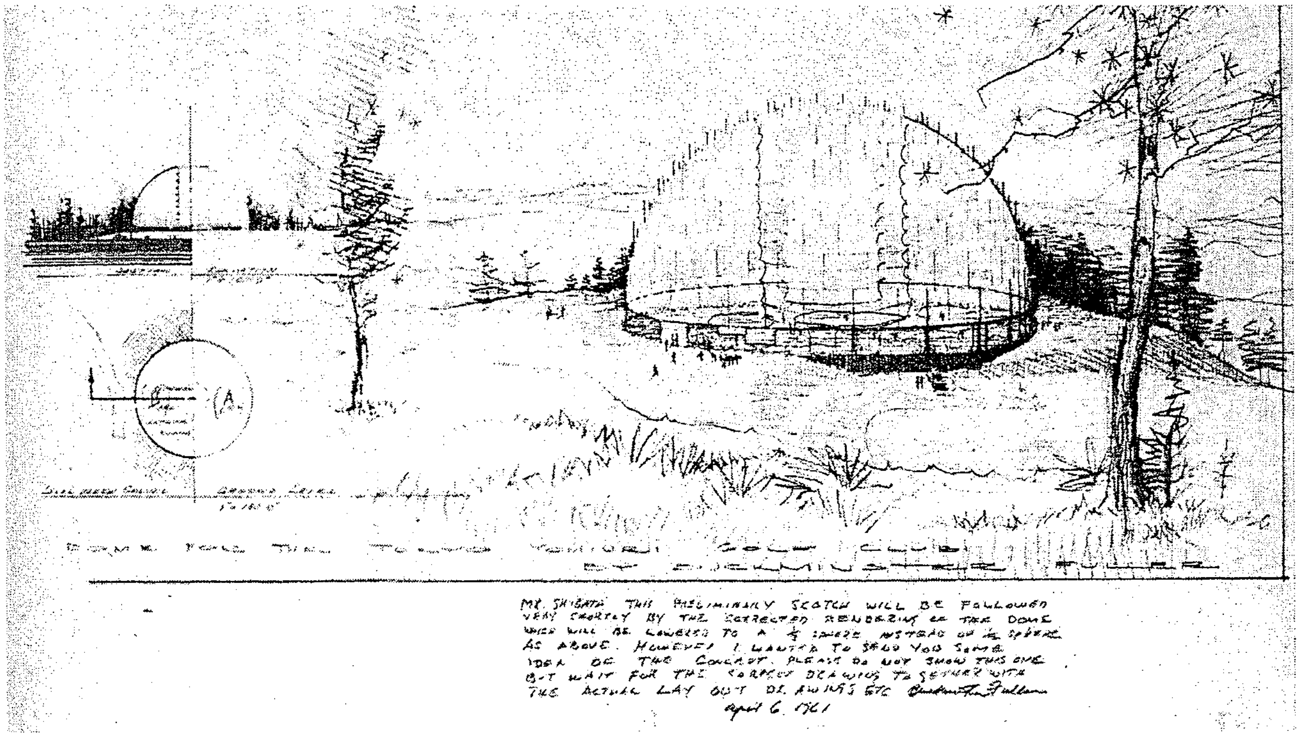
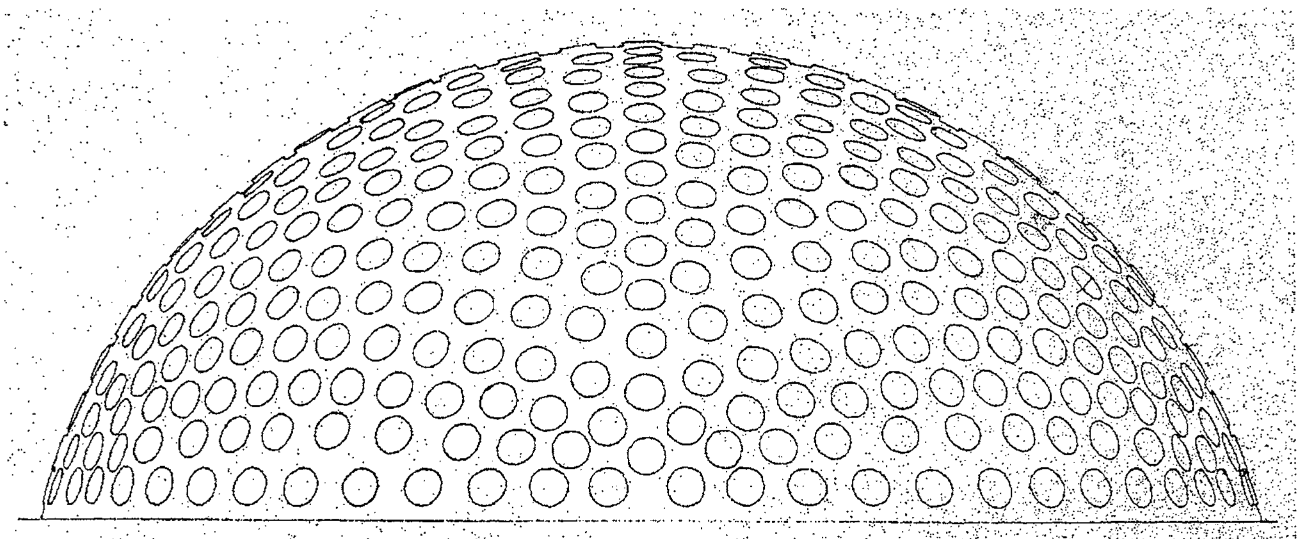


Fig.4.02e Design variations on Shoriki's Yomiuri Golf Club Dome. .1: J. W. Fitzgibbon first study; .2 Geometric Inc. pre-cast concrete version Source: J. Ward., ed., The Artifacts of R. Buckminster Fuller, Vol.4, pp.3-5.





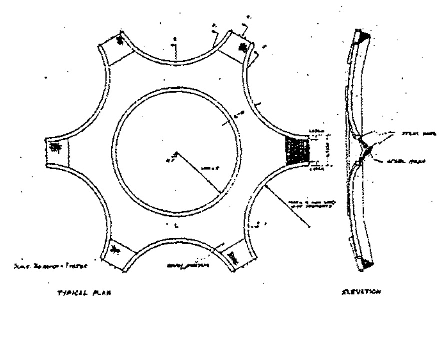
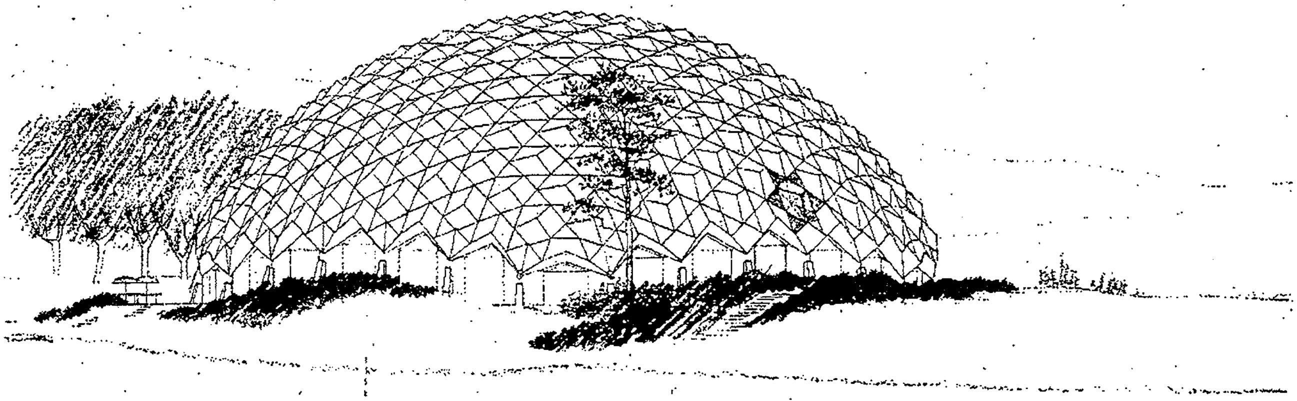
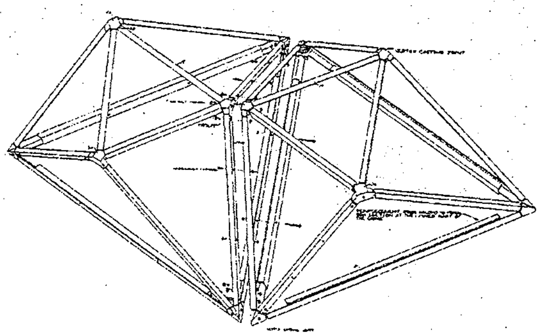
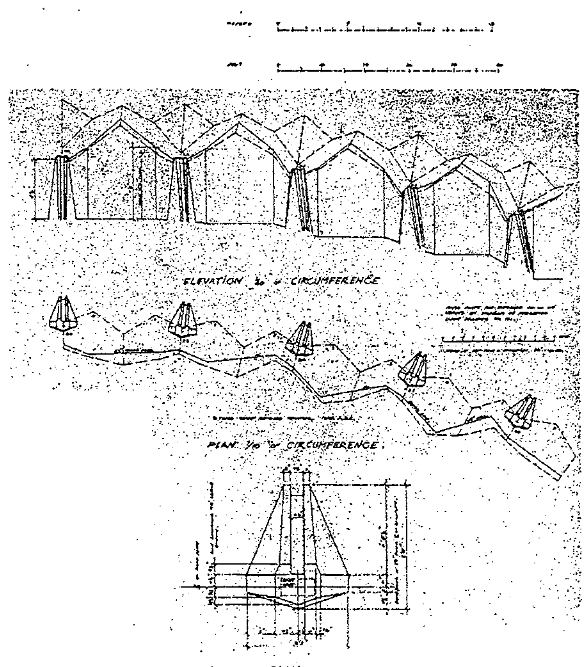


Fig.4.02f Design variations on Shoriki's Yomiuri Golf Club Dome. Final Geometric Inc. Stardome version. Source: J. Ward., ed., The Artifacts of R. Buckminster Fuller, Vol.4, pp.8-28.







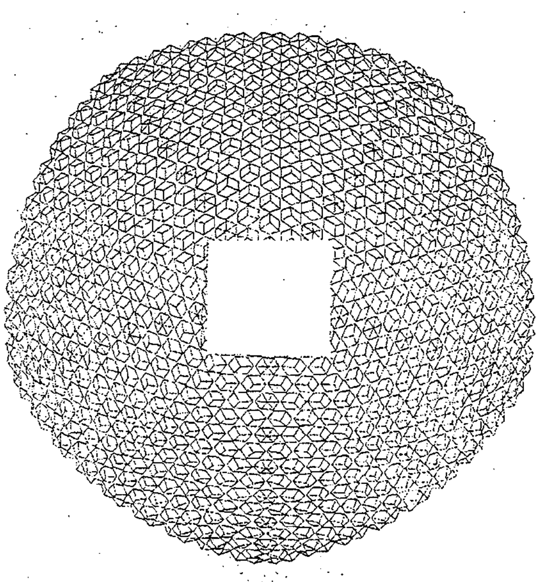


Fig.4.03a Triton City for the US Department of HUD, Source: J. Ward., ed., The Artifacts of R. Buckminster Fuller, Vol.4, pp.175-180.

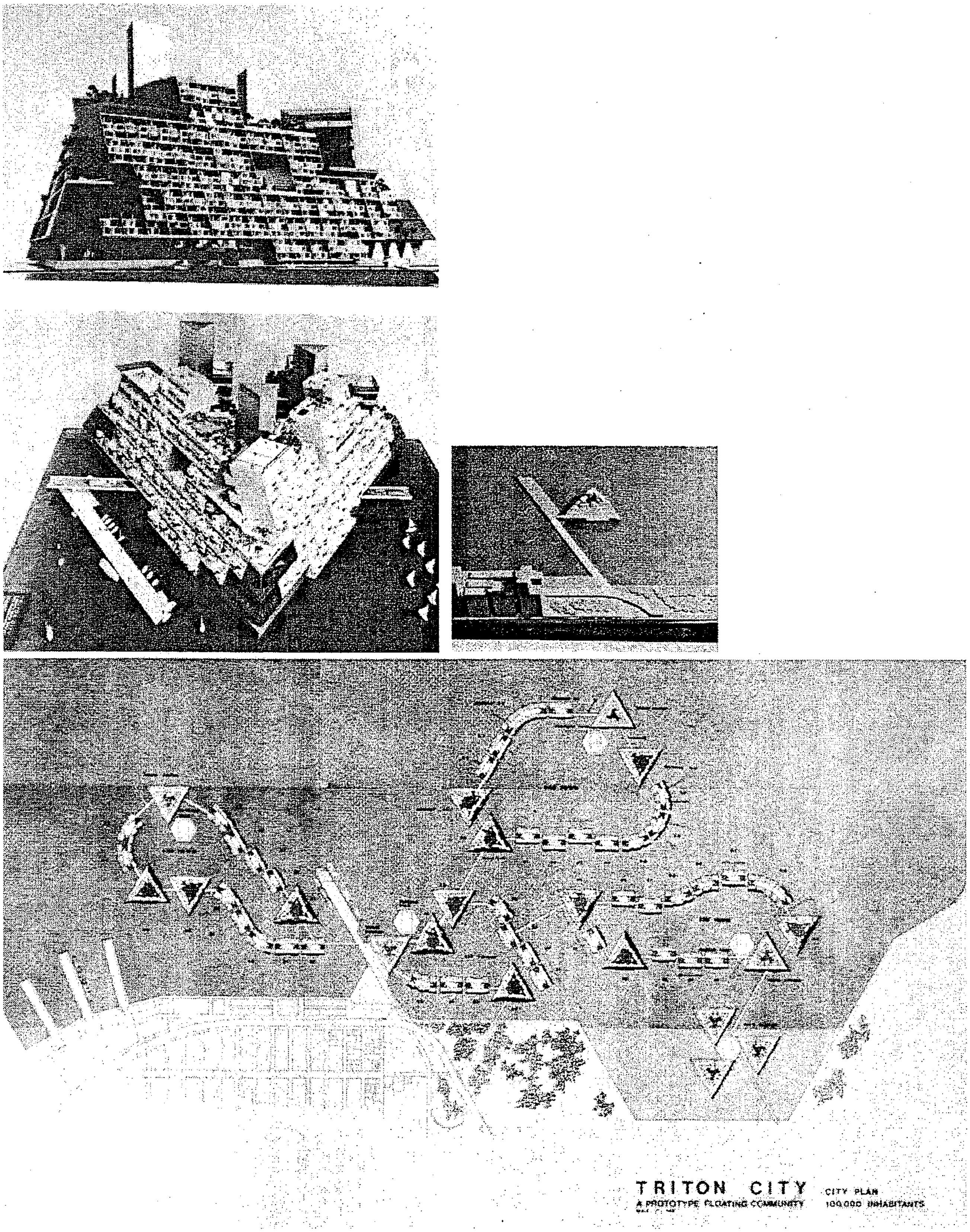


Fig.4.03b Fuller with C. Haar (Asst. Secretary of Metropolitan Development, HUD). Source: "Buckminster Fuller's Floating City", *The Futurist*, February 1969."

Fig.4.03c Housing project for Harlem-N.Y., aerial perspective. Source: June Meyer, "Instant Slum Clearance," *Esquire*, April 1965, pp.108-110.

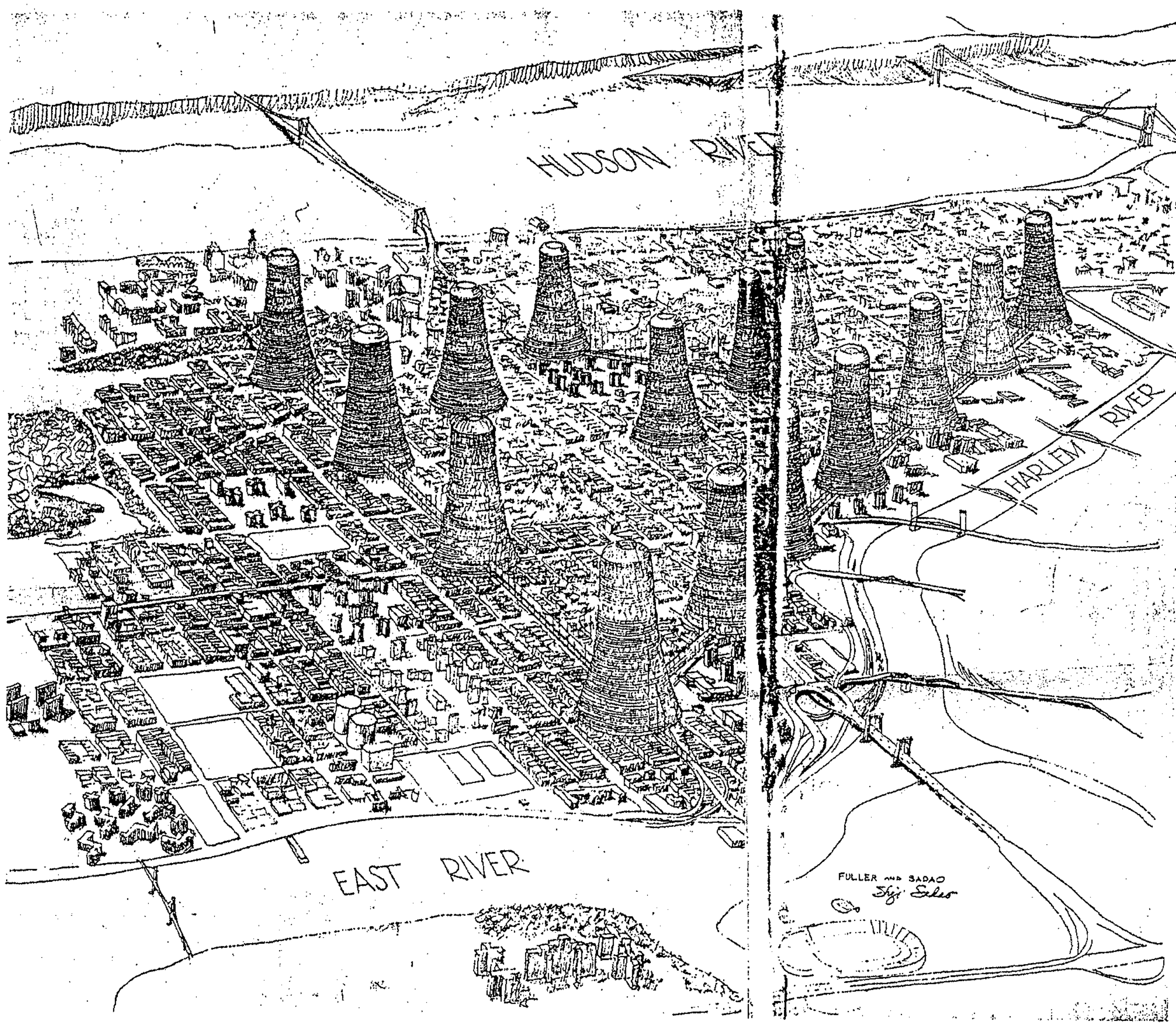


Fig.4.03d Housing project for Harlem-N.Y., section & plan of tower. Source: June Meyer, "Instant Slum Clearance," *Esquire*, April 1965, pp.108-110.

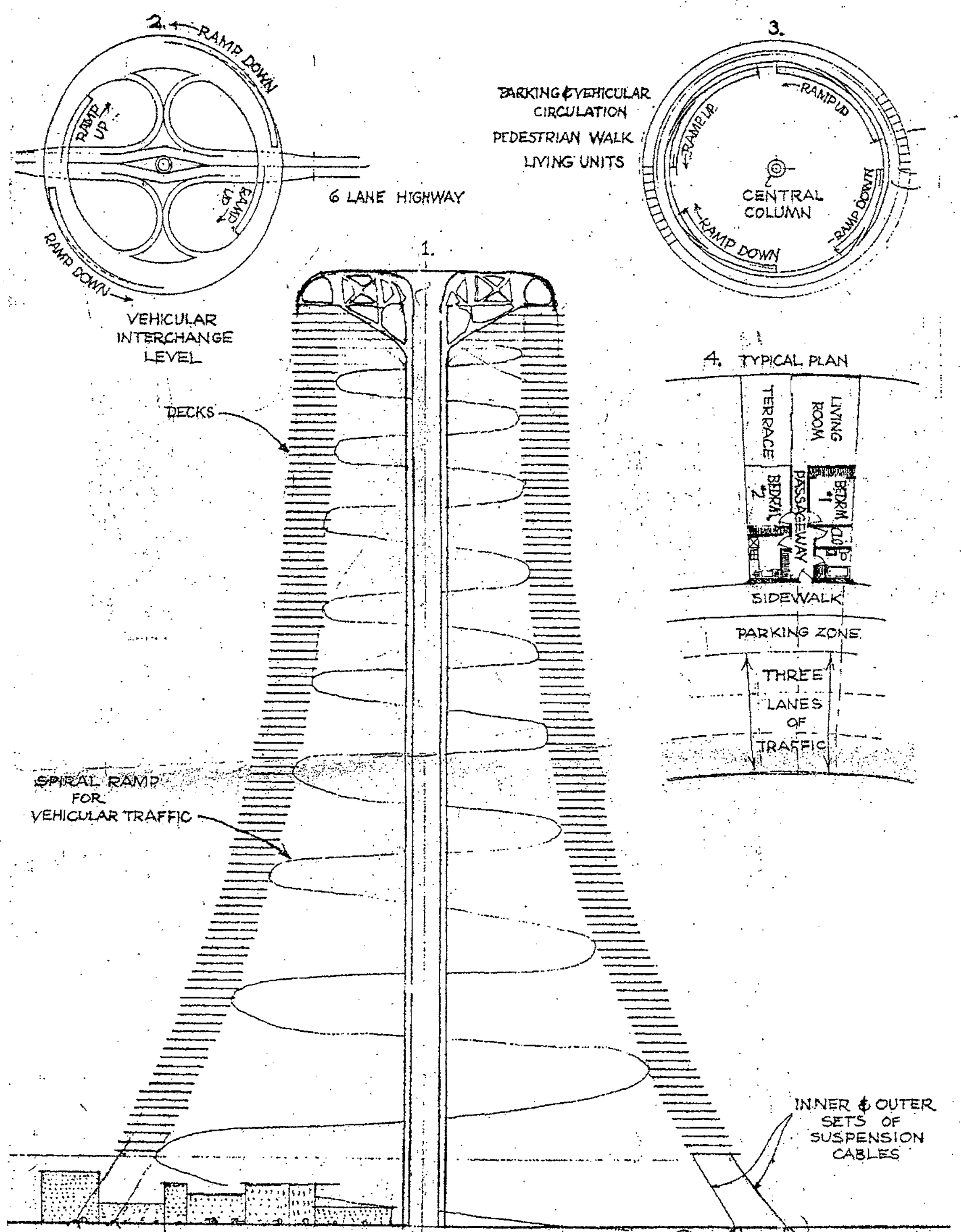
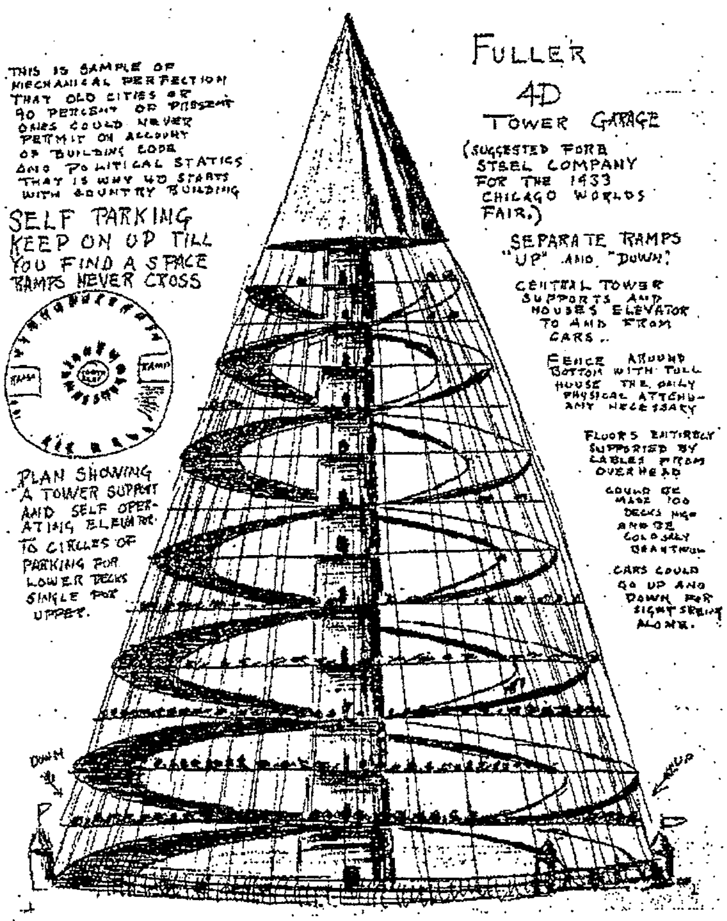


Fig.4.03e 4D tower garage. Source: J. Ward ed., The Artifacts of R. Buckminster Fuller, Vol.1, pp.41-42.



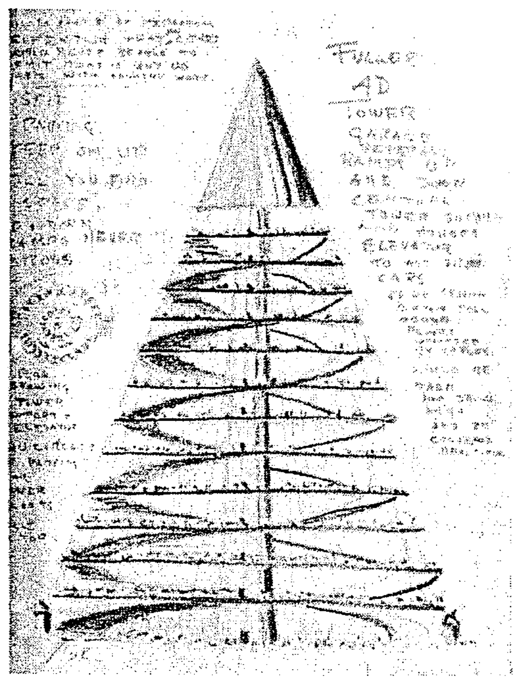
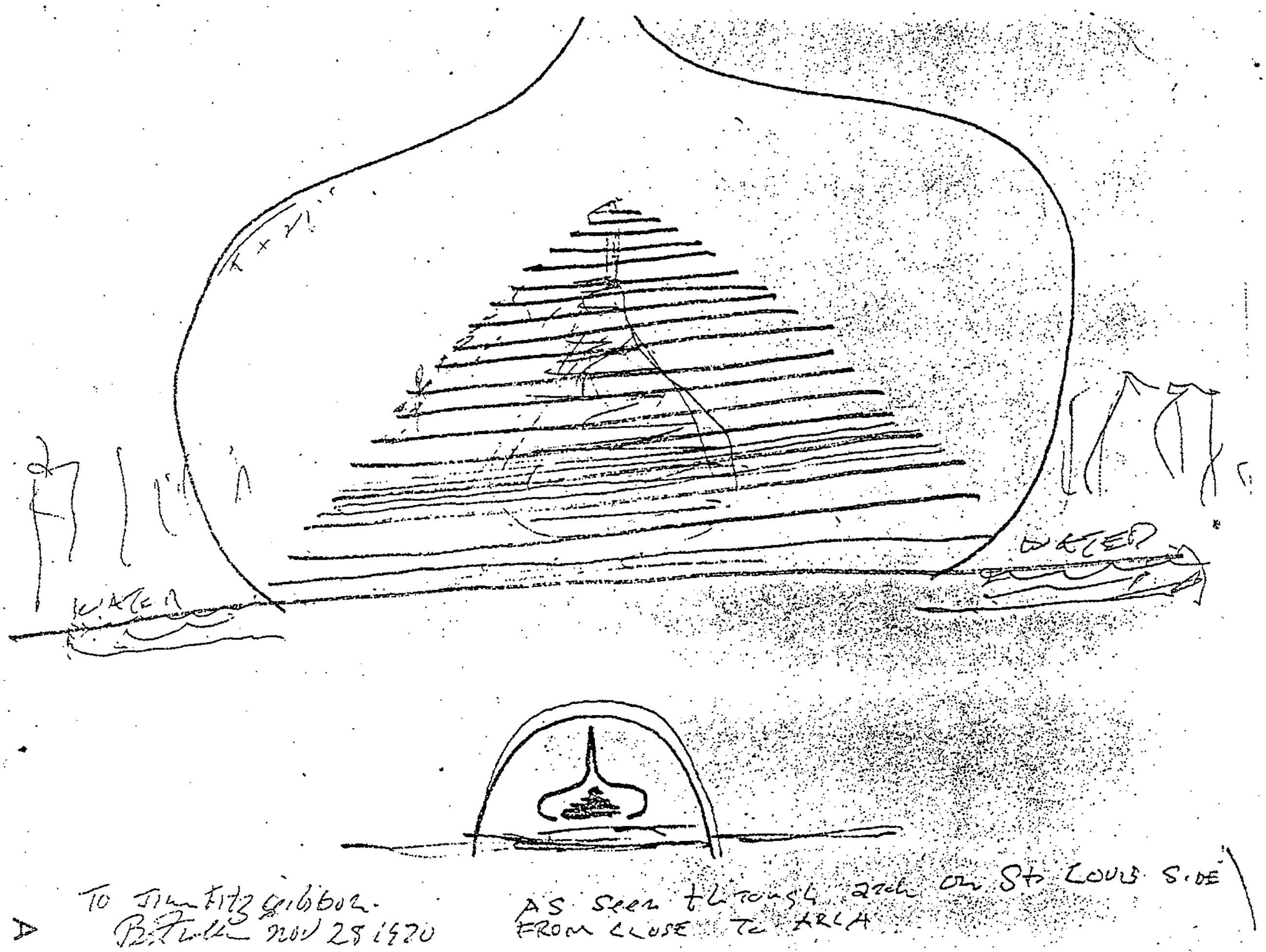


Fig.4.04a .1: R B Fuller, Sketch of OMR City Project as a pyramidal form, seen through Saarinen's Gateway Arch-St. Louis Missouri, November 1970, Source: J W. Fitzgibbon, "The Notebooks, Old Man River Project", September 1972, p.2; .2: R B Fuller, sketch, ca. 1970. Valley form, revised after the first East-St. Louis town forum. Source: BFI-OMR Folder (Active Files), 50/51.



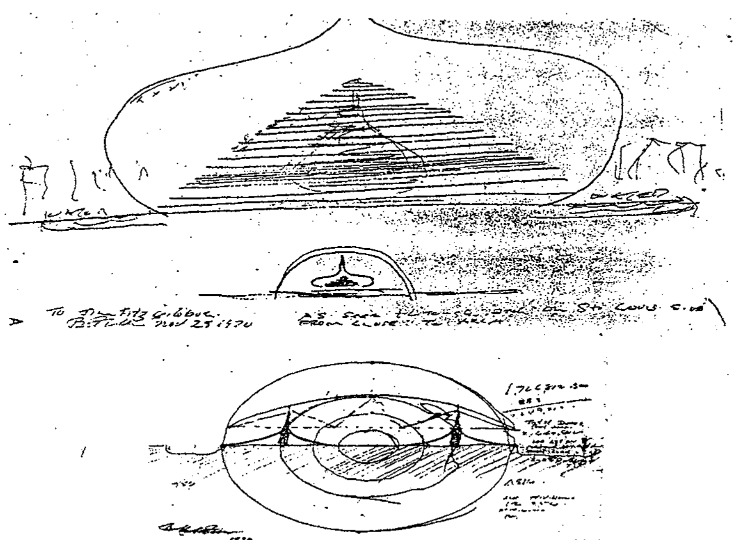
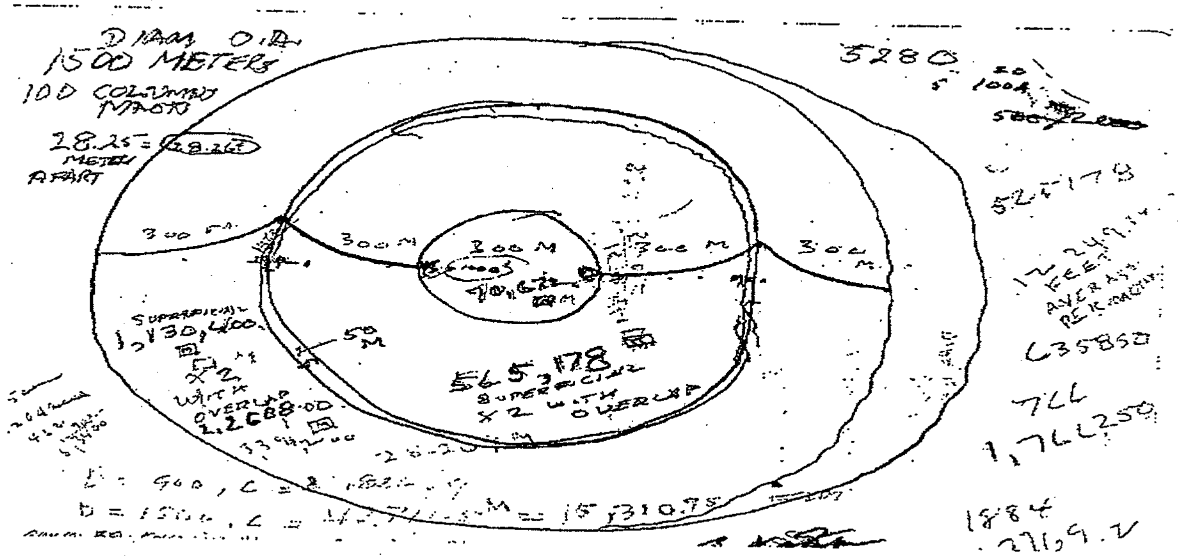
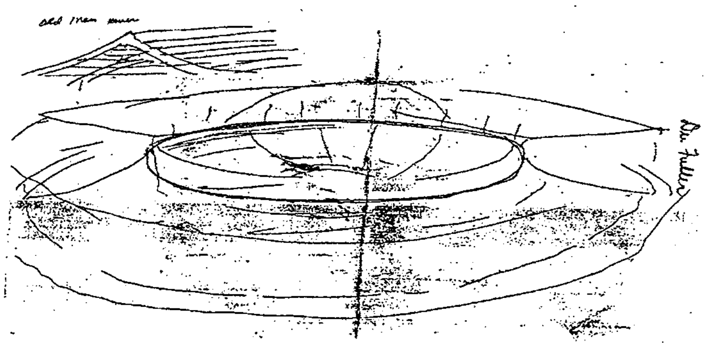


Fig.4.04a .3: R B Fuller, Sketch of OMR City Project. Source: BFI-OMR Folder (Active Files), 50/51; .4: R B Fuller, Sketch of OMR City Project showing a crater. Source: BFI-OMR Folder (Active Files).





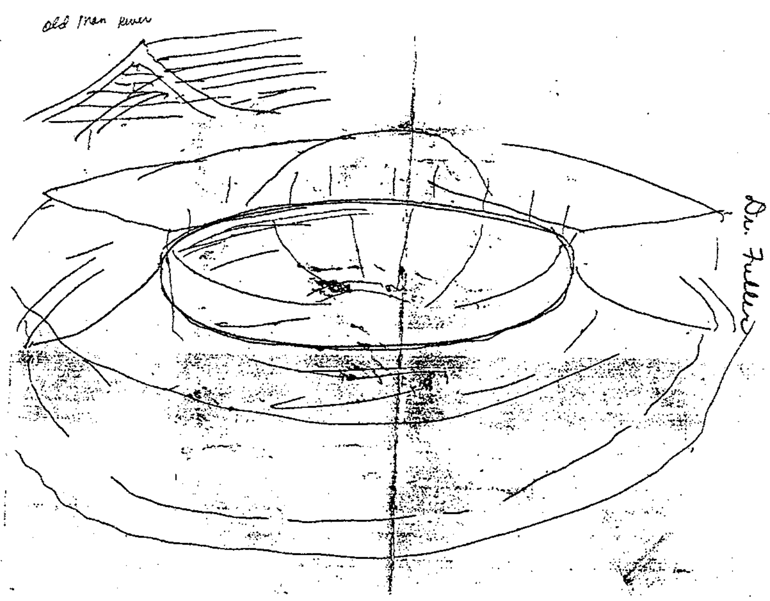
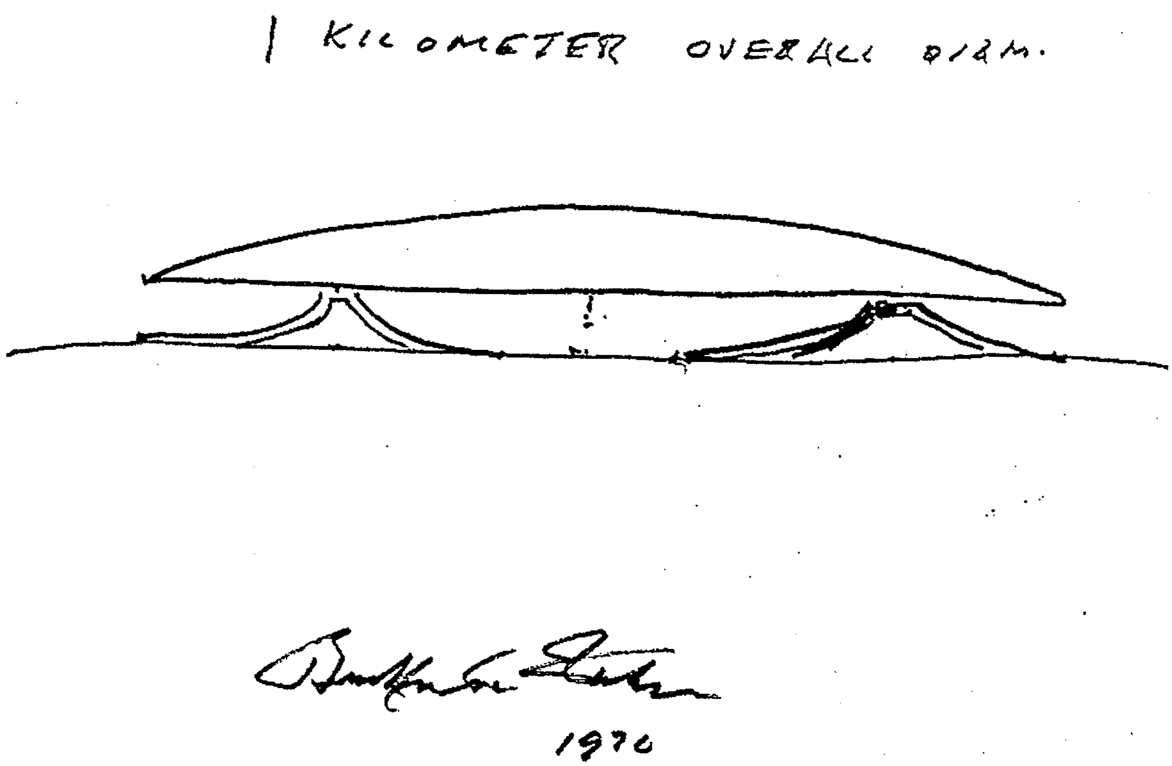


Fig.4.04a .5: R B Fuller, Sketch of OMR City Project with dome Source: BFI-OMR Folder (Active Files),Dwg. #BF 86.034; .6: R B Fuller, Sketch of OMR City Project showing a crater with dome supported on a ring of trussed masts. Source: BFI-OMR Folder (Active Files),Dwg. #BF 86.033.



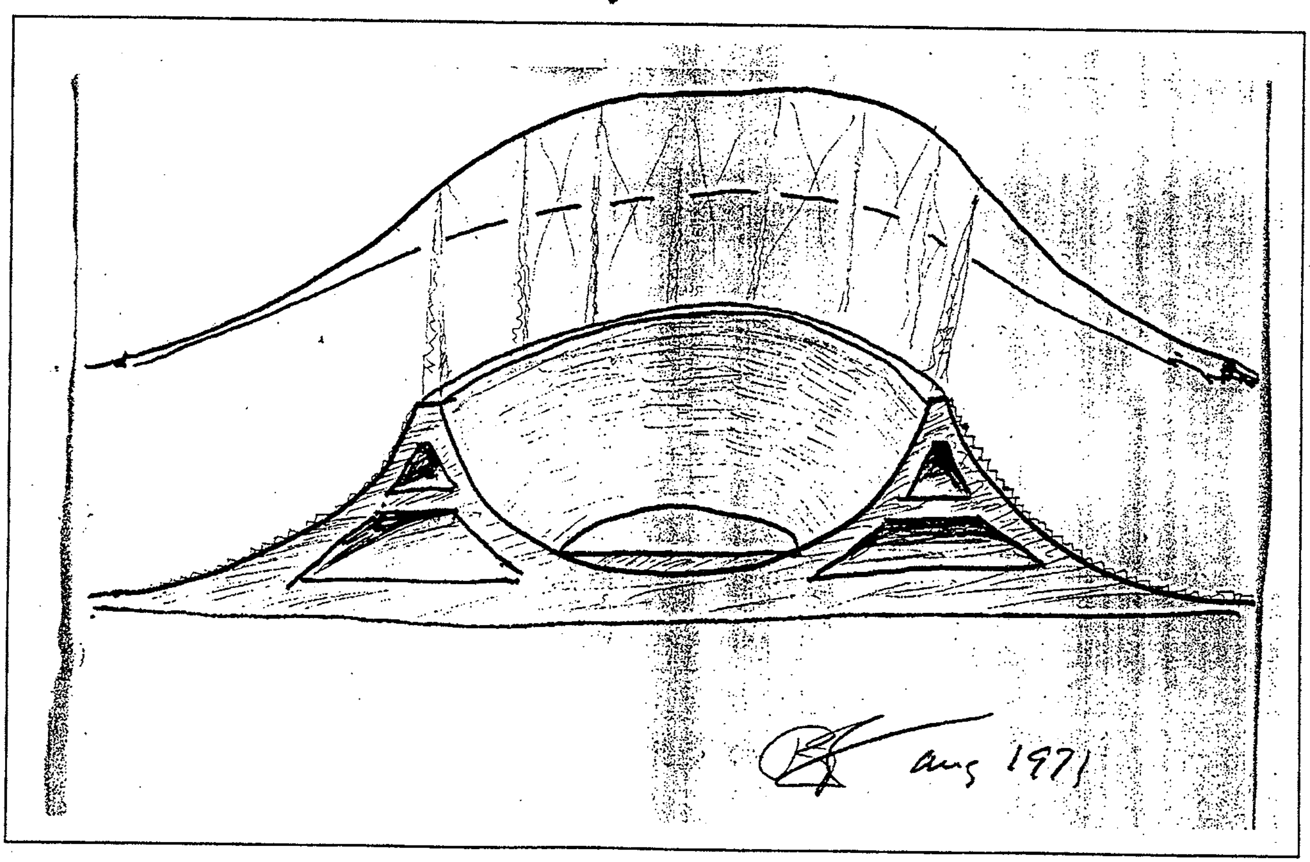


Fig.4.04b .1:J W Fitzgibbon, Sketch of OMR City, December 1970. Source: BFI-OMR Folder (Active Files).

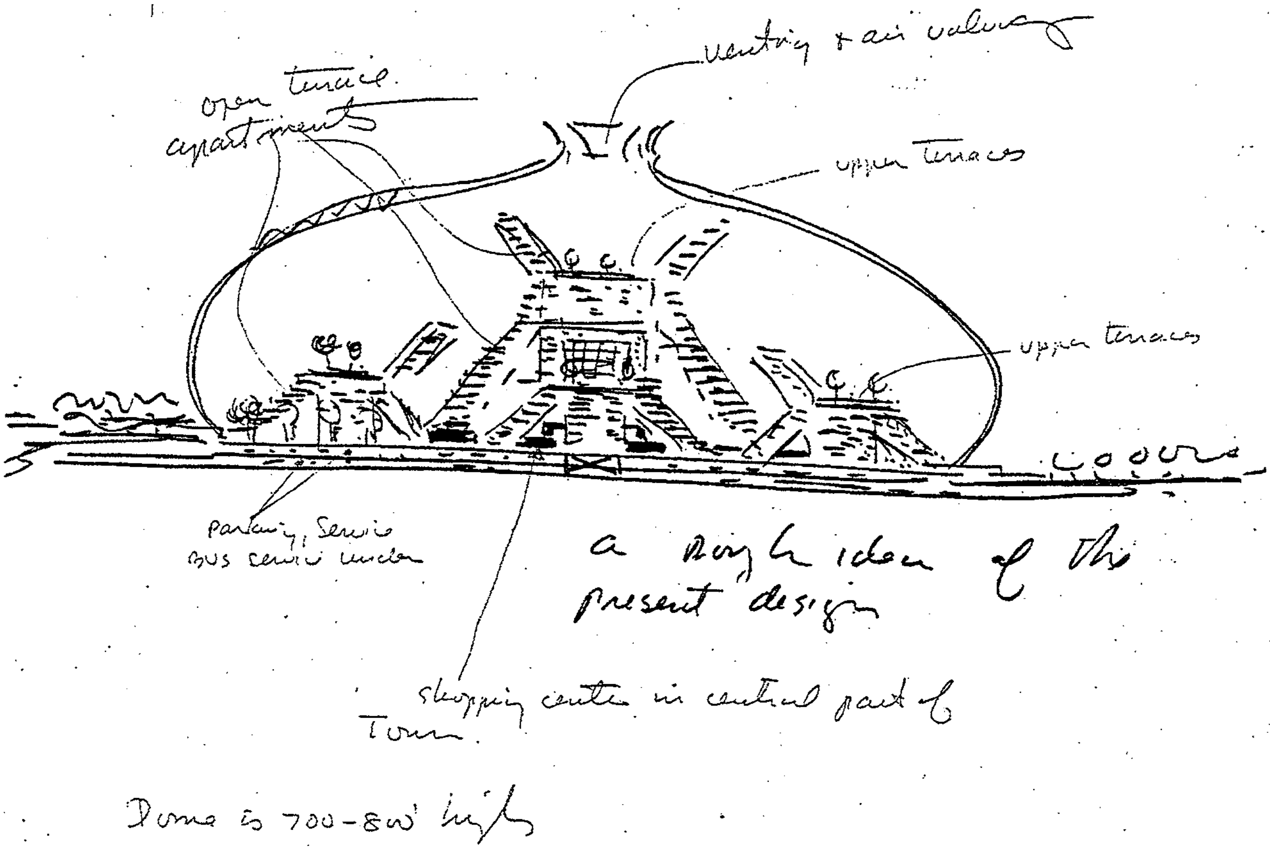


Fig.4.04b .2: J W Fitzgibbon, Sketch of OMR City, December 1970. Source: J W. Fitzgibbon, "The Notebooks, Old Man River Project", September 1972.

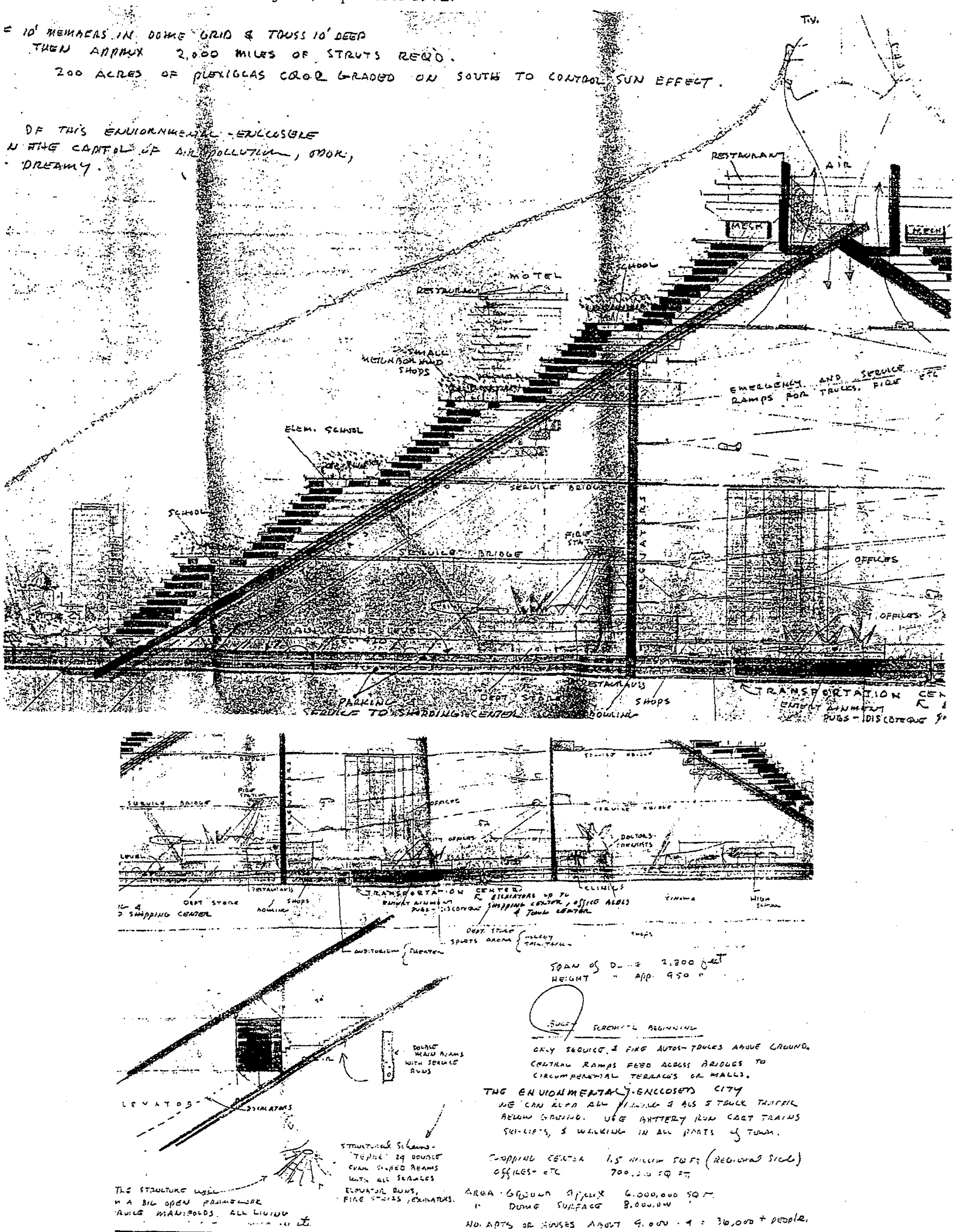


Fig.4.04c J W Fitzgibbon, Sketch of OMR City, undated. Source: BFI-OMR Folder (Active Files).

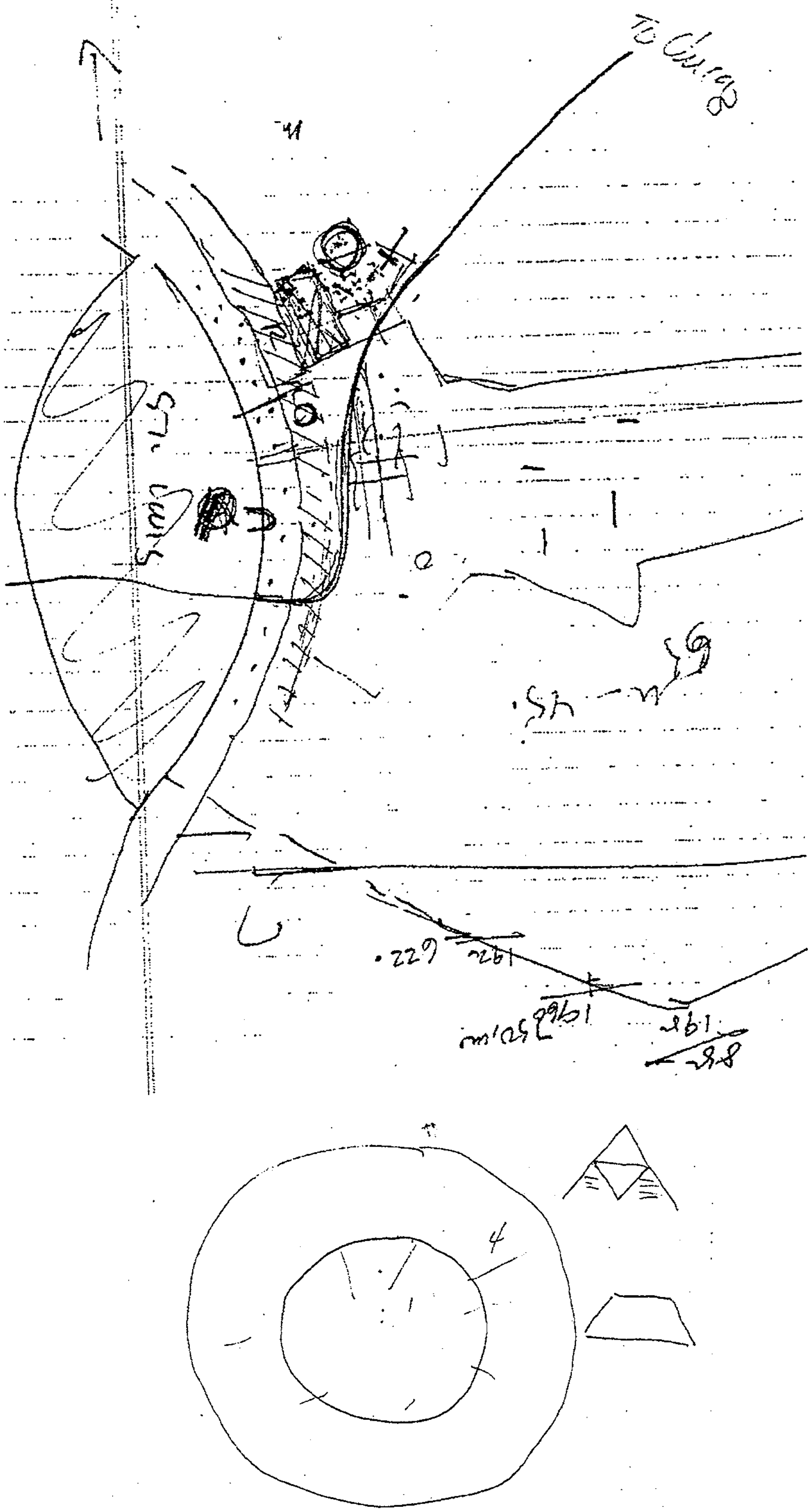


Fig.4.05a J.W. Fitzgibbon, Sketch of OMR City, January 1972. Source: BFI-OMR Folder (Active Files).

Fig.4.05b J.W. Fitzgibbon, Diagram of Section of OMR City, ca. February 1971. Source: J.W. Fitzgibbon, "The Notebooks, Old Man River Project," September 1972.

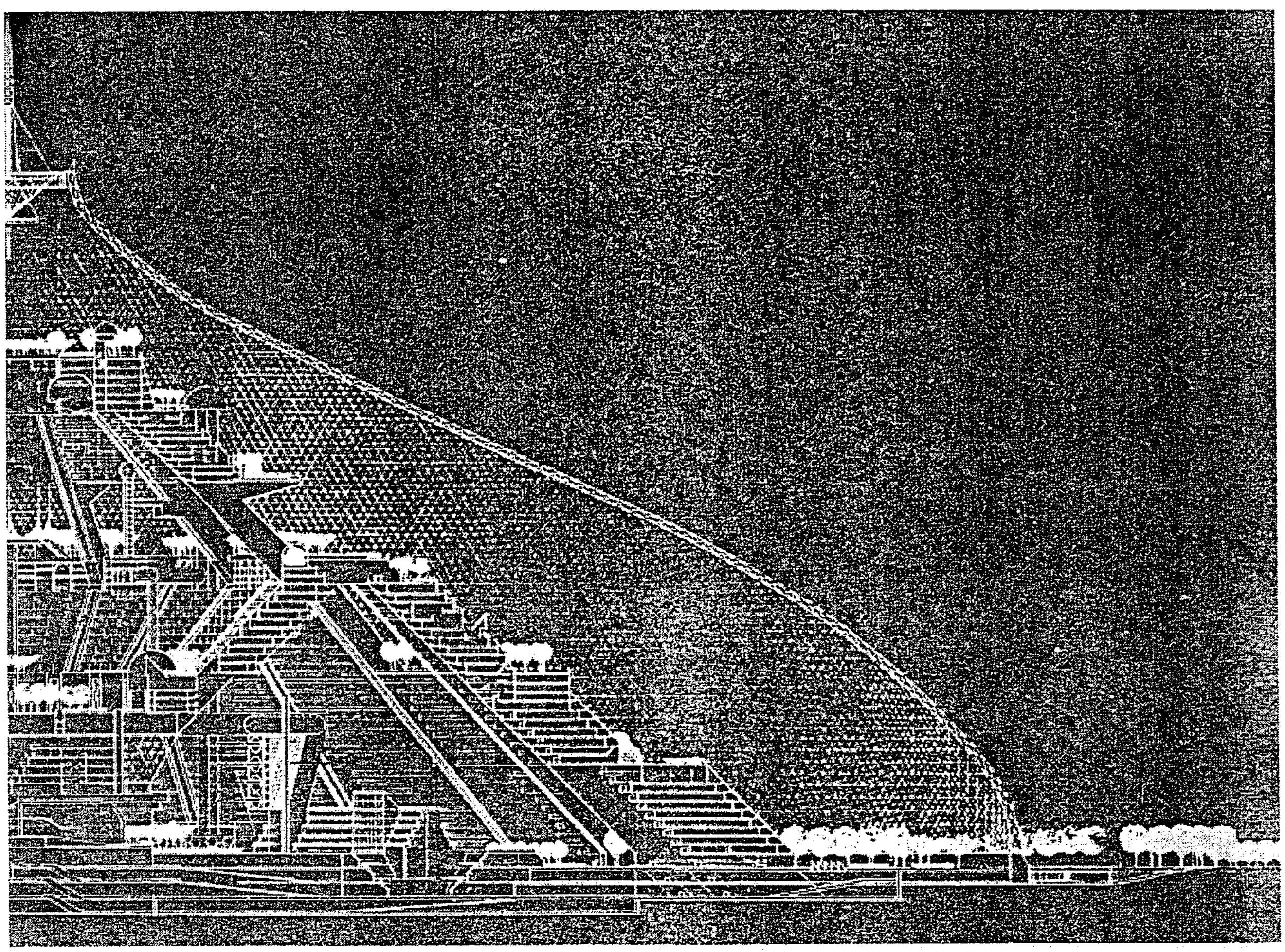


Fig.4.05c J.W. Fitzgibbon, Model of OMR City as seen north of Veterans Bridge, February 1971. Source: *Metro-East Journal* (City of East St. Louis), 2/26/71, p.11.

Fig.4.05d J.W. Fitzgibbon, Photographs of Model of OMR City as seen north of Veterans Bridge, February 1971. Source: BFI Photo--Non Leco.

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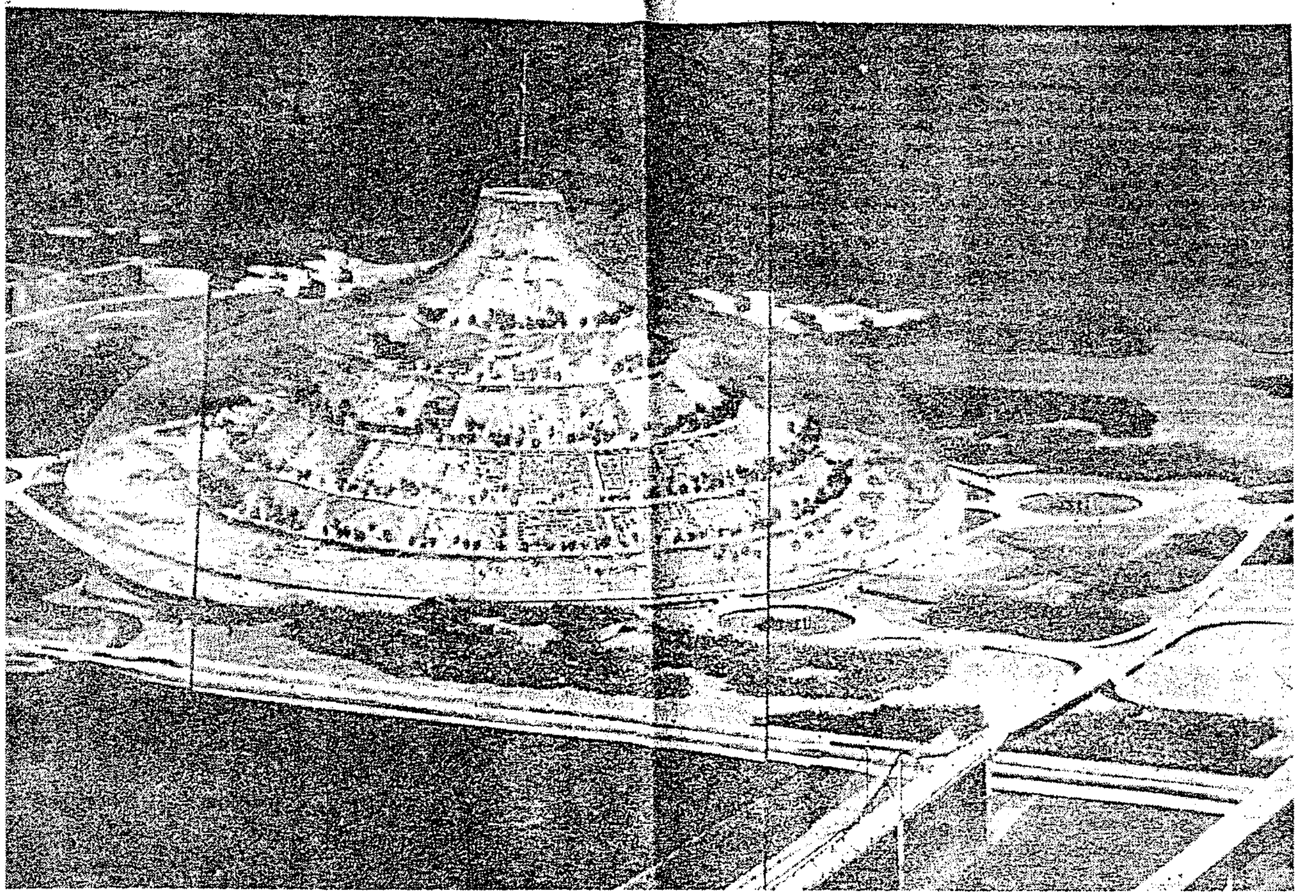


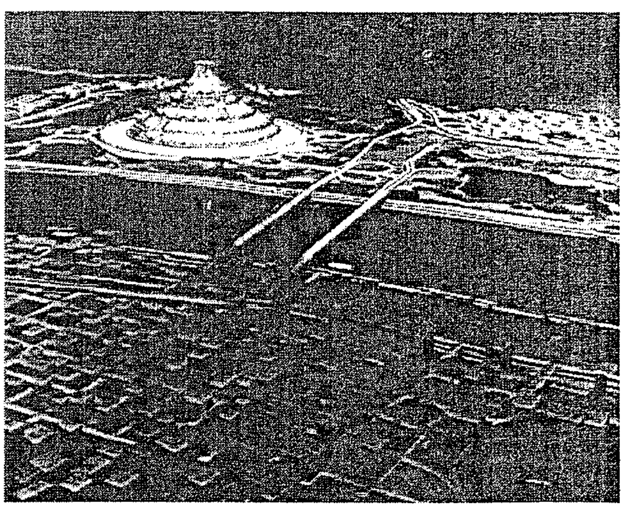
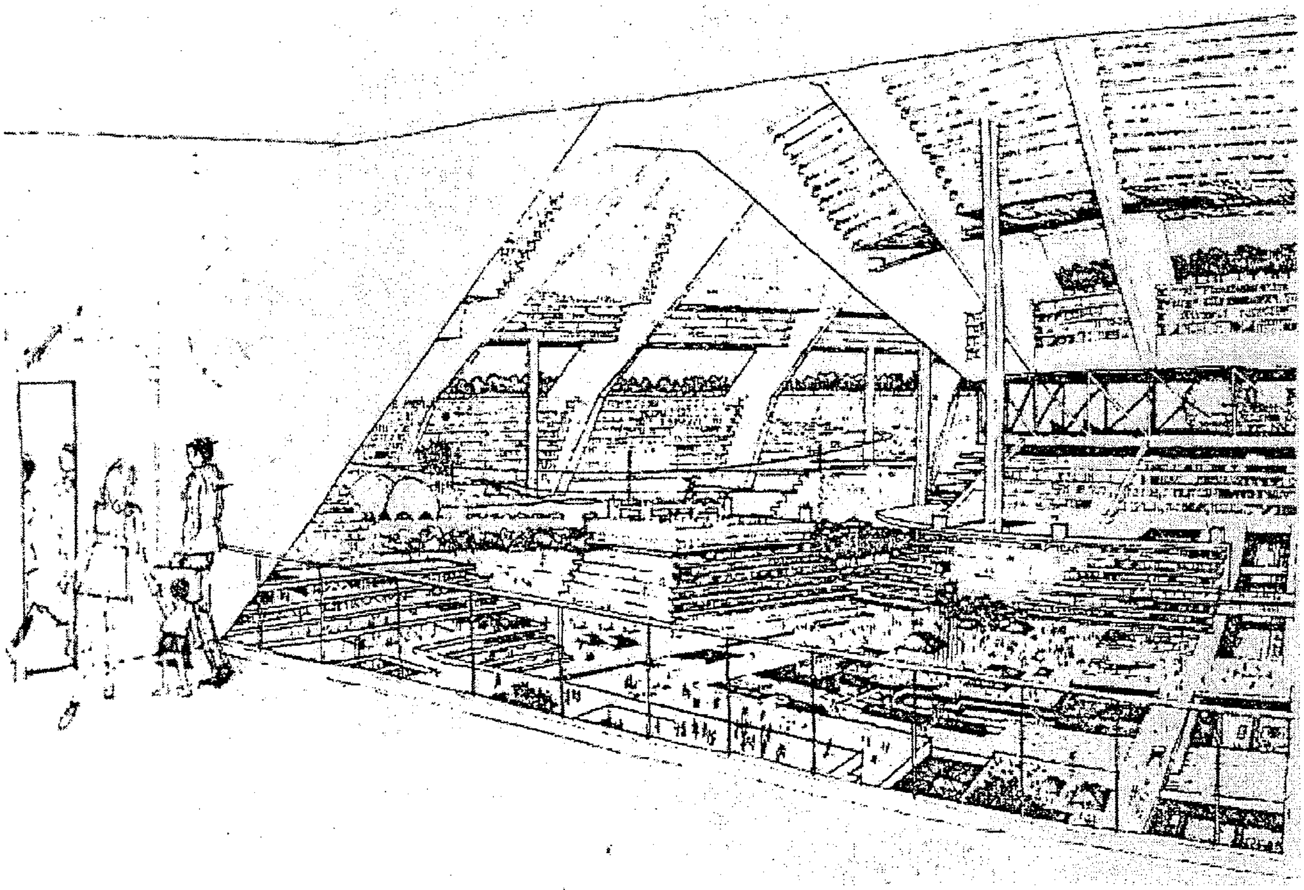


Fig.4.05e J W Fitzgibbon, View of Central Commercial Area of OMR City, ca. February 1971. Source: J W Fitzgibbon, "The Notebooks, Old Man River Project", September 1972.

Fig.4.05f J W Fitzgibbon, View of Ring park and Housing Block of OMR City, ca. February 1971. Source: J W Fitzgibbon, "The Notebooks, Old Man River Project", September 1972.



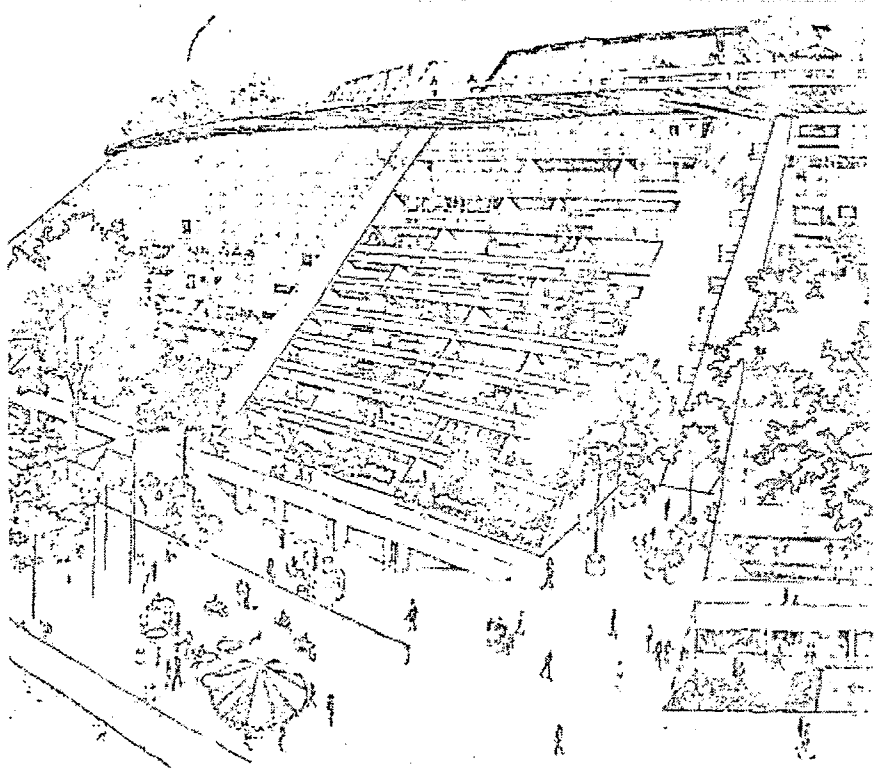
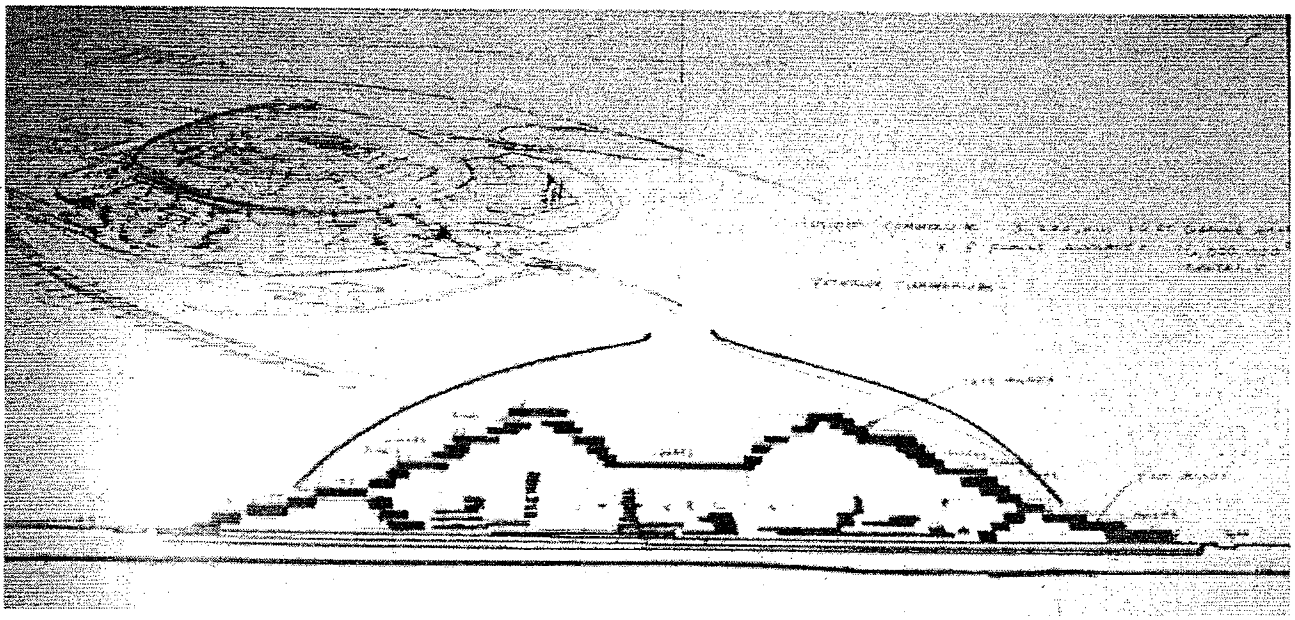


Fig.4.05g .1: J W Fitzgibbon, Sketch for the Valley form OMR. Source: M. Fitzgibbon slide collection; .2: Second model for the OMR, J.W. Fitzgibbon & School of Architecture, Washington University. Source: BFI-[?]



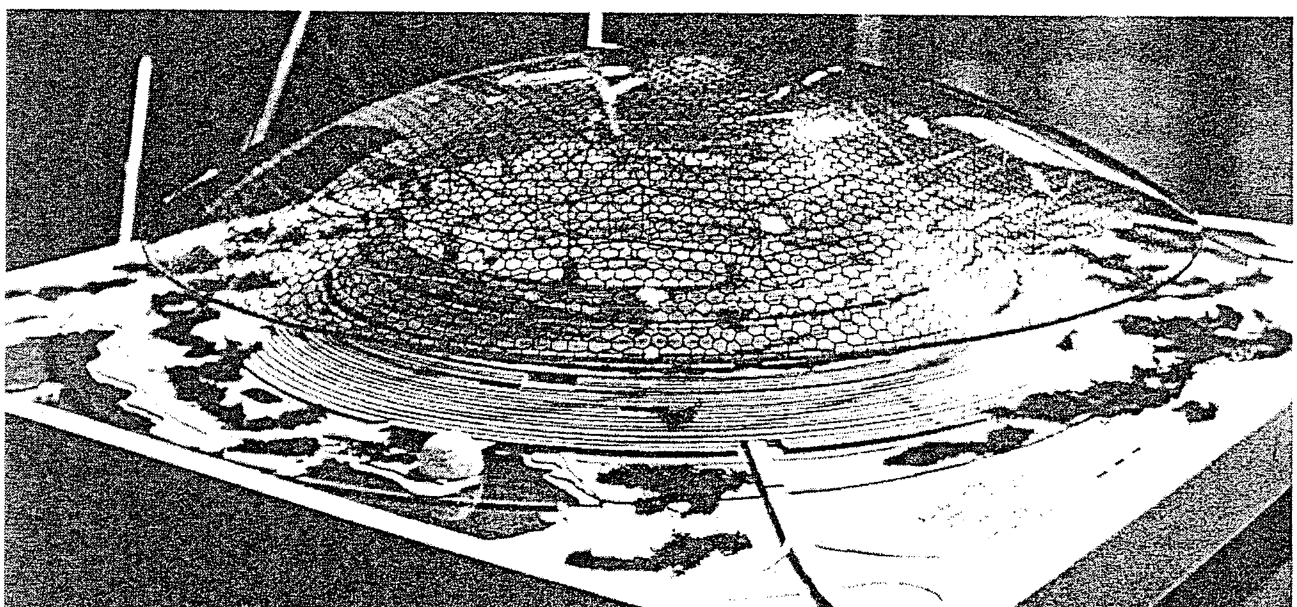
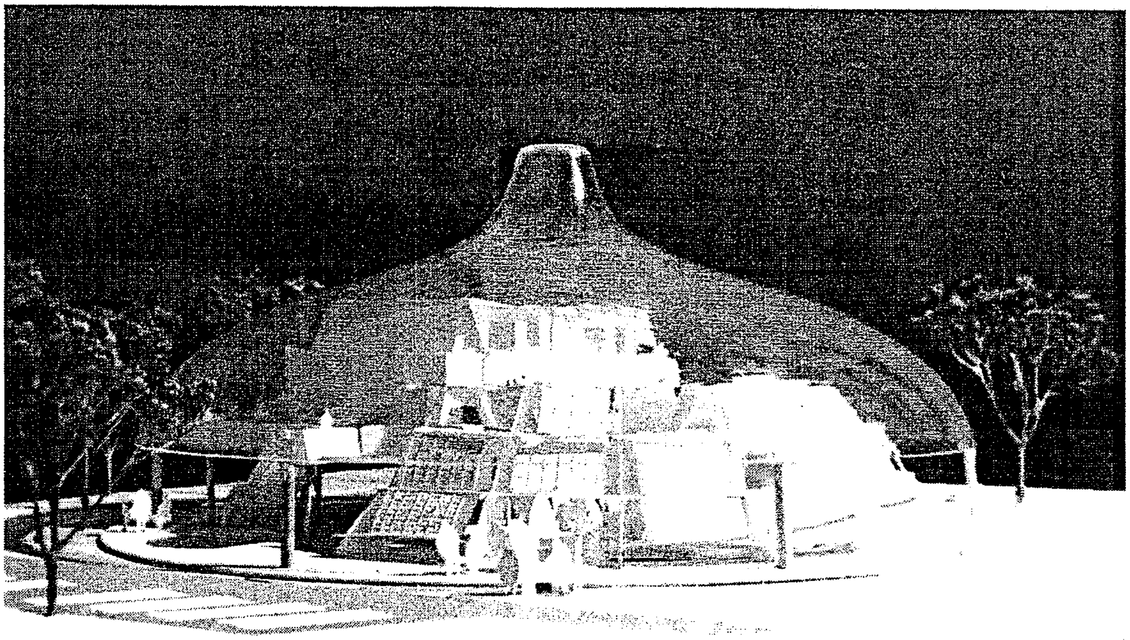


Fig.4.06a J. W. Fitzgibbon, Walk-in Model of OMR City, ca.1972. Source: M. Fitzgibbon's Collection.



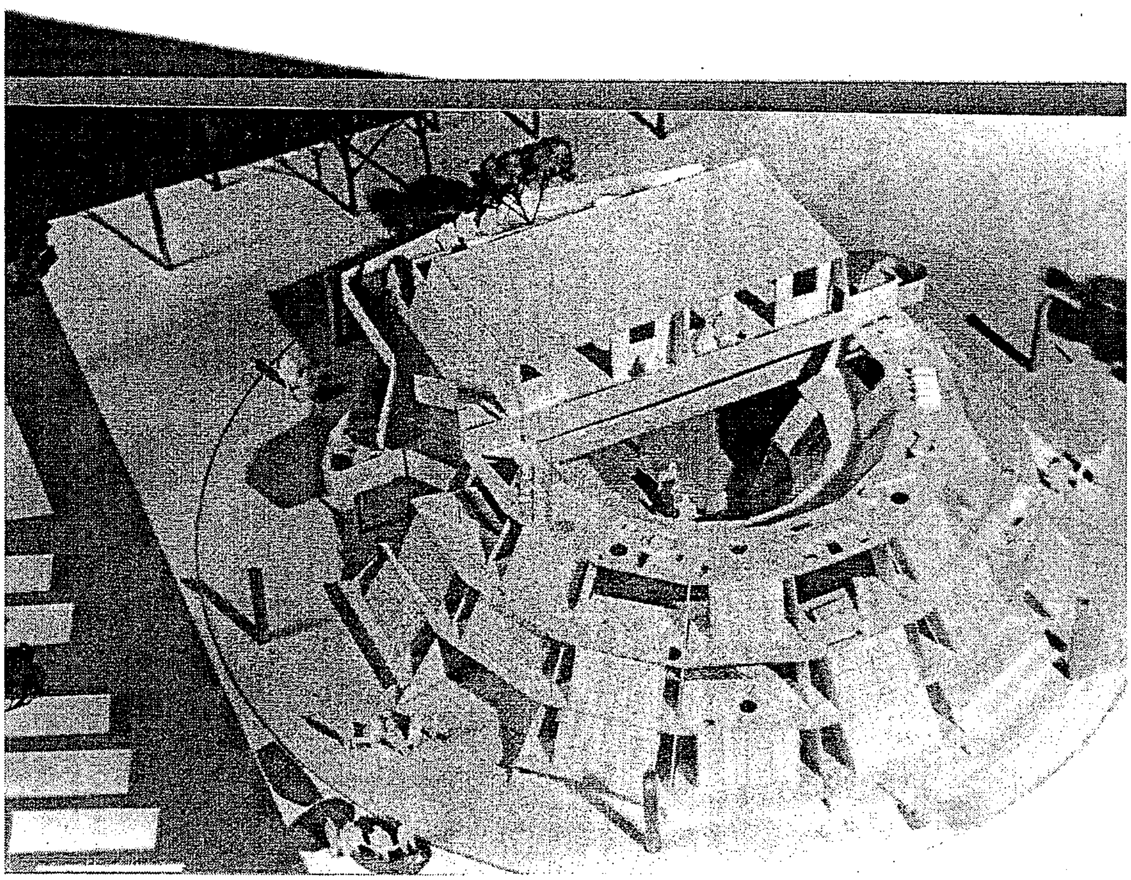


Fig.4.06b J W Fitzgibbon, Drawing of the walk-in Model of OMR City, ca.1972. Source: M. Fitzgibbon's Collection.

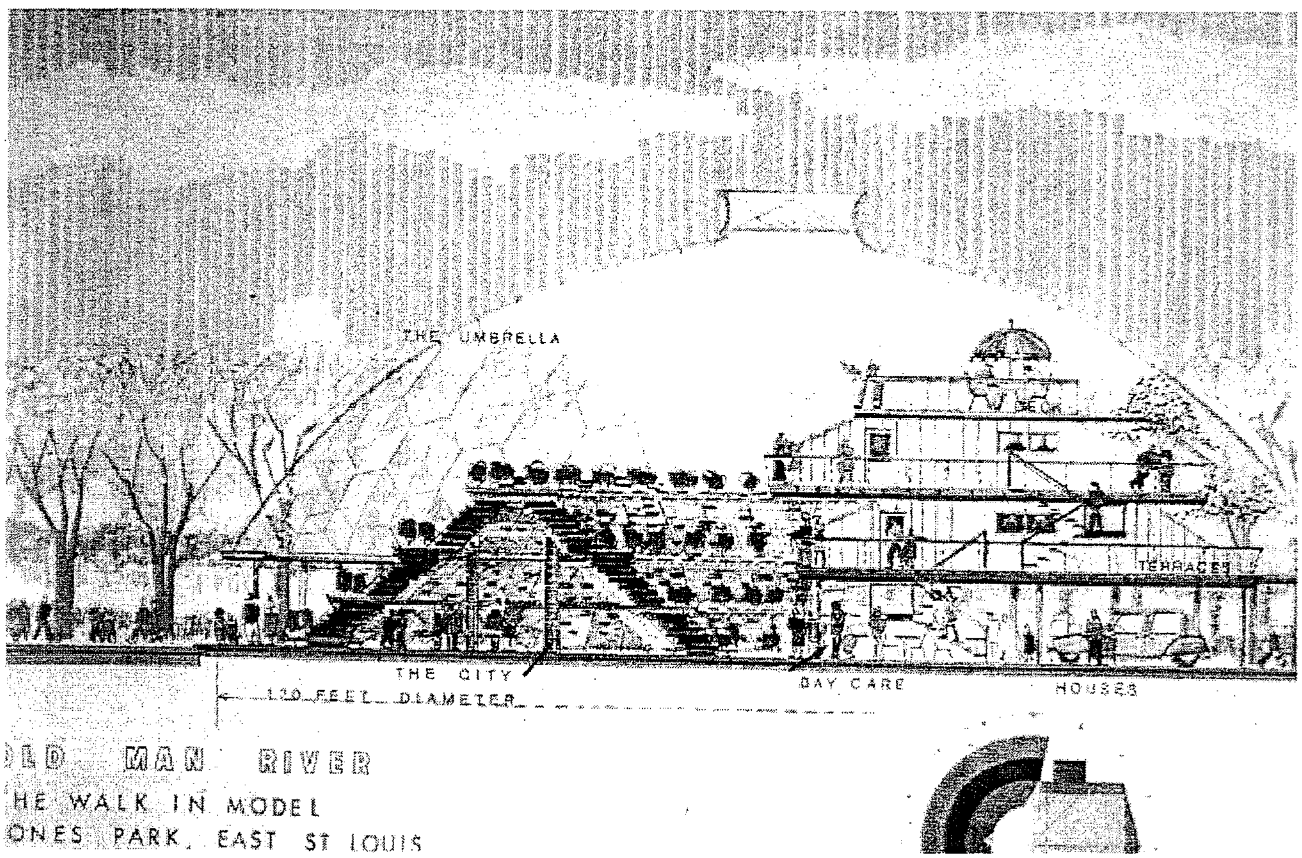


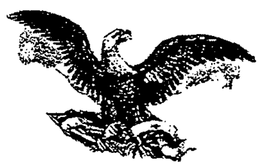
Fig.4.07 .1: East St. Louis Community Economic Development Corporation; .2: Promotional-Subscription Pamphlet, "Old Man River High Technology Association." Source: BFI-OMR Folder (Active Files).

OLD MAN RIVER
COMMUNITY ECONOMIC
DEVELOPMENT CORPORATION

energy
jobs industry housing

The East ST. Louis Community Economic Development Corporation

a NOT FOR PROFIT corporation established by east st louis citizens to develop the design and structure for the new city and build the walk-in model of OLD MAN RIVER in JONES PARK.



THE GOOD LIFE FOR ANY MAN DEPENDS ON THE GOOD LIFE FOR ALL MEN.

OLD MAN RIVER

An Environmental City With an Umbrella

TO BE BUILT ON THE EDGE OF EAST ST. LOUIS, ILL.

TO BE DEVELOPED, OWNED AND MANAGED BY THE CITIZENS

A PLEASANT CITY TO LIVE IN

A NEW IDENTITY FOR EAST ST. LOUIS

APPLICATION FORM

Please make checks payable to: OLD MAN RIVER HIGH TECH CITY ASSOC. 2000 State Street E.ST.Louis IL. 62205 (618) 274-2177 Cost-$25

My Name ______

Address ______

City ______

State ______ Zip ______

Recipient's Name (If gift) ______

Address ______

City ______

State ______ Zip ______ 3MURR

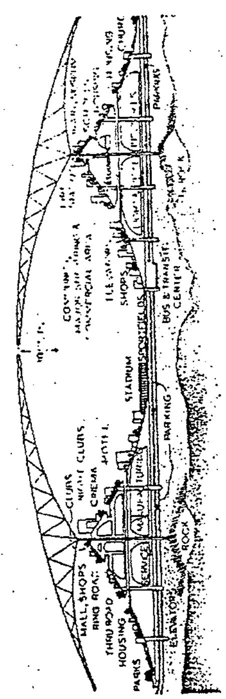
MEMBERSHIP BENEFITS

Each member will have the benifit of working in his or her specialty, in one of the following Old Man River components.

You will also recieve a certificate verifying your membership.

Please check one of the following Old Man River Components:

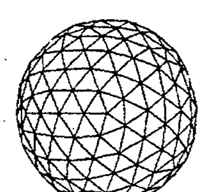
GOVERNMENTAL COMPONENT ___	PROGRAMMING ___
MANAGEMENT COMPONENT ___	ECONOMIC COMPONENT ___
SOCIAL COMPONENT ___	FINANCIAL COMPONENT ___
ENVIRONMENTAL COMPONENT ___	PHYSICAL COMPONENT ___



UNDER COVER:
Geoshelter and Geodesic Dome Design of R. Buckminster Fuller

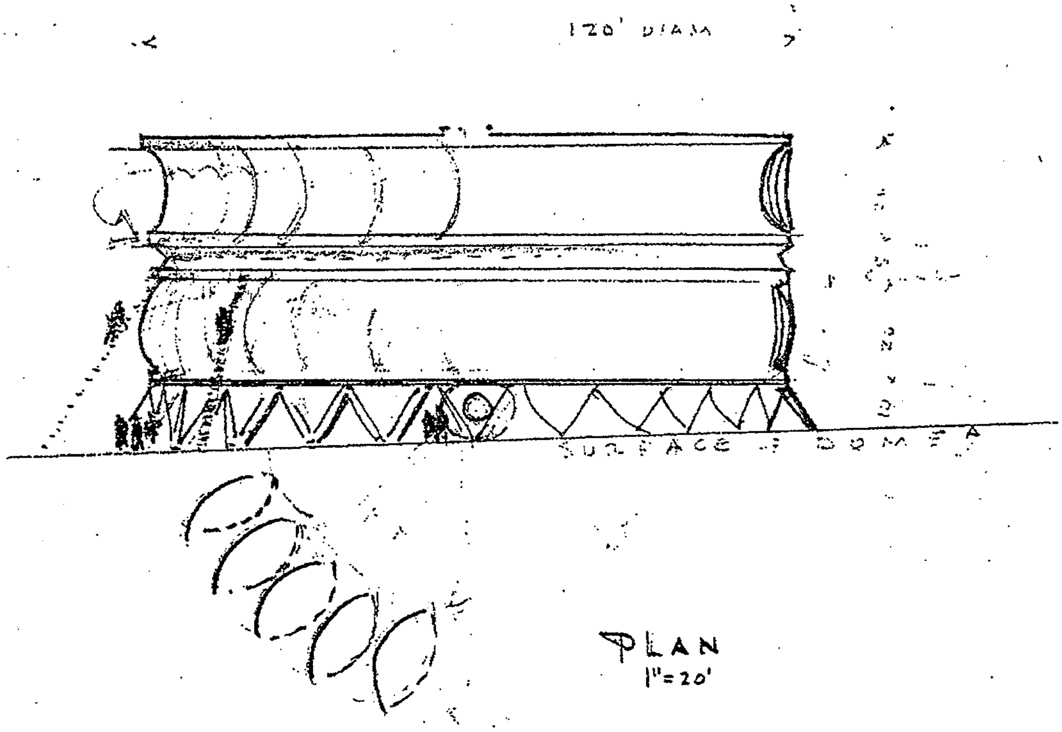
Become an Associate Member of the

OLD MAN RIVER HIGH TECH CITY ASSOC.



Read the details in this folder, fill out the application form, and return it today.

Fig.4.08 J W Fitzgibbon, Passive energy devices of OMR City, ca.1972. Source: BFI-OMR Folder (Active Files).



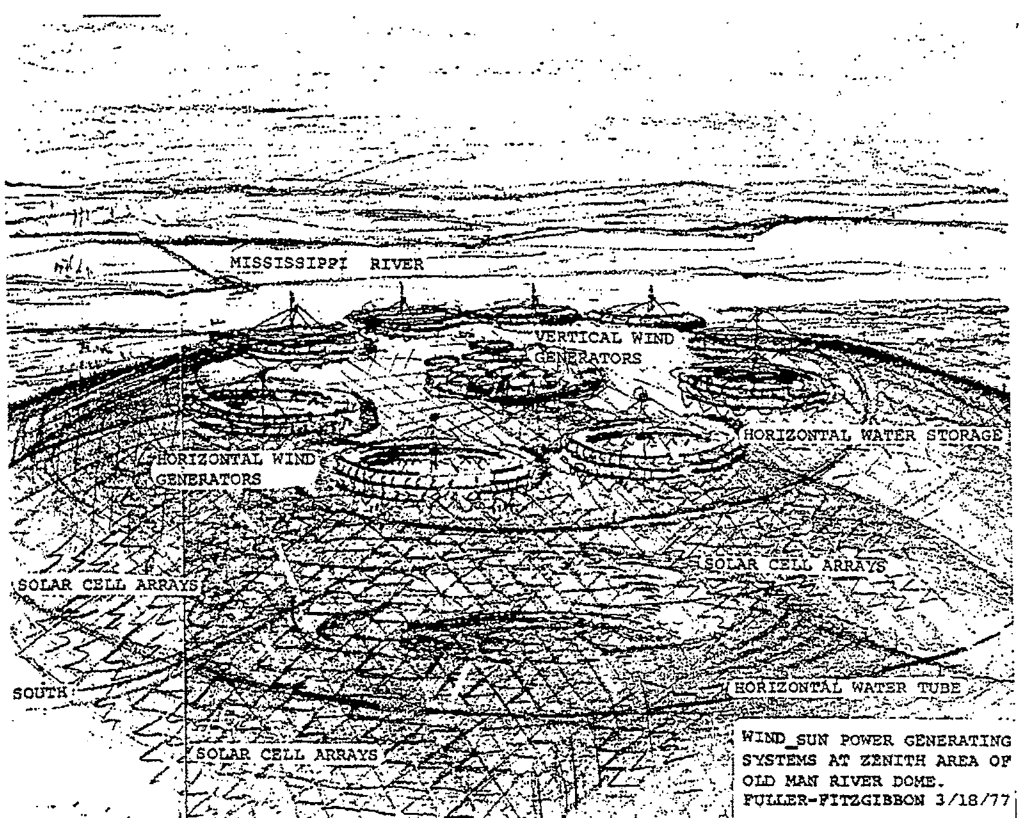


Fig. 33 Dome with Horizontal Wind Mills Fitzbibbon

Fig.4.09a Charas, Urban dome-builders. Source: BFI Photo C-21 series.

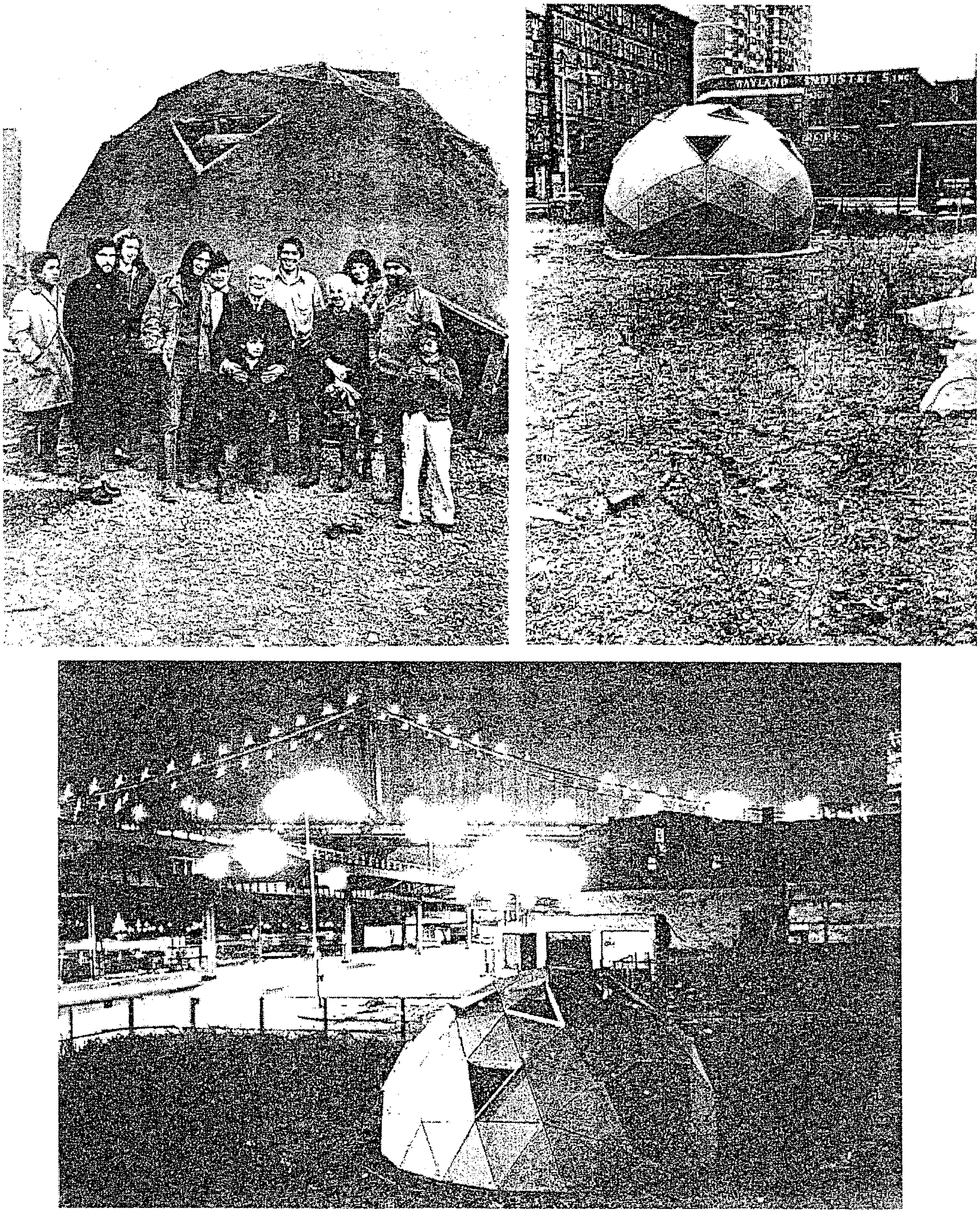


Fig.4.09b Charas, Urban dome-builders. <u>Source:</u> BFI Photo C-21 series.

Fig.4.09c Charas, Urban dome-builders. Source: Michael Ben-eli, "A Project with R. Buckminster Fuller."

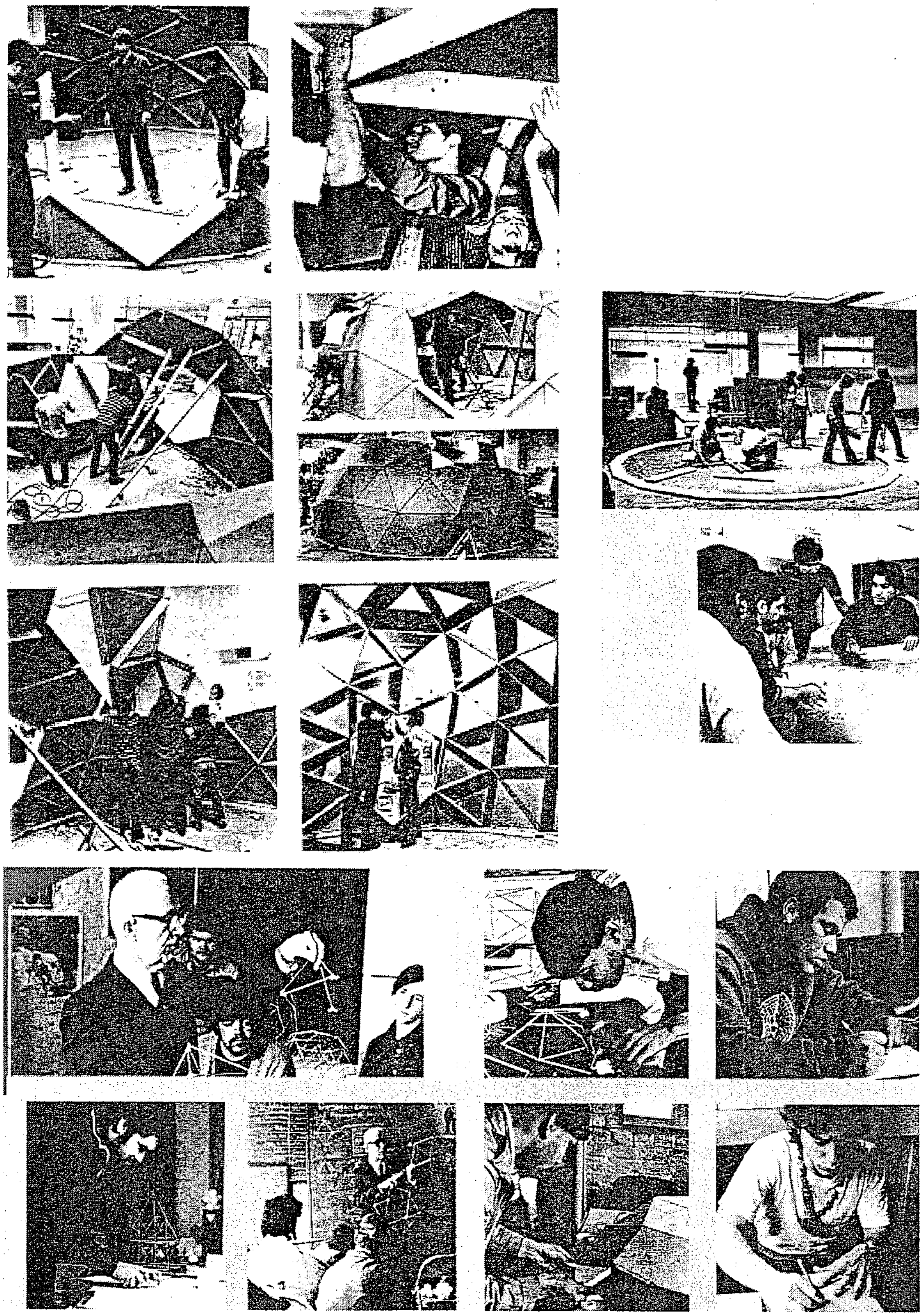


Fig.4.10 "Dome Aids Building Boom." Source: *My Weekly Reader* (Parade/The Junior Newspaper), Vol. XLV, Issue 18, February 3-7, 1964.

Vol. XLV • Issue 18 • February 3-7, 1964 4

MY WEEKLY READER

NEWS PARADE/THE JUNIOR NEWSPAPER

Dome Aids Building Boom

More than a dime out of every dollar spent in the U.S. is used for building. Americans build more than any other people in the world.

Our builders are always looking for better, faster, and easier ways of putting up buildings. They are always searching for new materials and new designs.

Dome Is Light and Strong

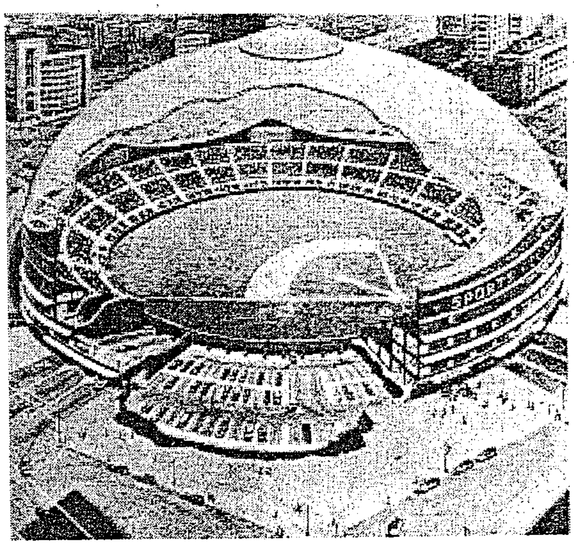
The geodesic (je-uh-DES-ik) dome is fast and easy to build. It was designed by Buckminster Fuller. Mr. Fuller's dome can be made in almost any size. It is not costly to make. No columns are needed for support. The geodesic dome uses less material to cover more space than any other building. The dome is about the lightest and strongest building ever made.

The outer "skin" of the dome can be aluminum, plastic, steel, wood, or bamboo. The domes are easily put together by matching parts by color. Non-English-speaking people can follow the simple color plan with little trouble. The domes are so light they can be lifted by helicopter.

The geodesic dome is used for many kinds of shelter. Servicemen live in these domes in Antarctica, Okinawa, and other places. The domes are used for U.S. shows at world trade fairs, and for greenhouses and theaters.

Domes May Shelter Cities

Someday, a geodesic dome may be built over a whole city. The city would be air-conditioned. In such a weatherproof city, walls of houses and stores would be built only for privacy and beauty.



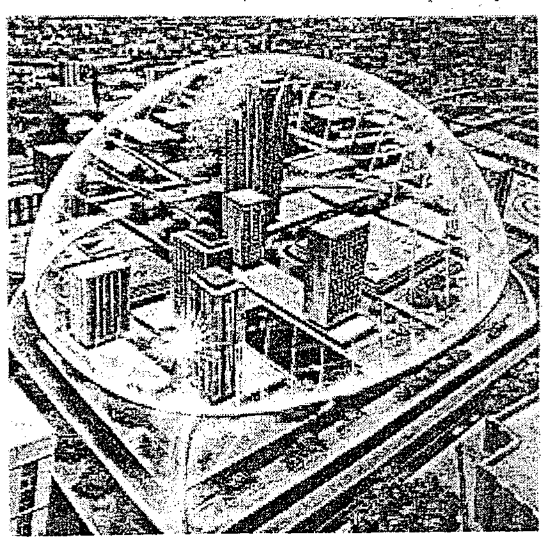


Fig.4.11a Excerpts of Findings of British Architectural Students Association (BASA) - UIA World Congress, Paris 1965. Source: BFI-CR271.

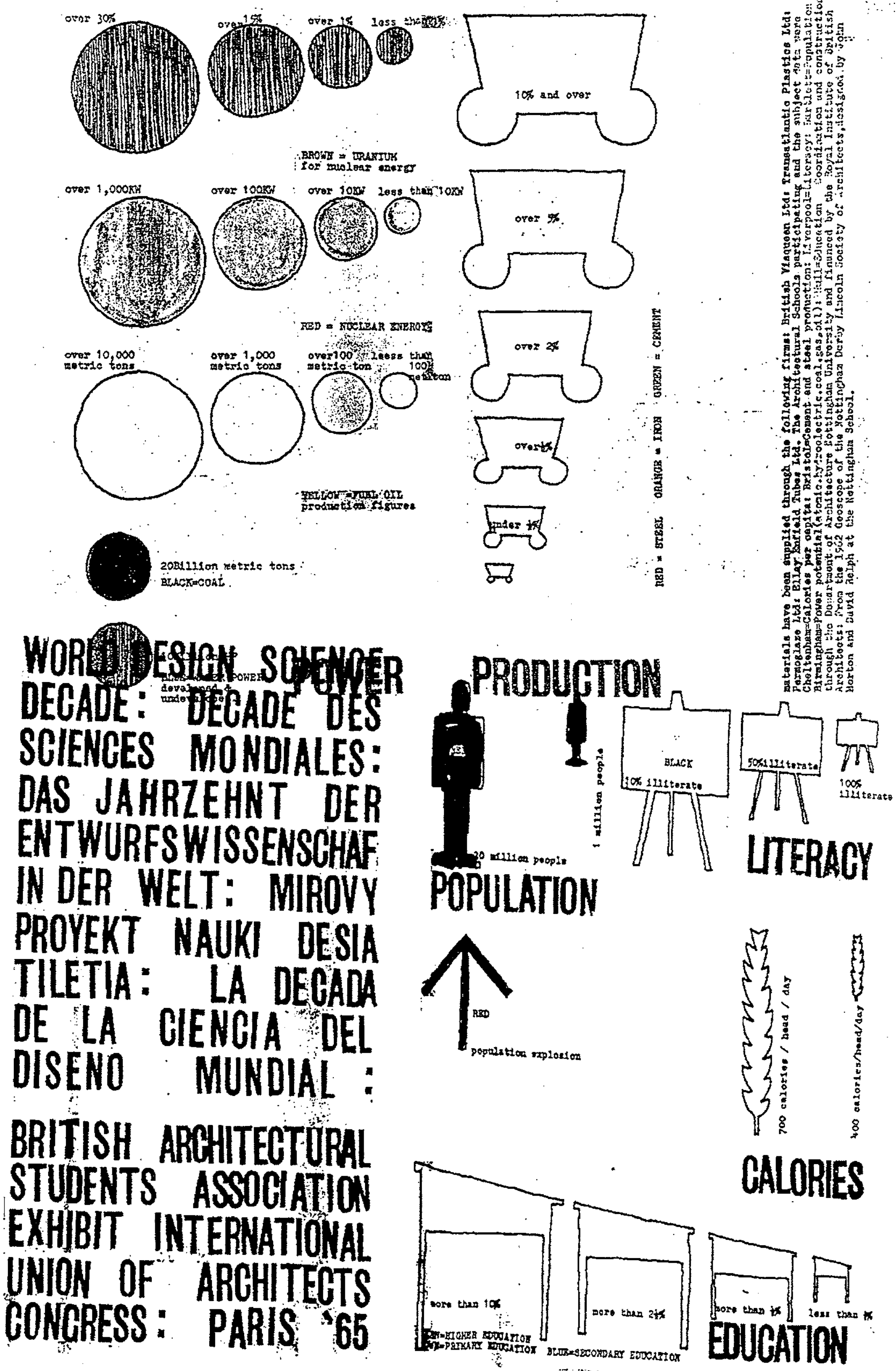
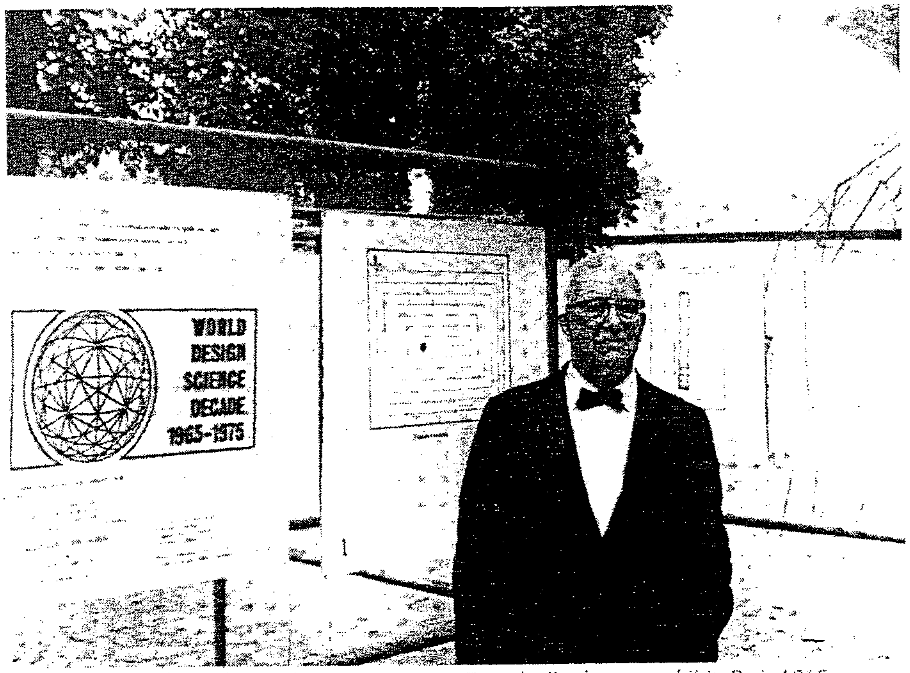


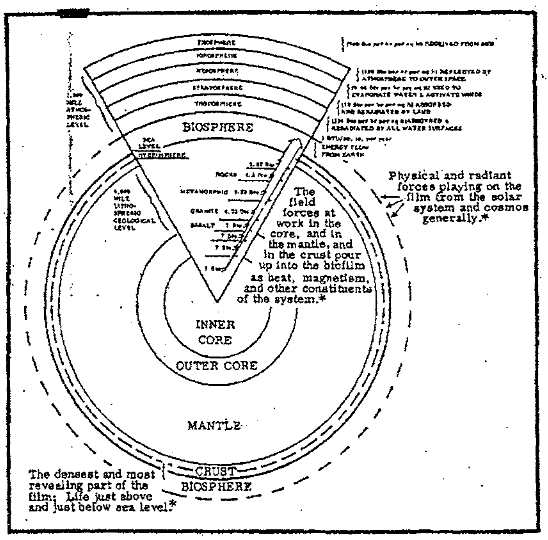
Fig. 4.11b .1: Fuller at the launching of the World Design Science Decade 1965-1975, Paris 1965. Source: BFI Trimtab, Vol.5, No.3, Autumn 1990, p.4; .2: Excerpts from World Resources Inventory , WDSD-SIU.



Buckminster Fuller at the World Design Science Decade Conference exhibit, Paris 1965.

WORLD DESIGN SCIENCE DECADE 1965 - 1975
MIROVY PROYEKT NAUKI DESIA TELETIA 1965 - 1975
NAVRH ROKU SVETOVE VEDY V DESITILETI 1965 - 1975
LA DECADA DE LA CIENCIA DEL DISENO MUNDIAL 1965 - 1975
DAS JAHRZEHNT DER ENTWURFSWISSENSCHAFT IN DER WELT 1965 - 1975
DECADE DES SCIENCES MONDIALES D'AVANT - PROJETS ARCHITECTAURAUX 1965 - 1975

WORLD DESIGN SCIENCE DECADE 1965-1975



4. Earth and the Biosphere

LA TERRE ET LA BIOSPHERE:

La biosphere, ou biofilm est une mince couche d'air respirable et de terrain, qui enveloppe le globe. C'est en suspend, dans cette couche mince que tous les organismes vivants se trouvent et se maintiennent.

DIE ERDE UND DIE BIOSPHAERE:

Die Biosphaere, oder Biofilm ist die duenne Schicht einatmungsmoeglicher Luft und Boden um die Erde, innerhalb welcher alle lebenden Organismen erhalten werden.

EARTH AND THE BIOSPHERE:

The biosphere, or biofilm is the thin layer of breathable air and soil around the earth within which are sustained all the living organisms.

ЗЕМЛЯ И БИОСФЕРА: Биосфера или биофильм это тонкий слой дыхательного воздуха и почвы вокруг земли в пределах которого поддерживается существование всех живых организмов.

Fig.4.11c Fuller at a World Game session in New York, ca. June-July 1969. Source: World Game Report, NY School of Painting and Sculpture, 12 June-31 July, 1969.

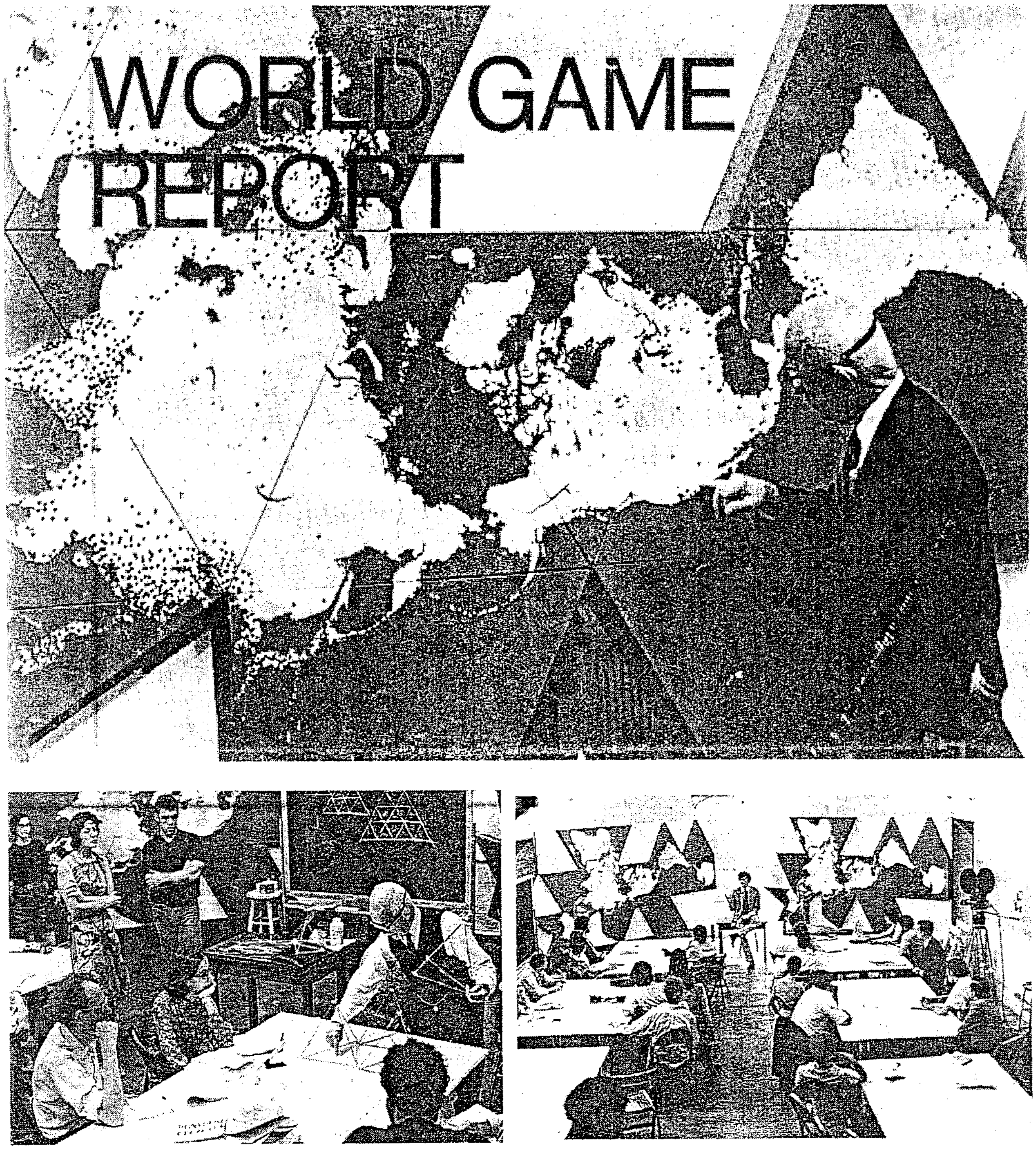
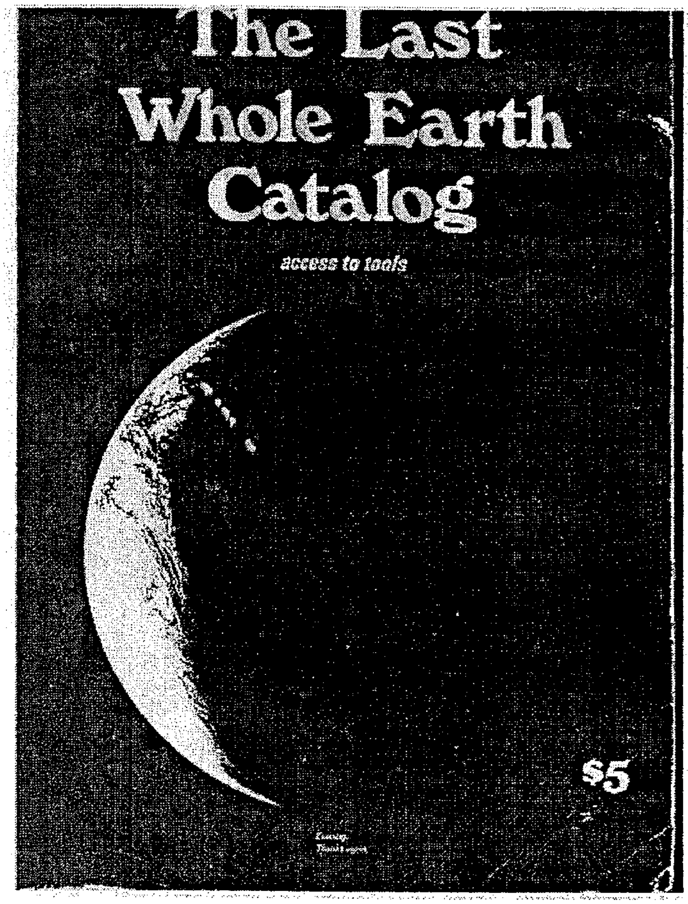


Fig.4.12a The Last Whole Earth Catalog & Dome Cookbook.



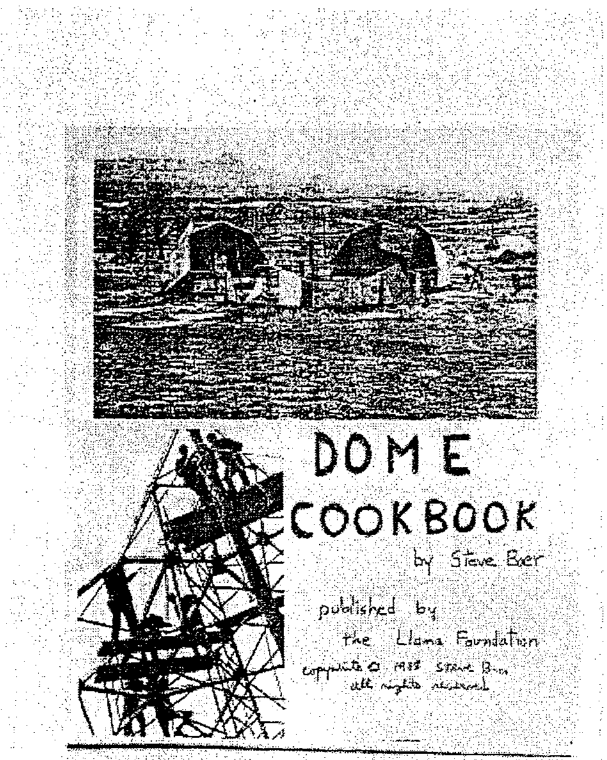


Fig.4.12b *Domebook One* and *Domebook Two*.

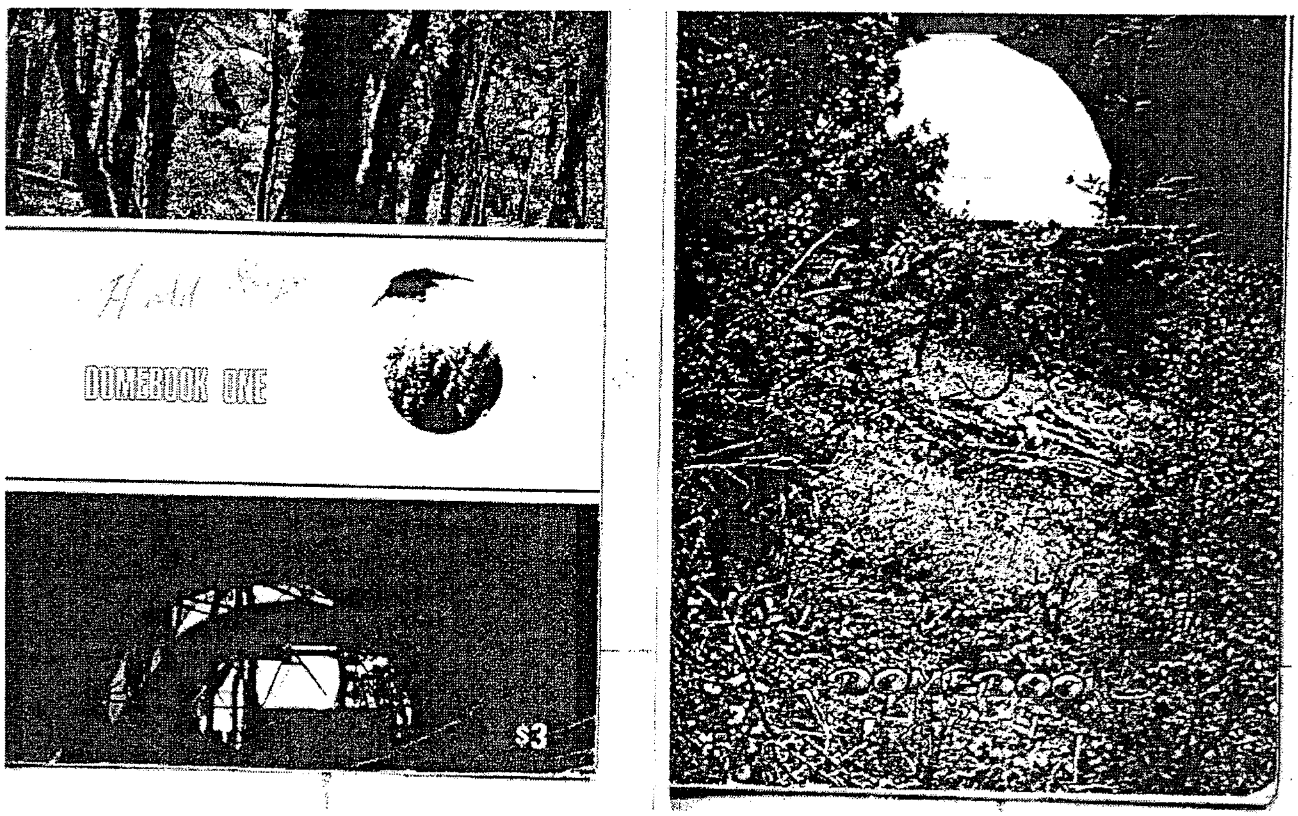


Fig.4.13a Domes of Drop City, Trinidad-CO., ca. October 1968. Source: BFI-CR285.

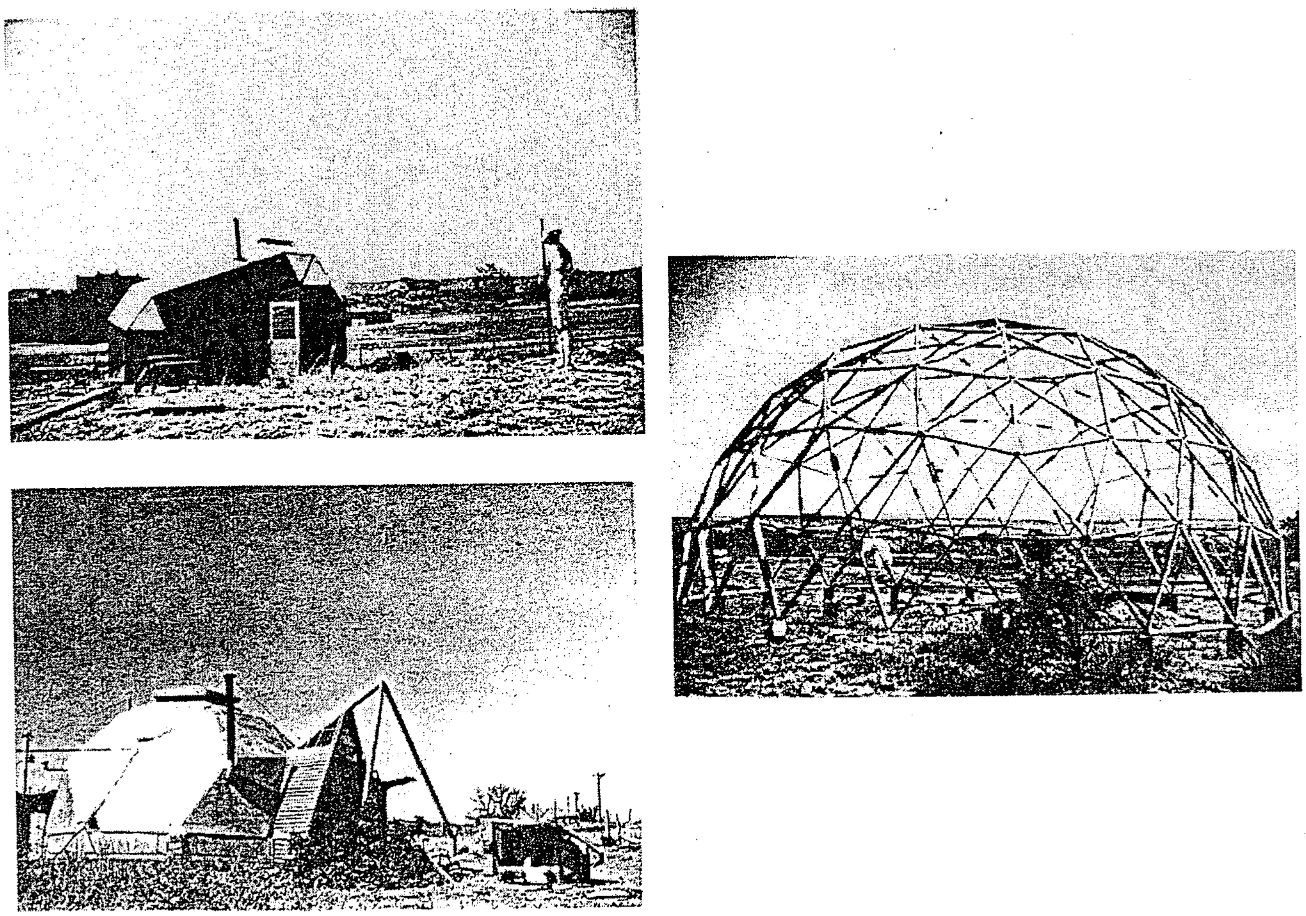


Fig.4.13b Living in Drop City, Trinidad-CO. Source: *The Denver Post*, ca. October 1968.

GEODESIC GYPSY CITY

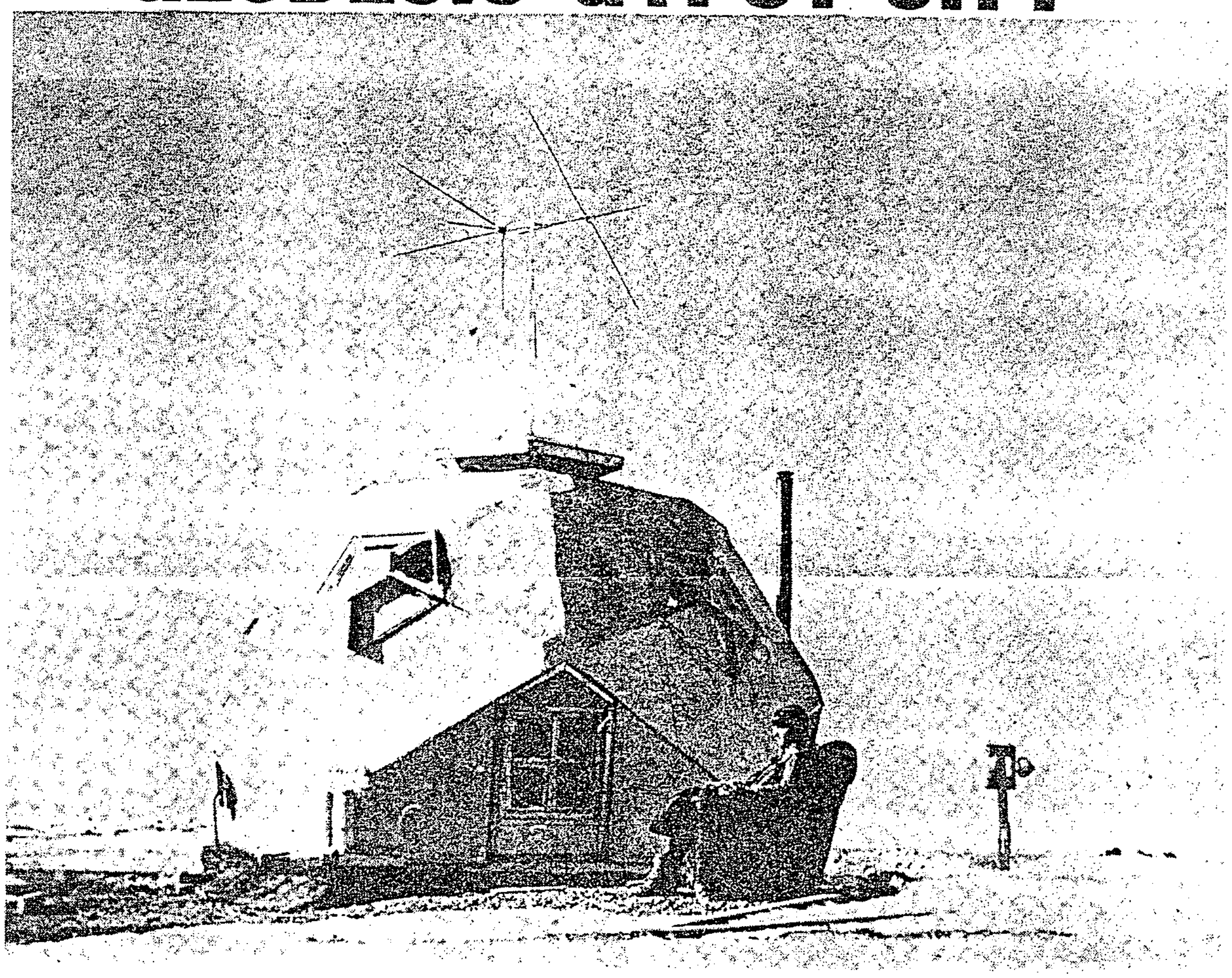


Fig.4.13c View & Plan of Drop City, Trinidad-CO., ca. May 1967. Source: "Drop City" in *Innerspace* (New York City, NY).

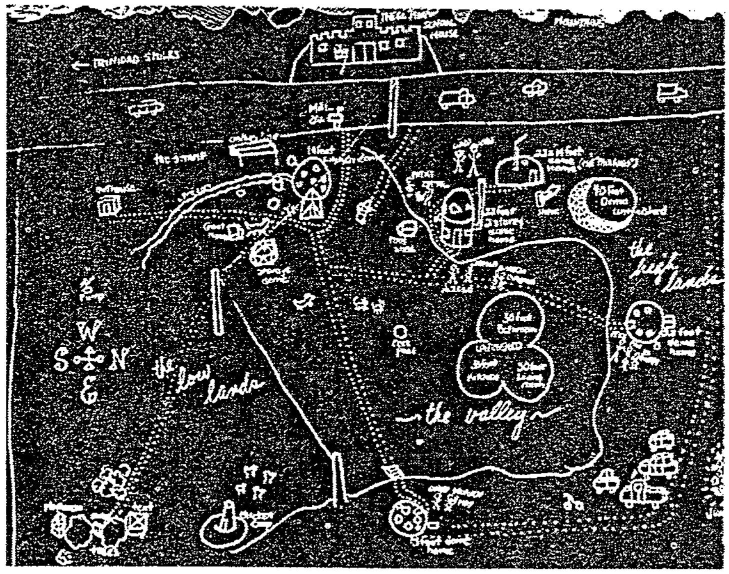
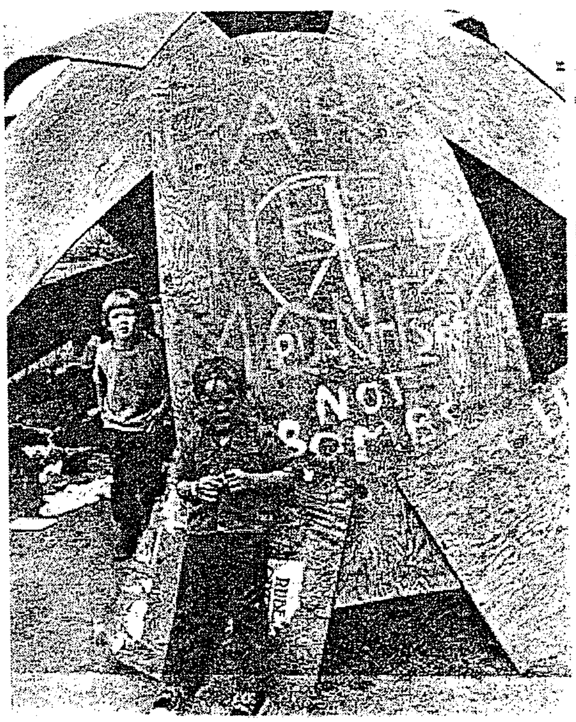


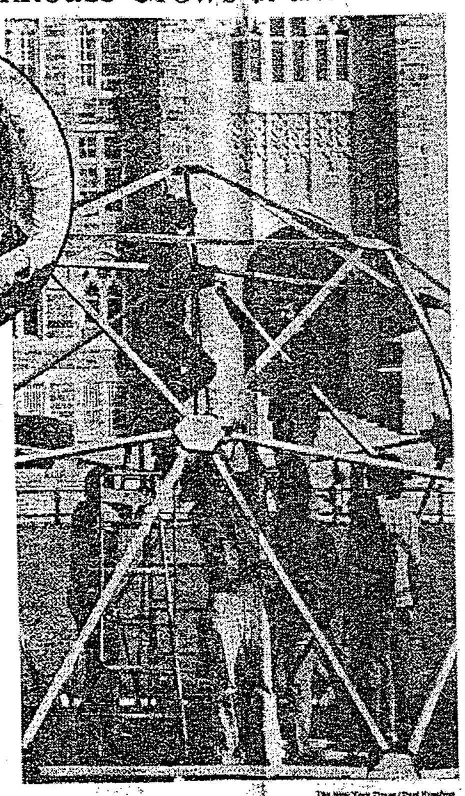
Fig.4.14a **.1:** Buckminster Fuller on Hippie Hill in San Francisco, January 1968. <u>Source:</u> *The Last Whole Earth Catalog*, 1971, p.4; .2: Plydome and "counterkids" in People's Park. San Francisco. <u>Source:</u> *New York Times Magazine* [?date]; **.3:** Geodesic as urban green-houses at Rose Hill Campus, Fordham University on occasion of the Alternative Community Technology Convention. <u>Source:</u> "Geodesic Greenhouse grows in the Bronx," *New York Times*, 18 April 1978.

Buckminster Fuller on Hippie Hill, San Francisco, 1968.



Counterkids. In People's Park, a "Plant seeds, not bombs" graffito graces a children's plywood play house inspired by Buckminster Fuller's geodesic domes.

Geodesic Greenhouse Grows in the Bronx



Twelve students at Fordham University erected the skeleton of a geodesic greenhouse on the university's Rose Hill campus in the Bronx yesterday to show how easy it is to put one up.

The structure was also put up as a trial run for an exhibition planned for the Alternative Community Technology convention, to be held in Washington at the end of the month. It is modeled after Buckminster Fuller's geodesic dome and was designed by three seniors at Fordham College — John Fontaneta, Doald Devey and Jim McGurk.

Small-Scale Urban Farming

The students created an identical structure in September 1977 as part of their research into the viability of small-scale urban farming. The original dome has produced several crops of lettuce, spinach, radishes, mustard and other vegetables and is still in operation.

"It was designed to be home-buildable," said Mr. Fontaneta, a biology major.

"It was interdisciplinary in approach — we didn't want to have just scientists involved," he said. "We wanted to make something that would be inexpensive and easy to build."

Mr. Devey, a sociology student, estimated the cost of construction materials, primarily wood and insulation, as "less than $500 in Manhattan, less than

Fig.4.14b Geodesic structures as a world vernacular form. <u>Source</u>: *Whole Earth Catalog*, July 1971.

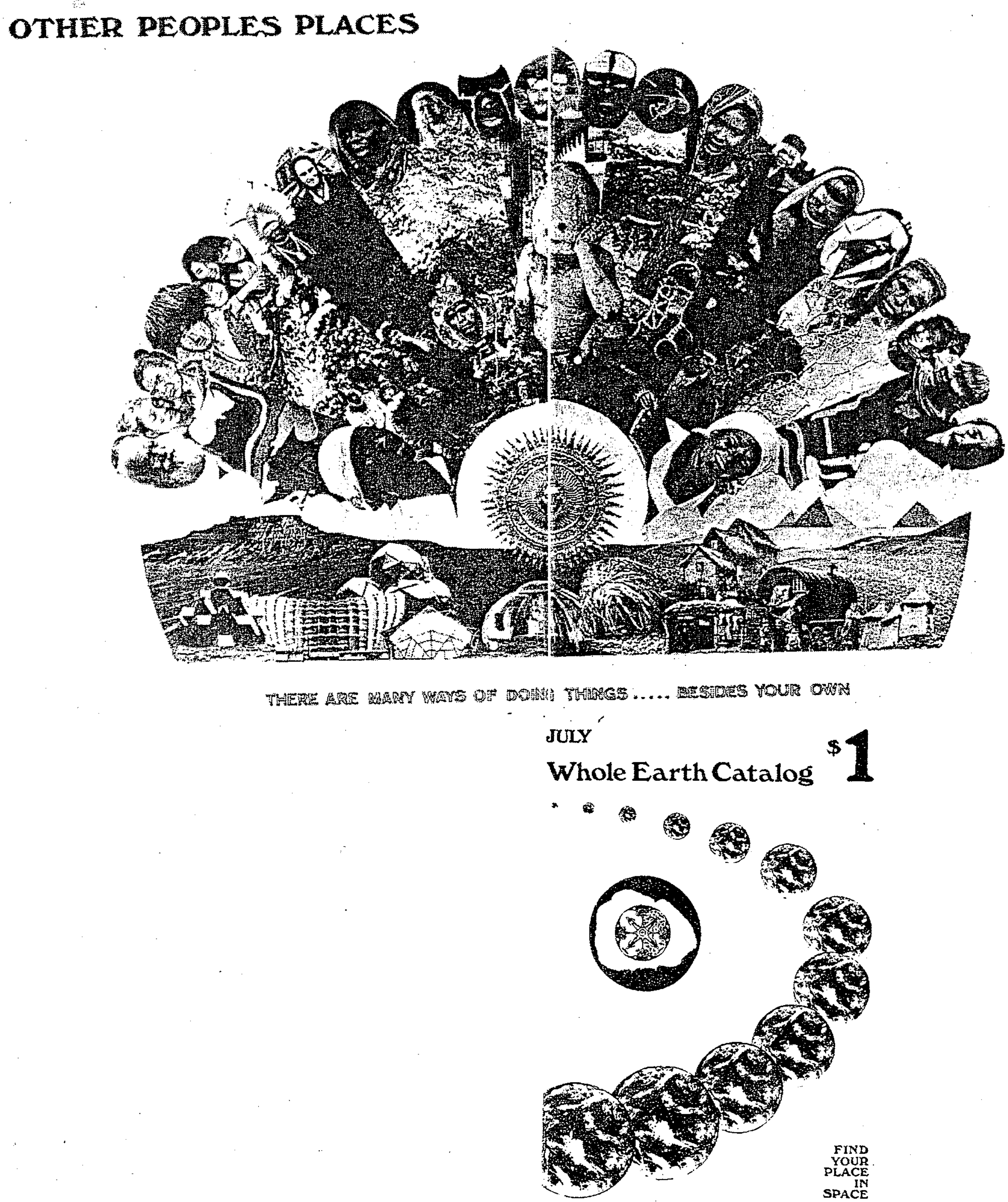
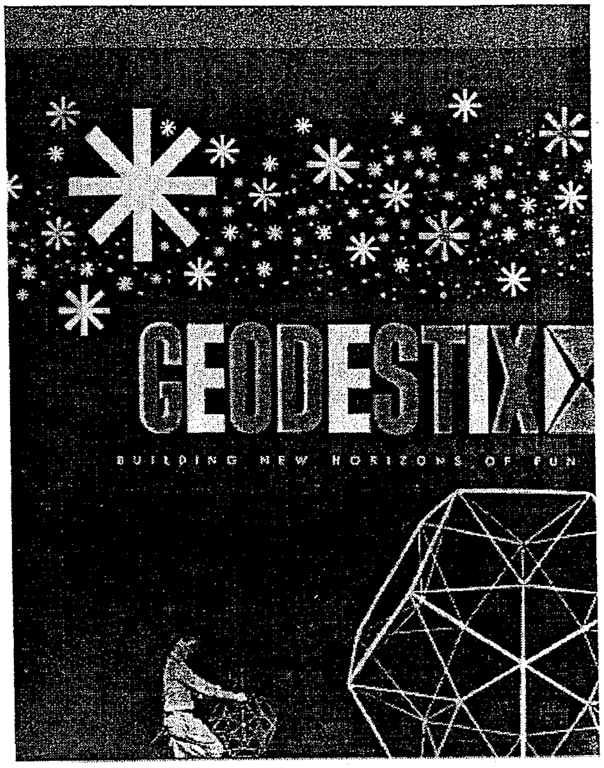
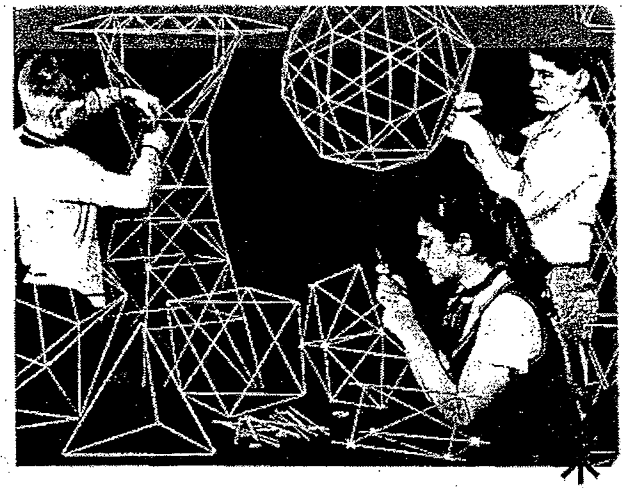


Fig.4.15a Advertisement for "Geodestix," undated. Source: BFI-CR199.
Fig.4.15b Matrix Structures Inc., Advertisement for "Play-dome." Source: BFI-CR191.





AT SCHOOL - AT HOME

BUILD and LEARN

From the time he is taught to cut out paper snow flakes, man is endowed with fascination for geometric designs. And so, GEODESTIX have been created to fill a tremendous scope of interests . . . from play toys for youngsters, to educational kits for hobbyists and schools, to actual tools of architects and structural engineers in ascertaining functionalism and in achieving more aesthetic efficiency in designing and experimenting with futuristic structures.

Solid geometry is as old as Greek Mythology, practically all its theories being developed and systematized thousands of years ago. Yet the application of the principles through the use of GEODESTIX opens new horizons of fun, knowledge and experimentation.

JUNIOR PLAY-DOME

Since the PLAY-DOME made its debut at the Toy Fair last March, we have had many inquiries for a smaller, lighter model suitable for both indoor and outdoor play and sized for easy use by the smaller fry.

Your interest in the original PLAY-DOME makes us feel sure that you will be glad to hear of the arrival of the JUNIOR PLAY-DOME and our special introductory offer.

The JUNIOR PLAY-DOME when assembled is eight feet in diameter and four feet high — so can comfortably fit into most playrooms.

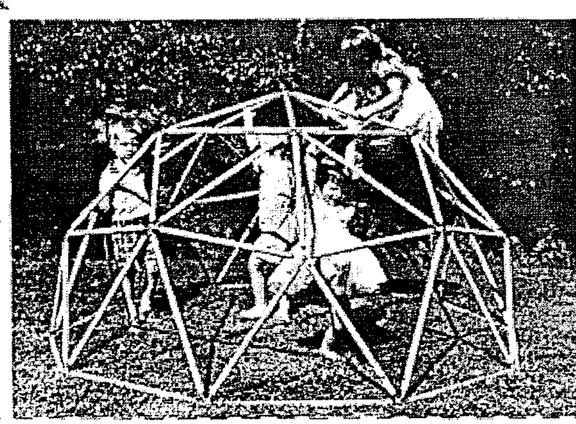
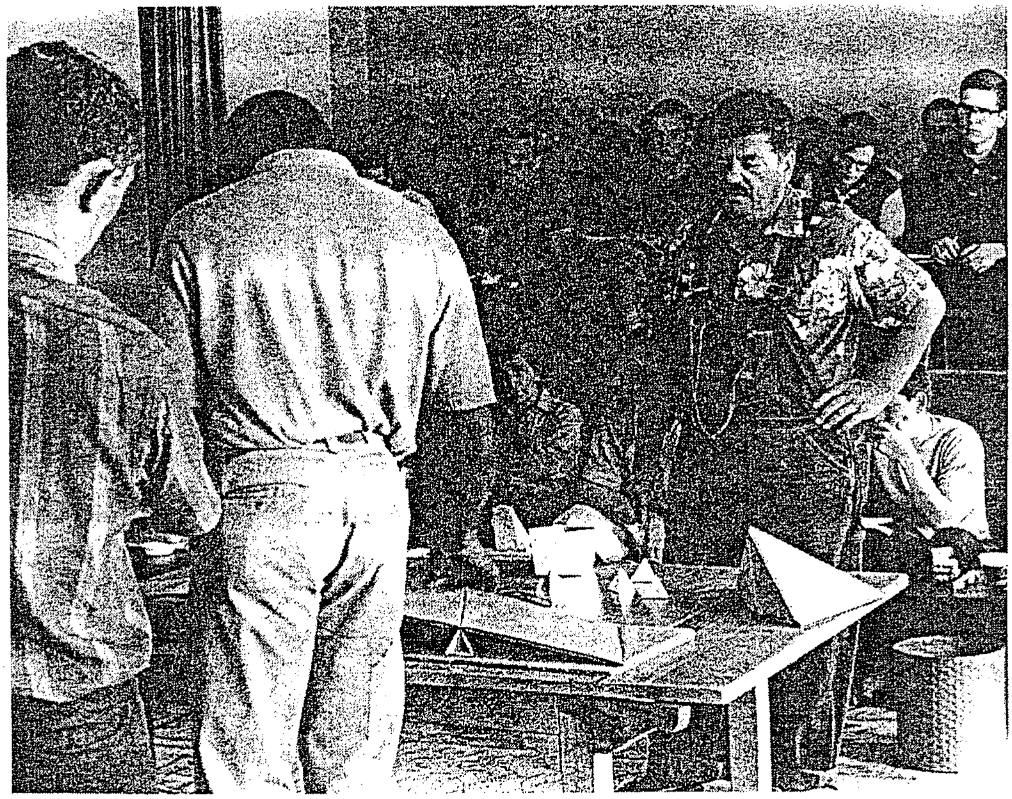


Fig.4.15c Fuller and children in Classroom at San Jose University-Children's Lab., ca. March. Source: BFI-G84 Box.

Fig.4.16a Chuck Dederich, founder of Synanon Foundation Inc. experimenting with Fuller's tensegrity structures. Source: BFI-CR332.



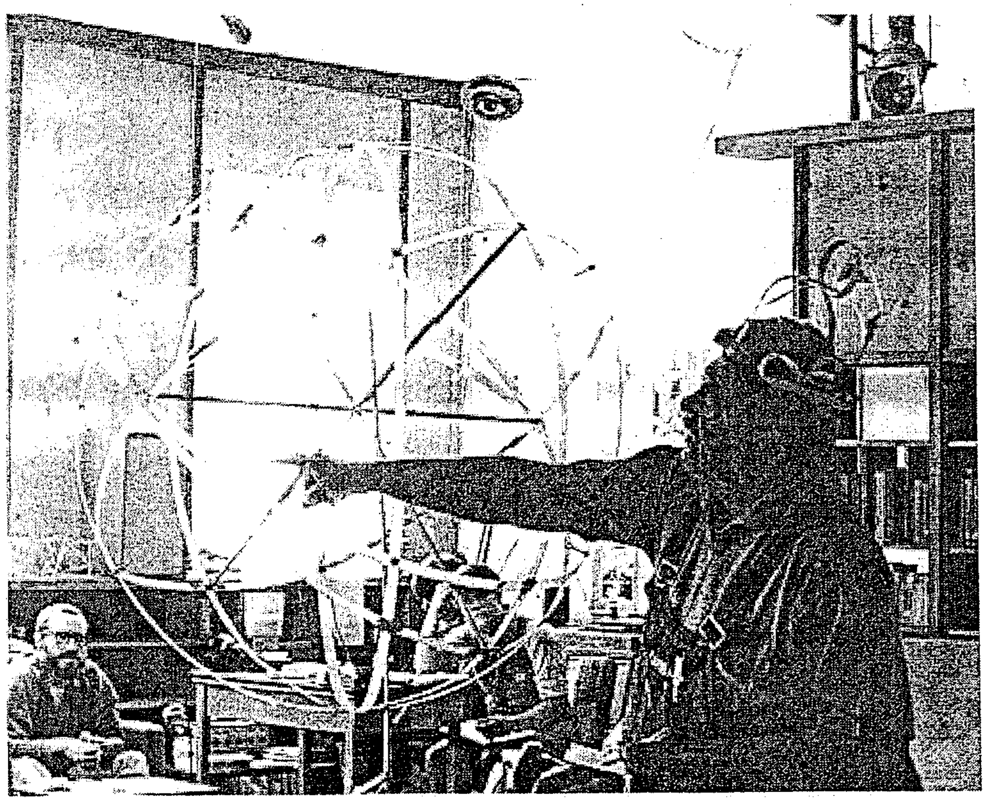


Fig.4.17a US Pavilion for Montreal-Expo'67, October/November 1964. Source: J. Ward., ed., The Artifacts of R. Buckminster Fuller, Vol.4, pp.55-60.

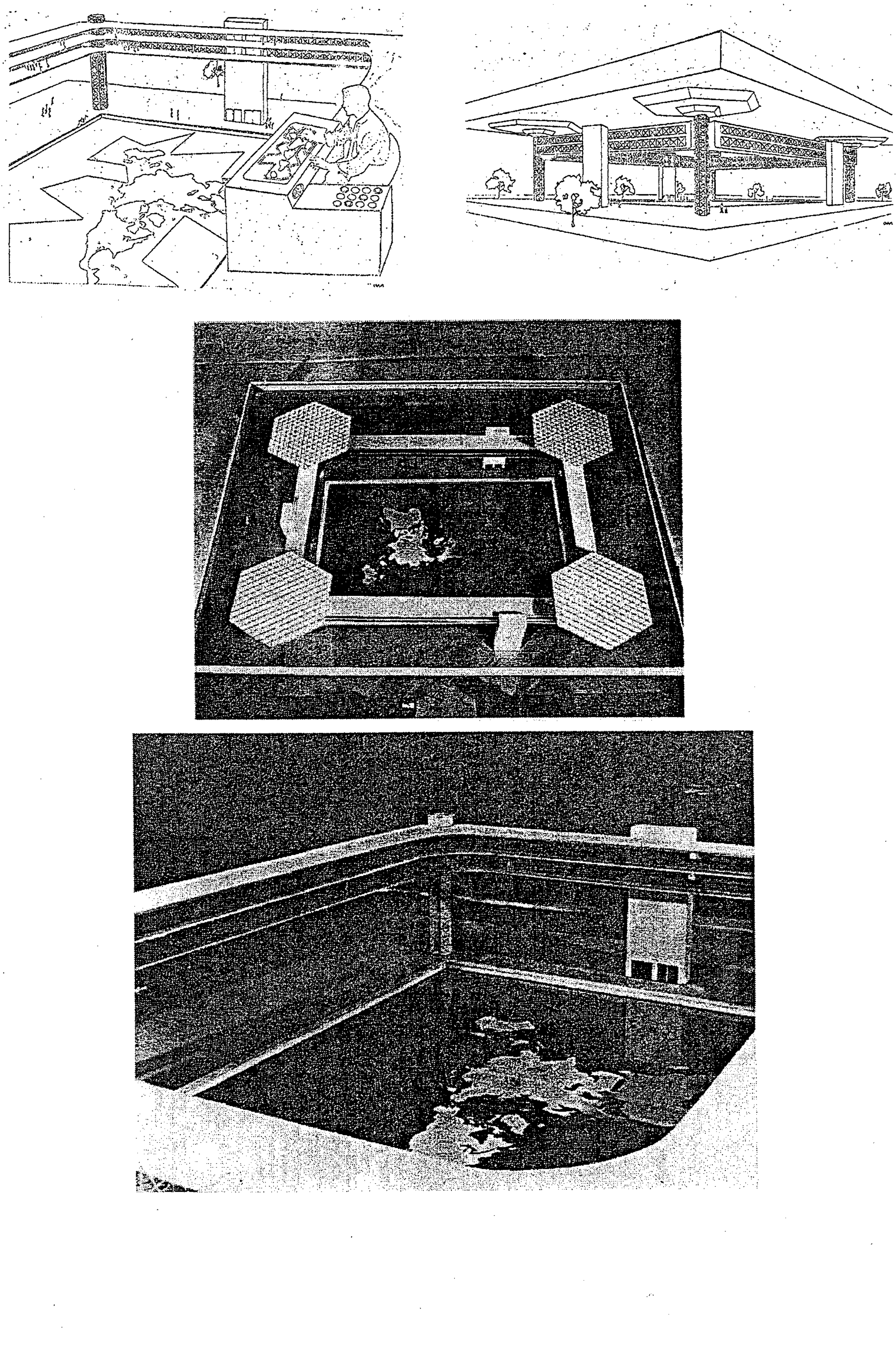


Fig.4.17b US Pavilion for Montreal-Expo'67, version in tensegrity-octahedron, ca. December 1964. <u>Source:</u> Memorandum of Cambridge Meeting, 12/29/64 on US Pavilion for Montreal 1967 World's Fair in BFI-CR265.

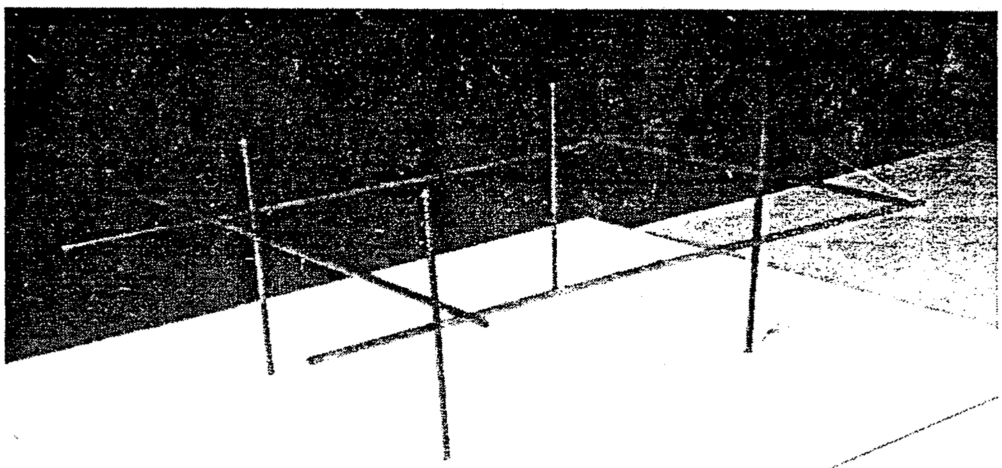


Fig.4.17c Sketch for two versions of 8-frequency truncatable tensegrity octahedron (triple and double bonded), for the American Pavilion-Montreal Expo'67, undated c. 1965. Source: BFI-CR266.

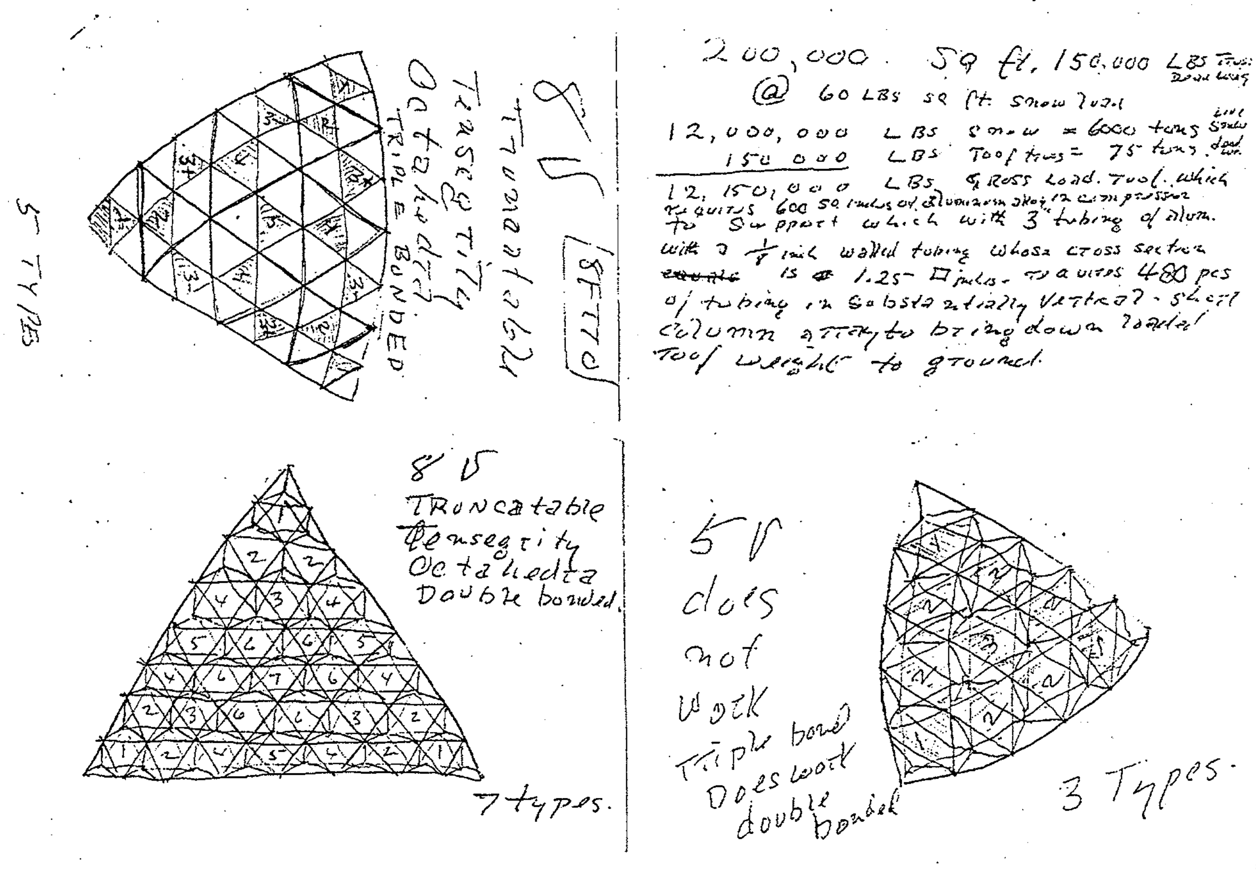
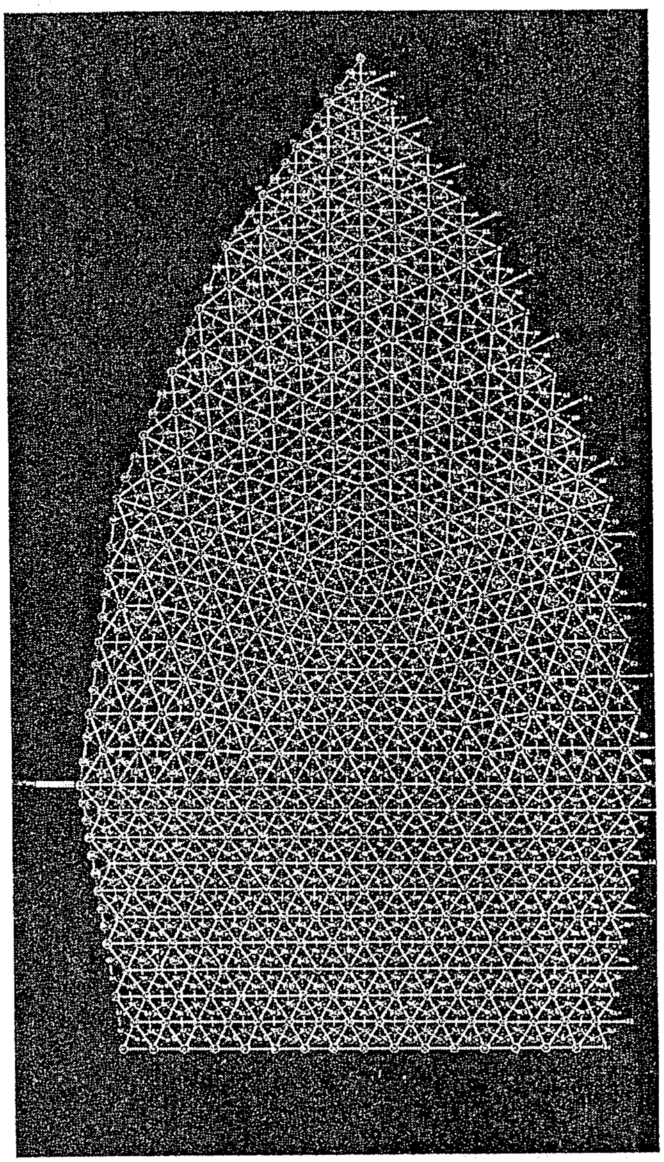
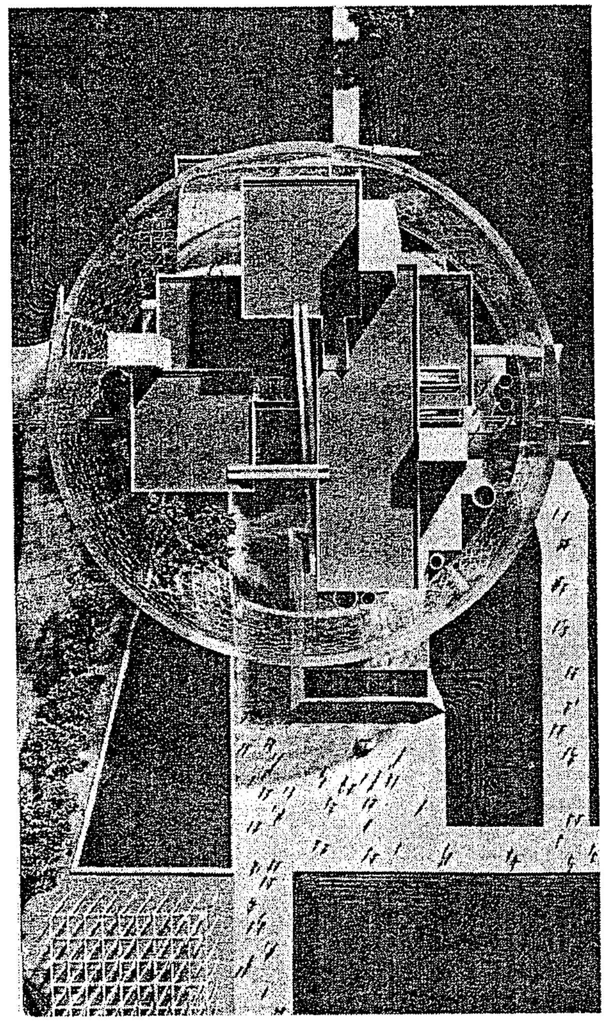
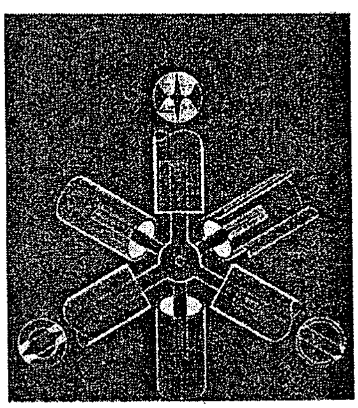


Fig.4.18a Model & details, American Pavilion at the Montreal-Expo'67. Source: "Bucky's Biggest Bubble", *The Architectural Forum*, June 1966.







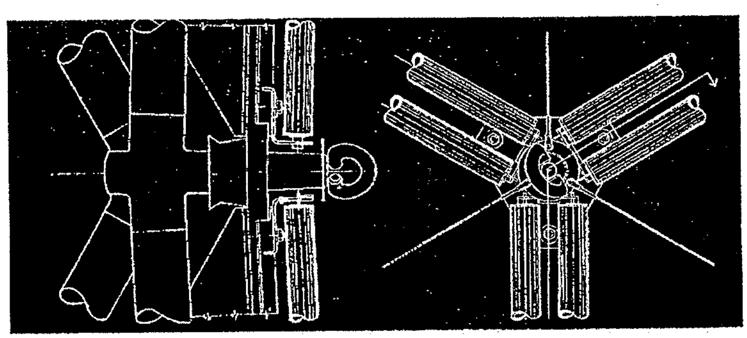
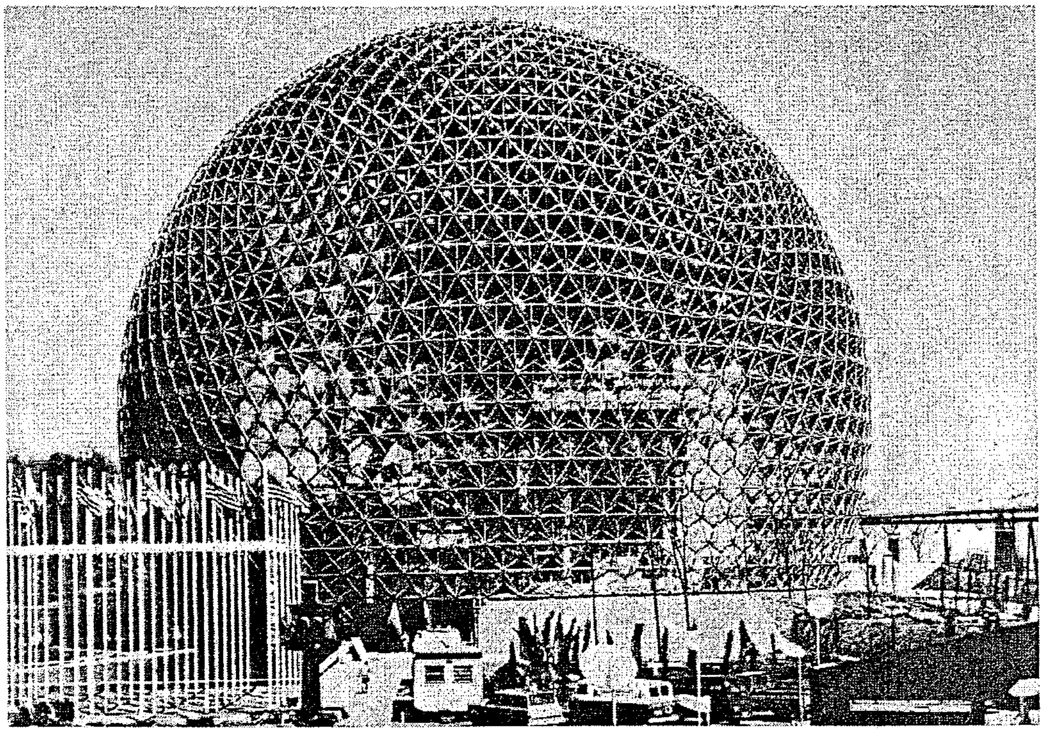


Fig.4.18b **.1:** Exterior view, American Pavilion at the Montreal-Expo'67.; **.2:**Interior, American Pavilion at the Montreal-Expo'67. Source: AD, July 1967.



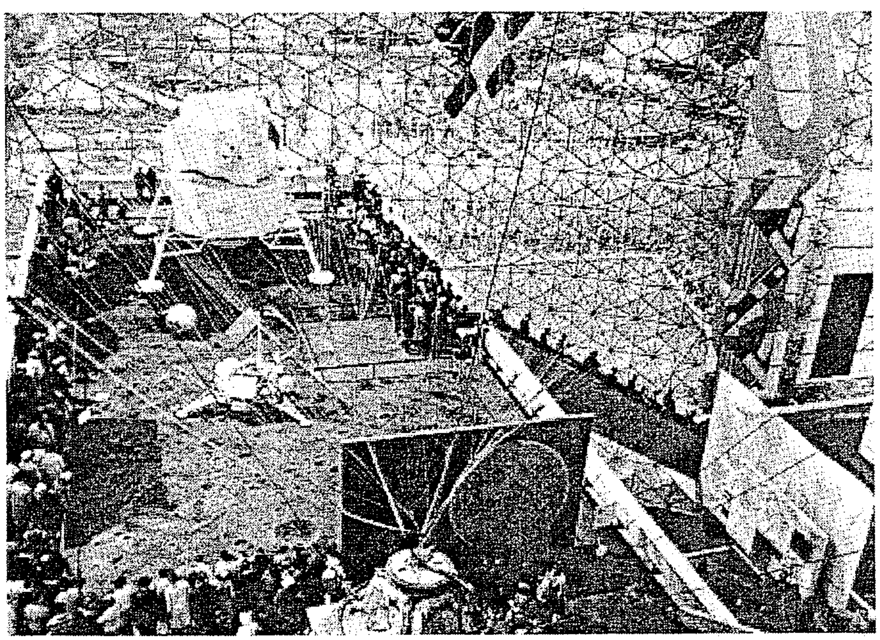
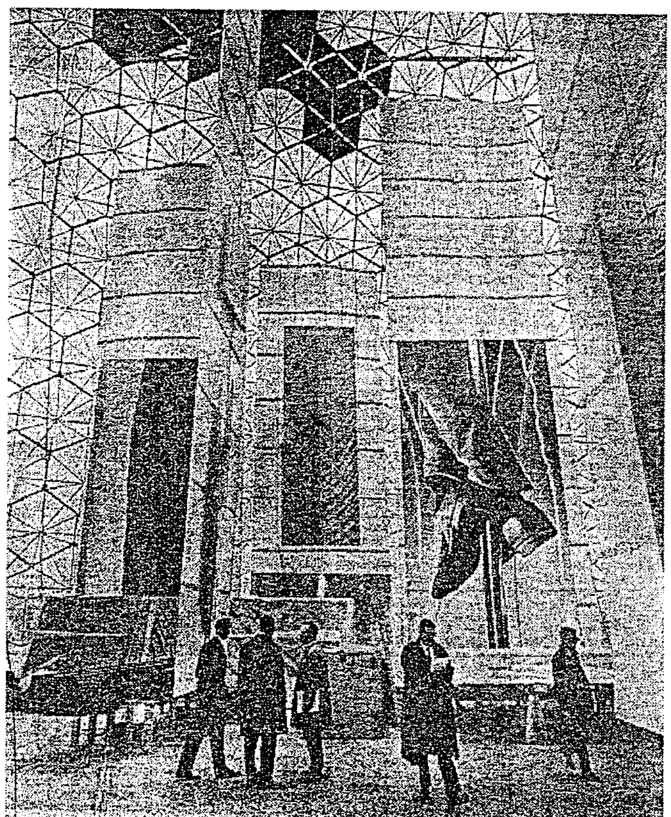


Fig.4.19a Interior, American Pavilion at the Montreal-Expo'67. <u>Source:</u> "Letters: Divergent Views About Expo 67," *The New York Time*, Sunday June 4, 1967.

Fig.4.19b Interior, American Pavilion at the Montreal-Expo'67. <u>Source:</u> "Exorcism in Montreal," *The New York Times*, Sunday 30 April '67.

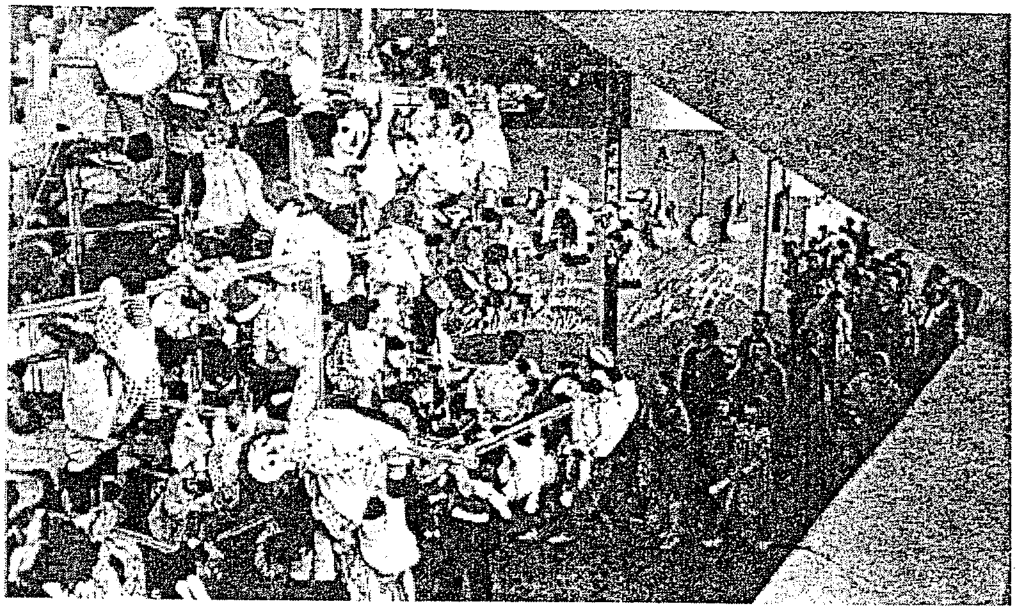
CONTROVERSIAL—Photographs of Hollywood film stars are a major feature of United States Pavilion at Expo 67. Object at upper right is a Mercury space capsule suspended from the roof of the geodesic dome.



"American Painting Now" during installation in Montreal

James Rosenquist's "Firepole" is a guest in what amounts to a clubroom for an American clique.

Fig.4.19c	Ragdolls at the American Pavilion at the Montreal-Expo'67. Source: St. Louis Post Dispatch, 28 May 1967, p.5.
Fig.4.19d	Cartoon commentary, American Pavilion at the Montreal-Expo'67 - Apollo capsule. <u>Source:</u> "Sour Note at Expo'67," *The Knoxville News-Sentinel* 11 June '67.



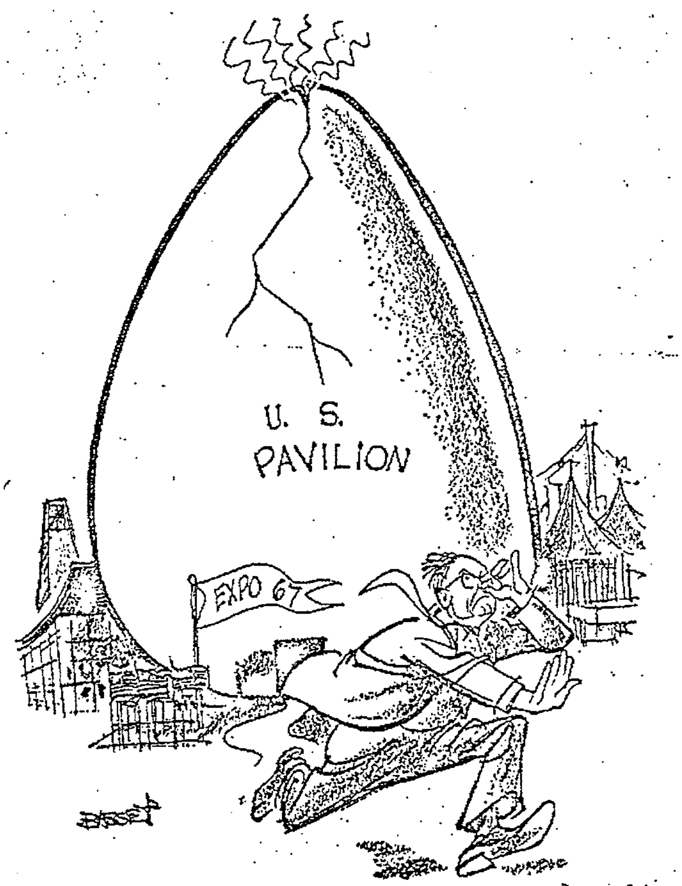


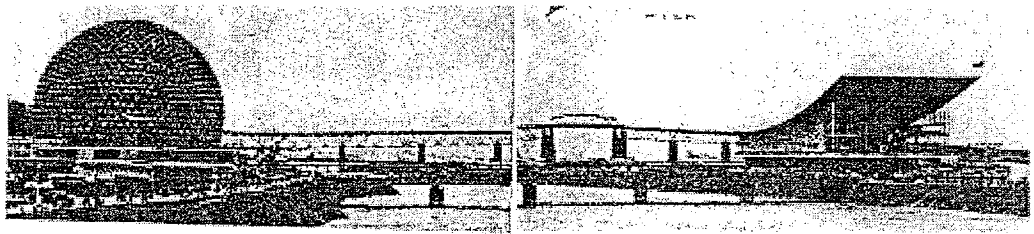
Fig.4.20a American and Soviet Pavilions at the Montreal-Expo'67. Source: "Another US-Russian Contest : Exhibits at Expo 67", *US News and World Report.*

Fig.4.20b American and Soviet Pavilions at the Montreal-Expo'67. Source: Architectural Forum May 1967, p.55.

U.S. News & World Report

LIFE AROUND THE WORLD

ANOTHER U.S.-RUSSIAN CONTEST: EXHIBITS AT EXPO 67



The huge American dome, 20 stories high, and . . . . . . across a river channel, the Russian pavilion

—Canadian Government Photo

[illegible] that are stirring up comment and controversy at the world's fair.

The Soviet display has been called "a cluttered department store," where the Russians, using a hard sell, are trying to present a soft picture of life in their homeland.

An American critic has described the U.S. show as "a non-helpful theme carried [illegible]

Here, the Soviet Union and the United States are as far apart at Expo 67 as they are in ideology.

Where the U.S. uses "op" and "pop" art, Hollywood faces and such memorabilia as the guitar of Elvis Presley, the Russians use conventional displays of [illegible] planes, and industrial models dressed up with moving parts and flash.

[illegible] is covered with an acrylic skin that glitters in the daytime and glows at night.

The display inside was put together by the Cambridge Seven Associates, a firm of designers chosen by the U.S. Information Agency.

There is a space exhibit featuring two [illegible], both [illegible] from actual [illegible]

[illegible] and a collection of "[illegible] Ann" dolls. The Hollywood section has blowups of famous movie stars and pin-up pictures.

The U.S. exhibit uses no charts, graphs or working models. It has no written messages longer than 30 words except for a welcoming statement from President Johnson.

Fig.4.20d American and Soviet Pavilions at the Montreal-Expo'67. Source: "An Expo Named Buckminster Fuller", *New York Time Magazine*, 5/23/67, p.81.

Fig.4.20c American and Soviet Pavilions at the Montreal-Expo'67. Source: "Cold War is Thawed at Canada's Expo 67", New York & Brooklyn Daily, 7/19/67.

Cold War Is Thawed At Canada's Expo 67

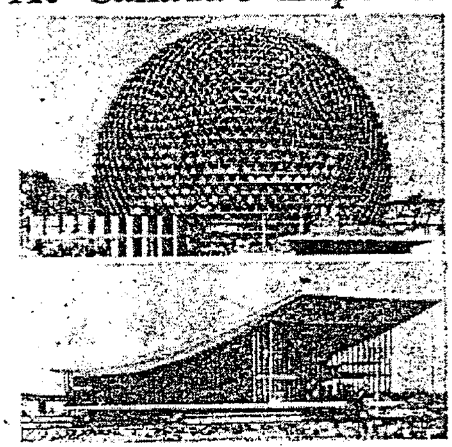
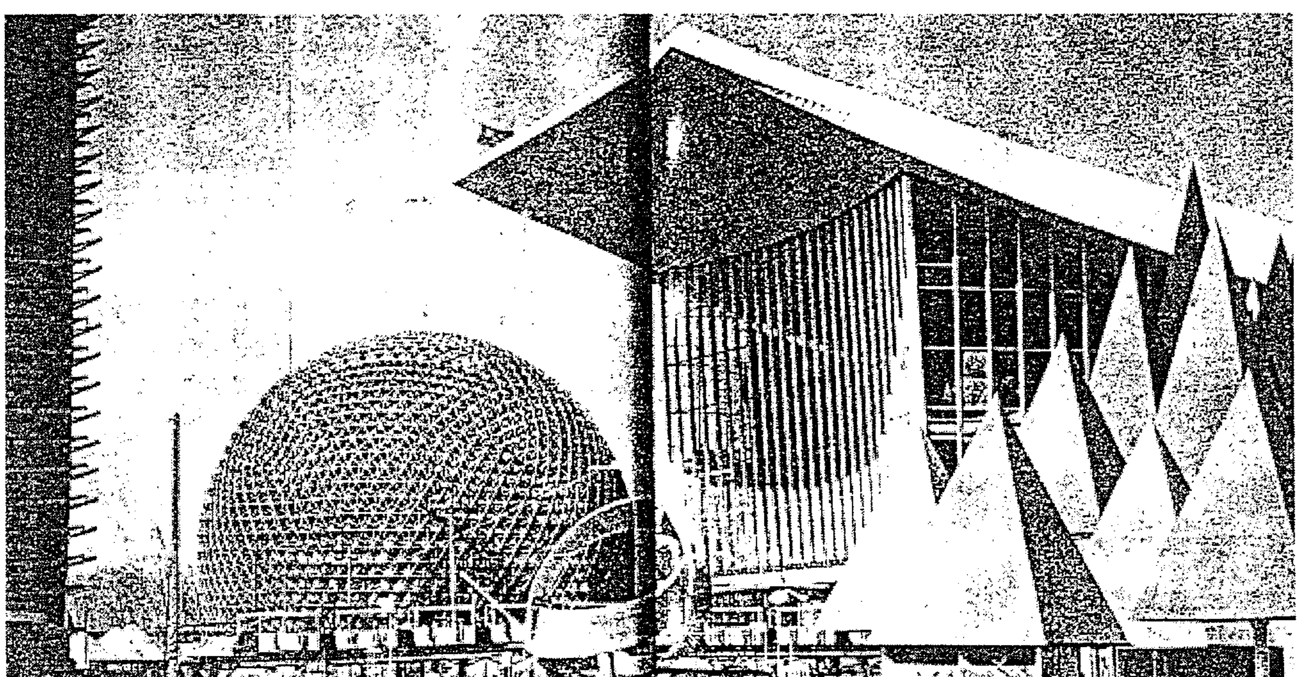


Photo-Feature By Frank Kuchirchuk



FULLER'S "SKYBUBBLE" — The U.S. exhibit at Montreal's Expo 67. Its "skin" interacts with the weather and changes color. Right, Russia's pavilion and a Canadian exhibit (peaked roofs).

Fig.4.20e Pavilions of the Eastern bloc countries, at the Montreal-Expo'67. Source: *Montreal Expo' 67 Terre des Hommes,* Banque Nationale de Paris, pp.48-49.

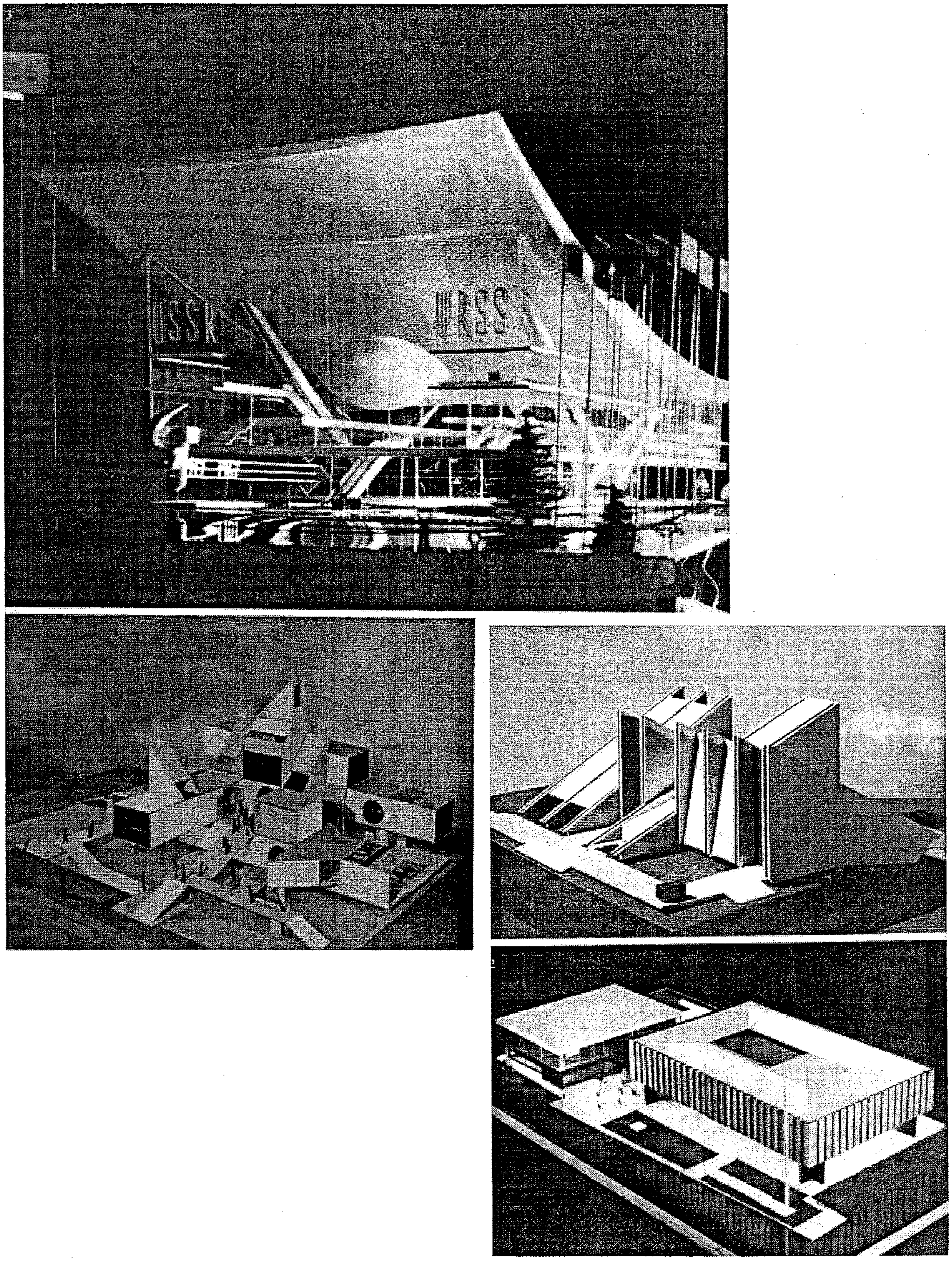
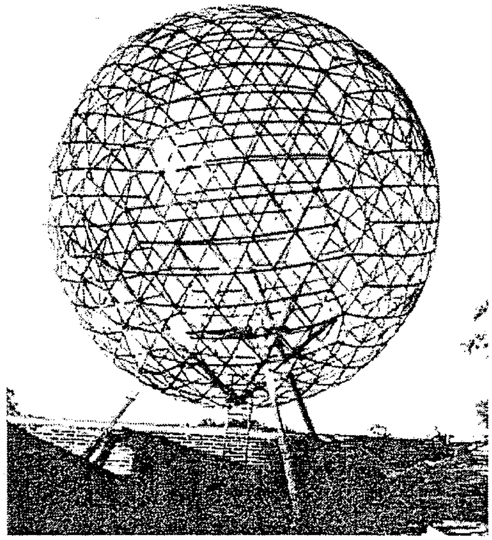


Fig.4.21a 20-foot diameter Miniature Earth dome, assemblage on top of Rand Hall, Cornell University 1952.
Source: BFI- Photo C-5-1 Series.



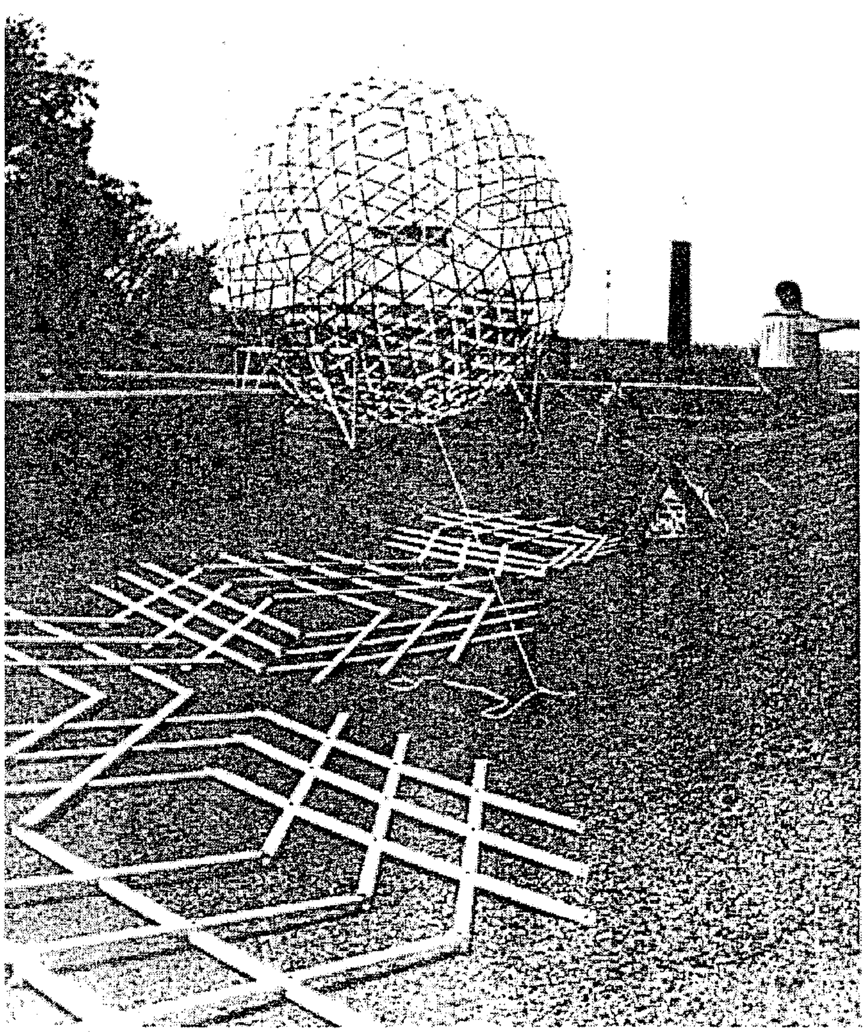


Fig.4.21b Miniature Earth dome project at University of Minnesota (with R. Rapson), 1954-156. Source: BFI-Photo M-25-1 & M-25-8 Series.

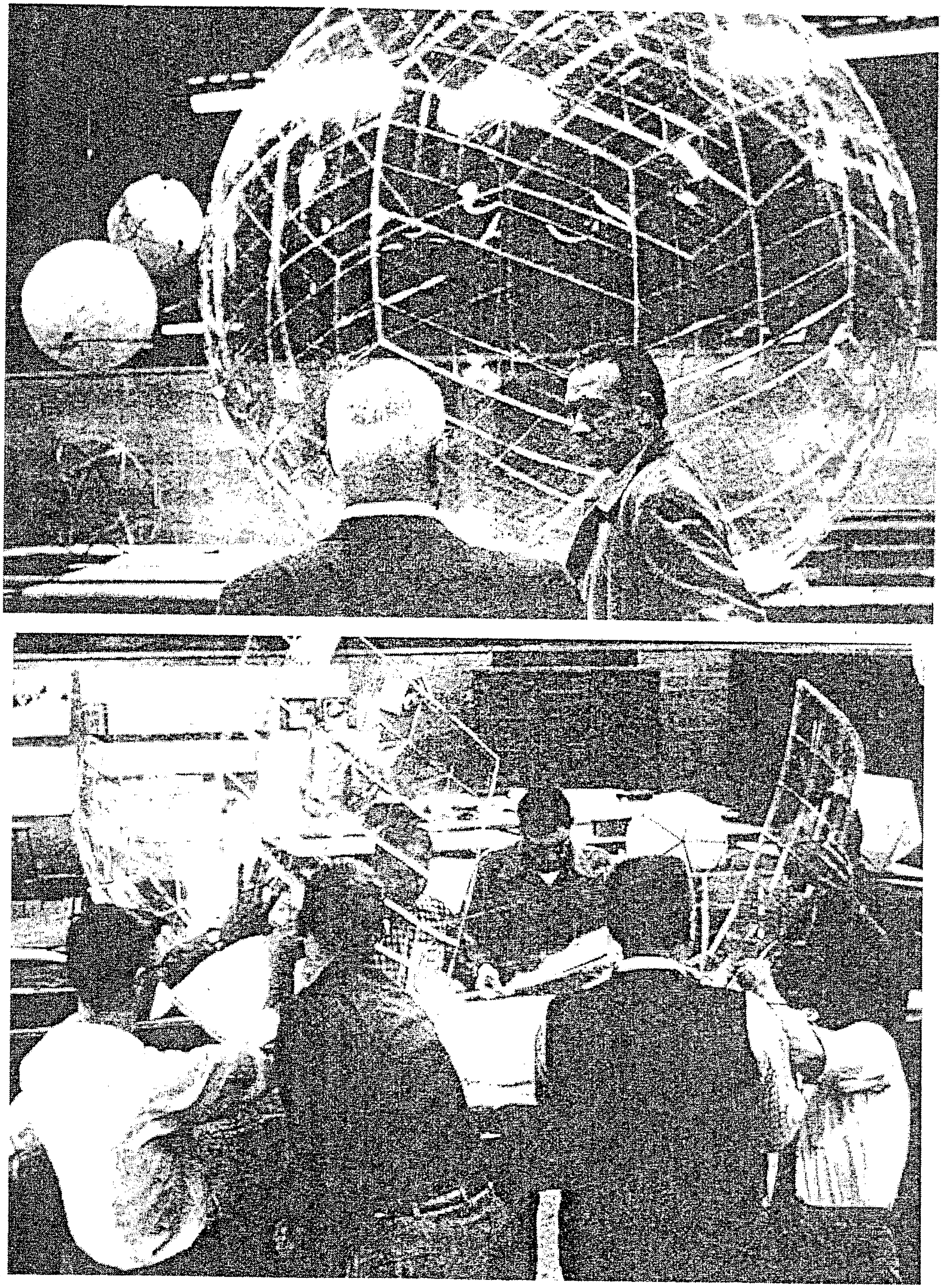


Fig.4.21c 200-ft diameter Miniature Earth dome on masts, at United Nations-Blakewell Ledge's-East River, New York City, by Winston Wedin, ca. 1956. <u>Source:</u> BFI- Photo G-7-1 Series.

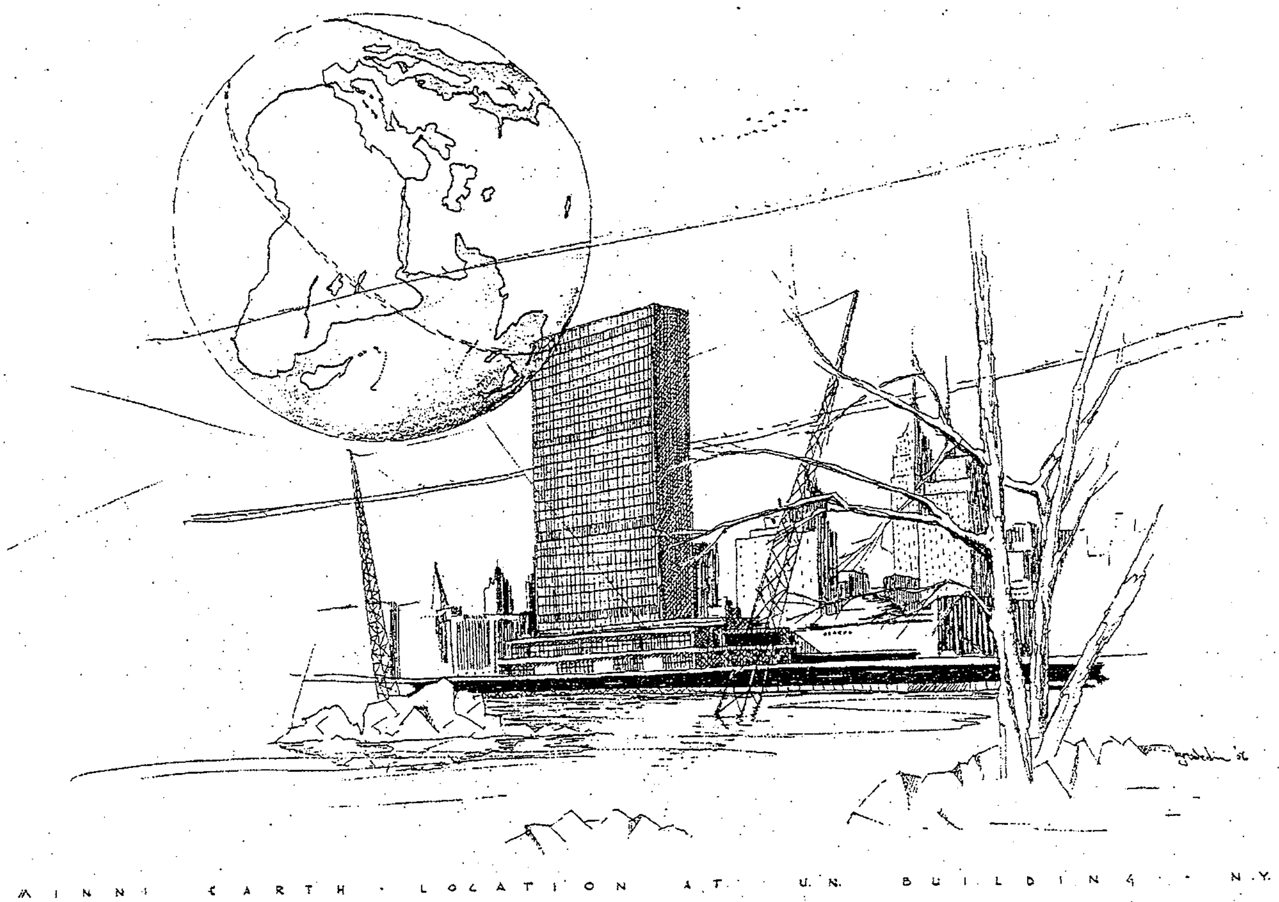


Fig.4.21d 7-m diameter Geoscope, at University of Nottingham, England, ca. July 1961 (in conjunction with IUA World Congress-London). Source: BFI- Photo G-11-1 Series.

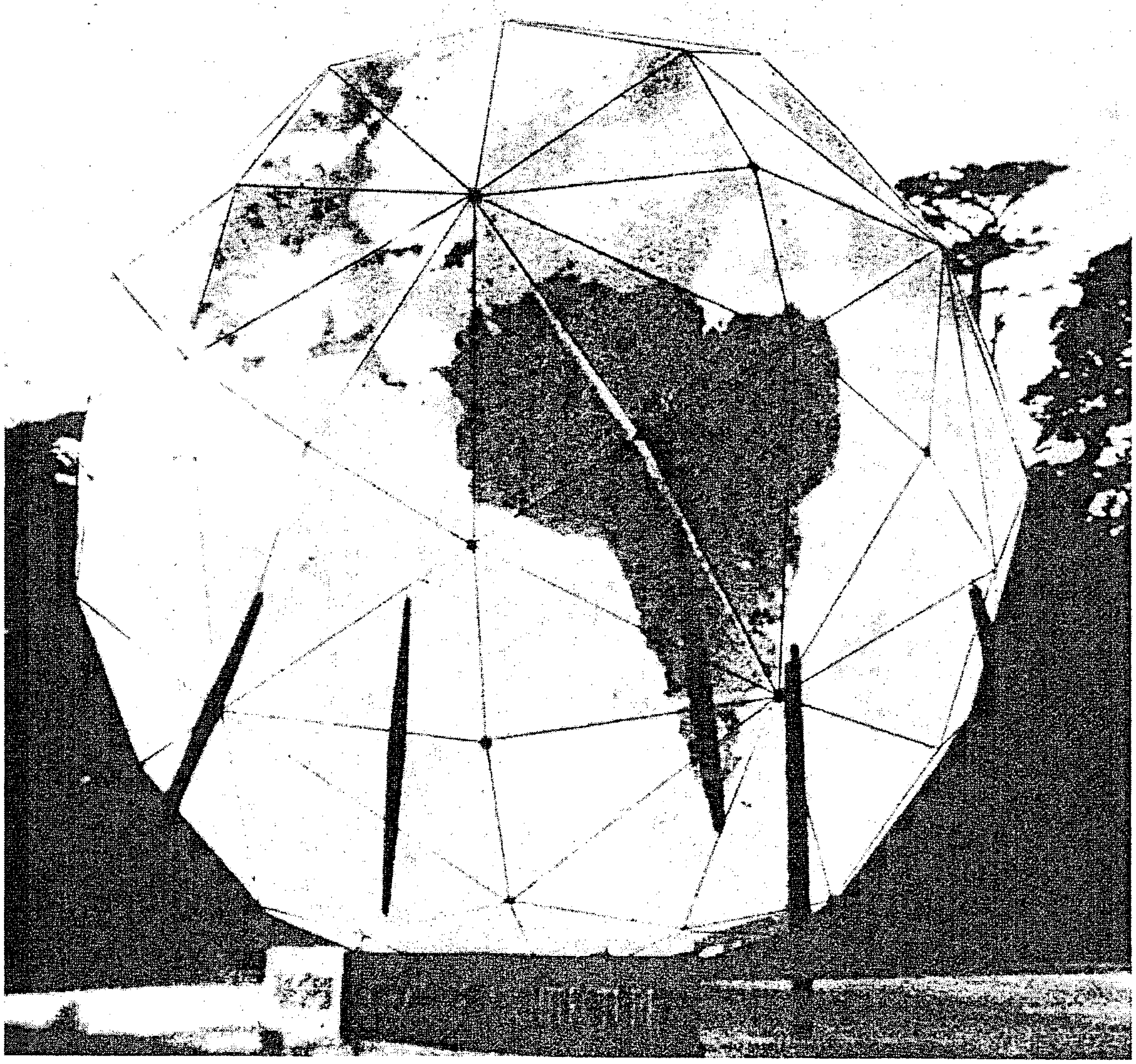


Fig.4.21e IUA World Congress-Paris, Fuller with J. McHale and B. Zevi, 1965. Source: BFI- Photo W-10-5 Series.

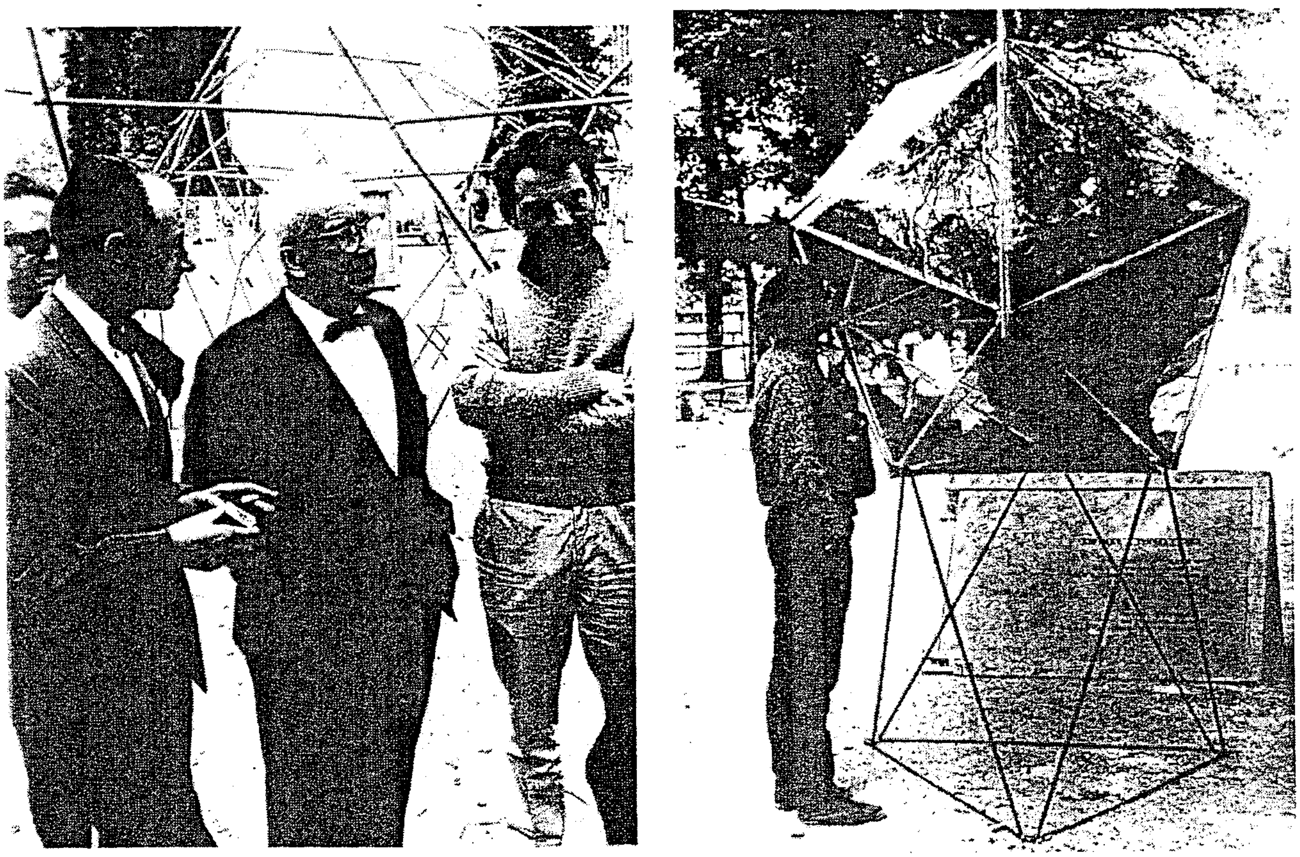


Fig.4.21f Peter Flyod's "Brussels Fair Globe: Geoscope" for a Nuclear Energy Display, ca. December 1957. Source: BFI-CR191.

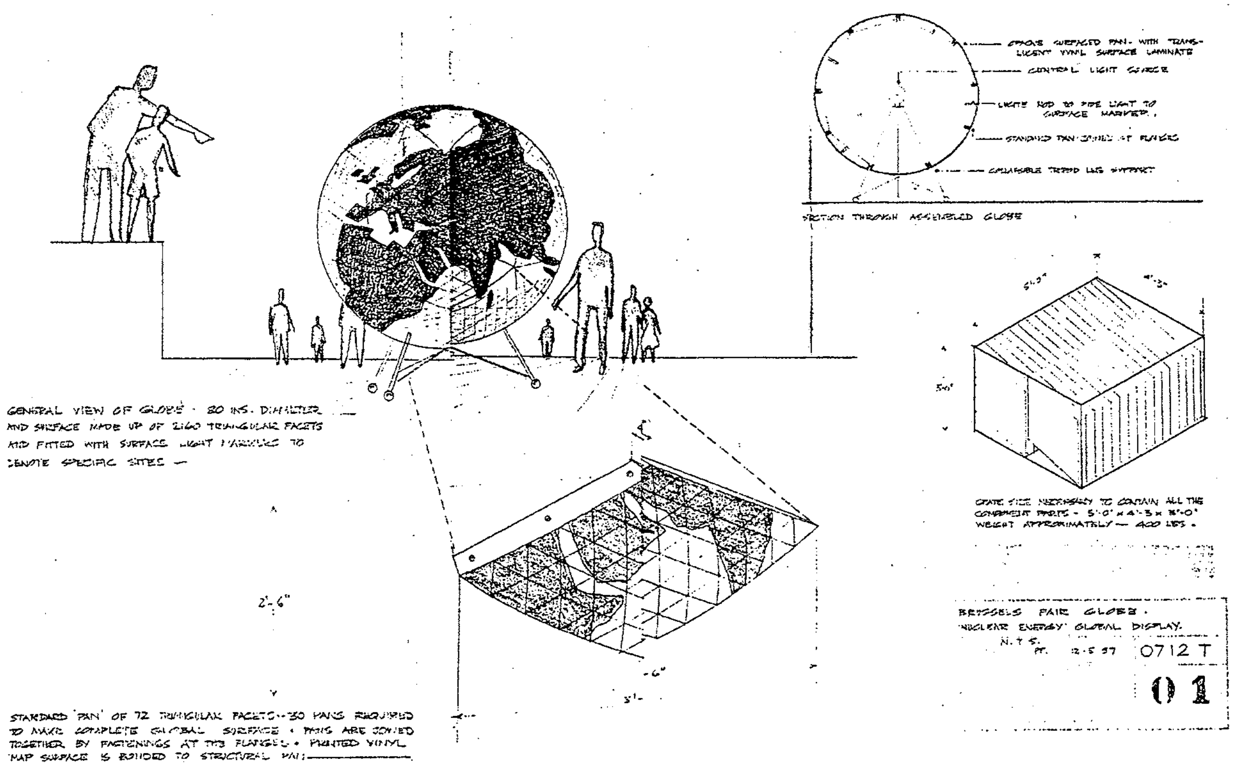


Fig.4.22a 600-ft diameter geoscopes, possibly for New York World's Fair 1964 , designed by J W Fitzgibbon, March 1960. <u>Source:</u> BFI- [?]

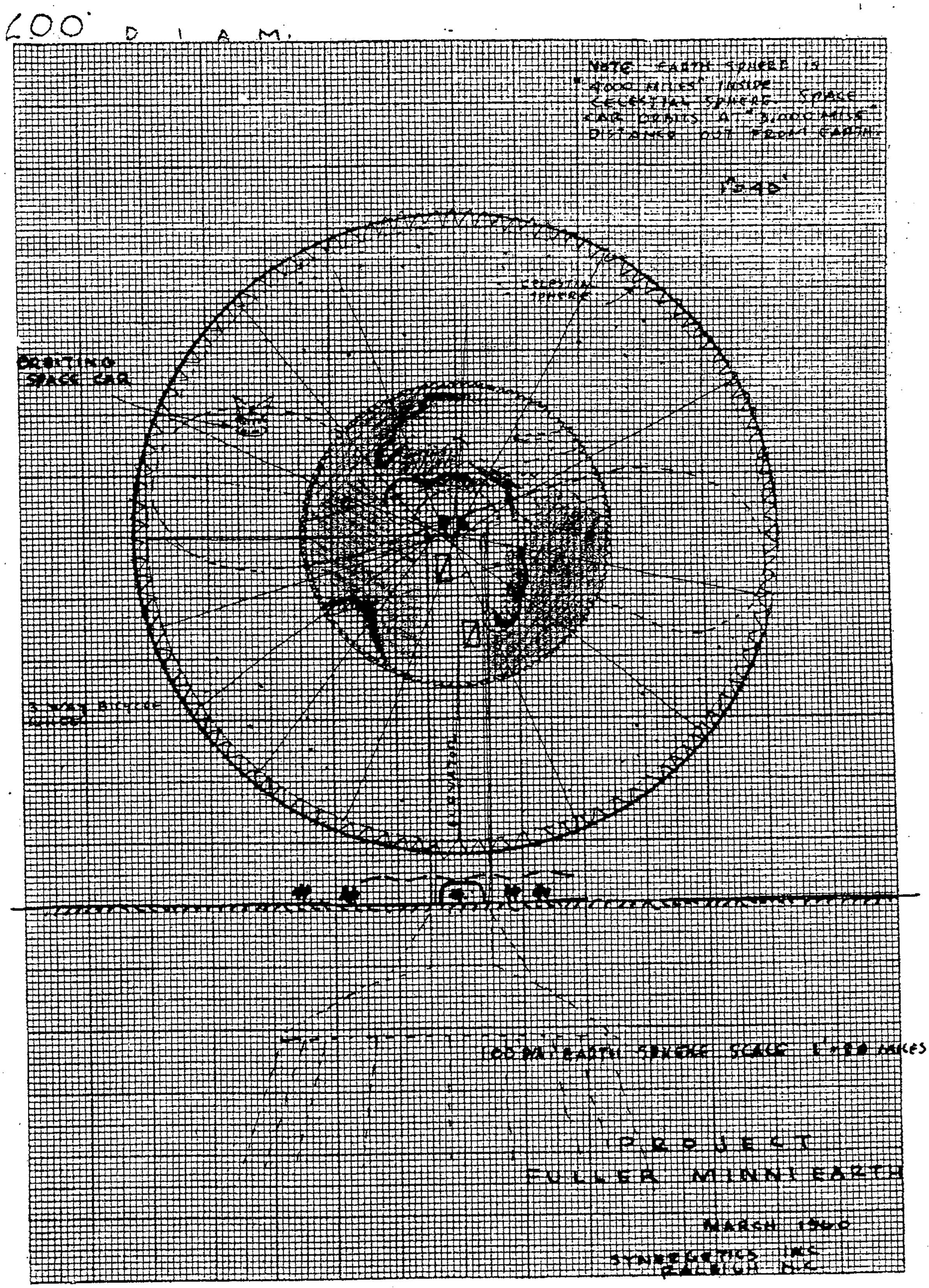


Fig.4.22b 200-ft diameter geoscope, possibly for New York World's Fair 1964 designed by J W Fitzgibbon, March 1960. Source: BFI- [?]

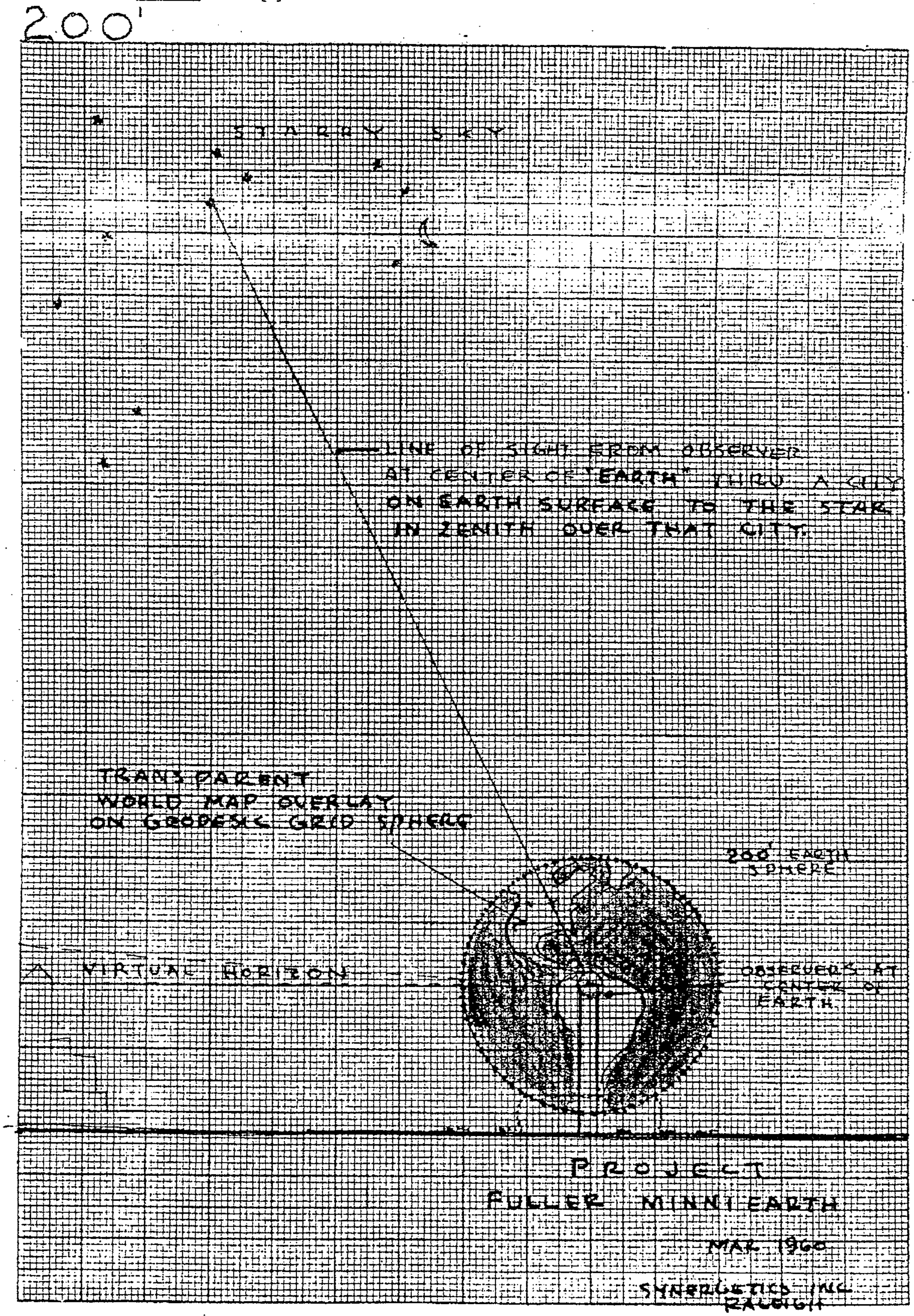
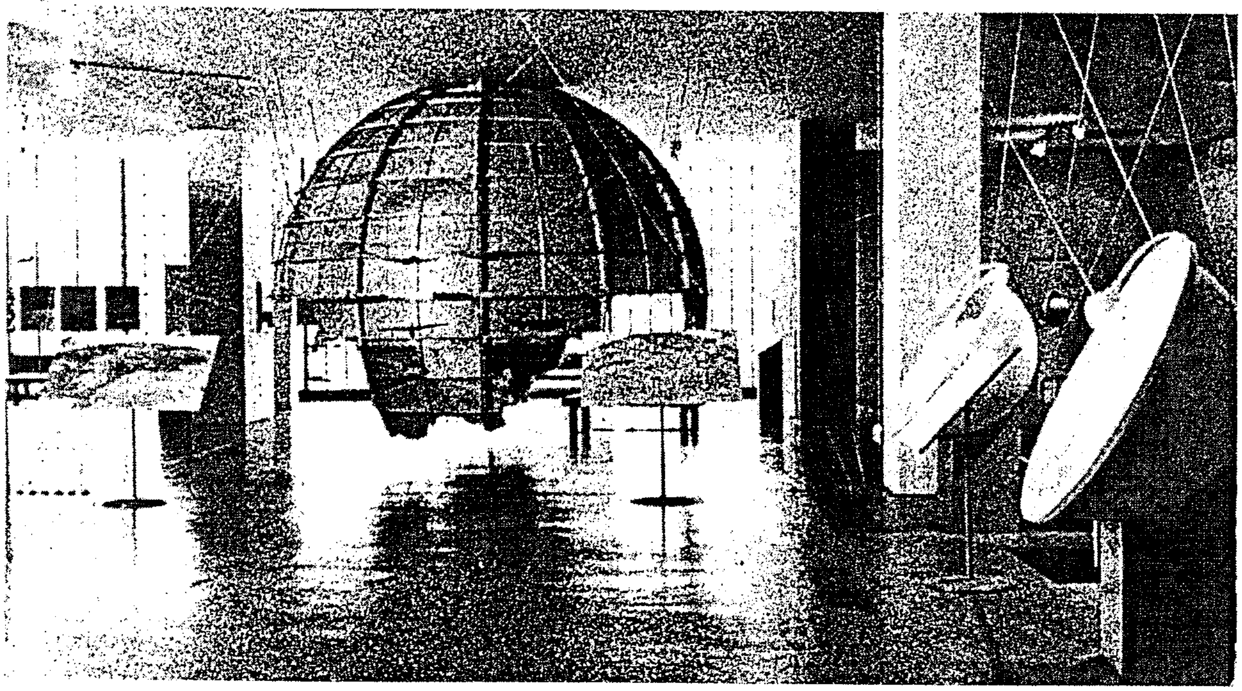


Fig.4.23a .1 : Herbert Bayer's "Airways to Peace. An Exhibition of Geography of the Future" at MoMA in August 1943; .2: 15-foot diameter, "Outside-in walk-in" demountable globe focal exhibition. Source: Herbert Bayer, Painter, Designer , Architect, pp.57-58.



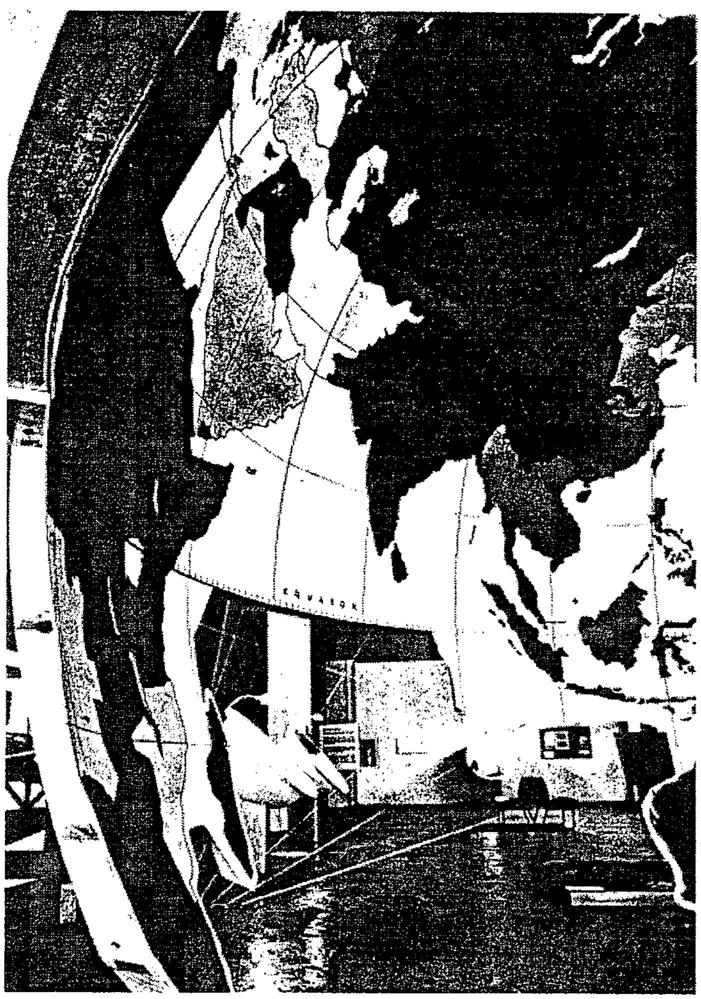
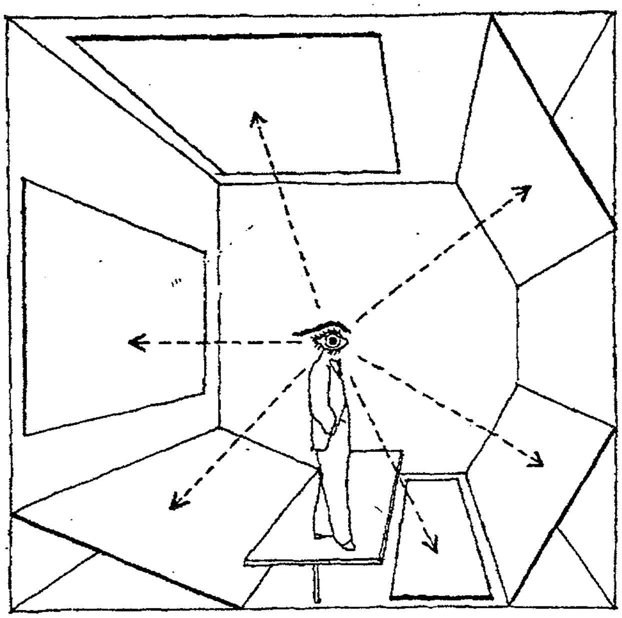


Fig.4.23b Herbert Bayer's 360-degree field of vision diagram for "Road to Victory" exhibition, 1930. Source: Arthur Cohen, Herbert Bayer, the Complete Work, MIT Press 1984, p.306.



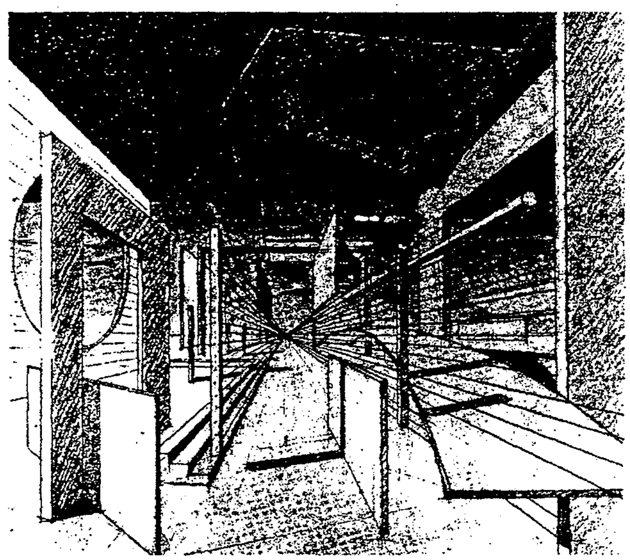
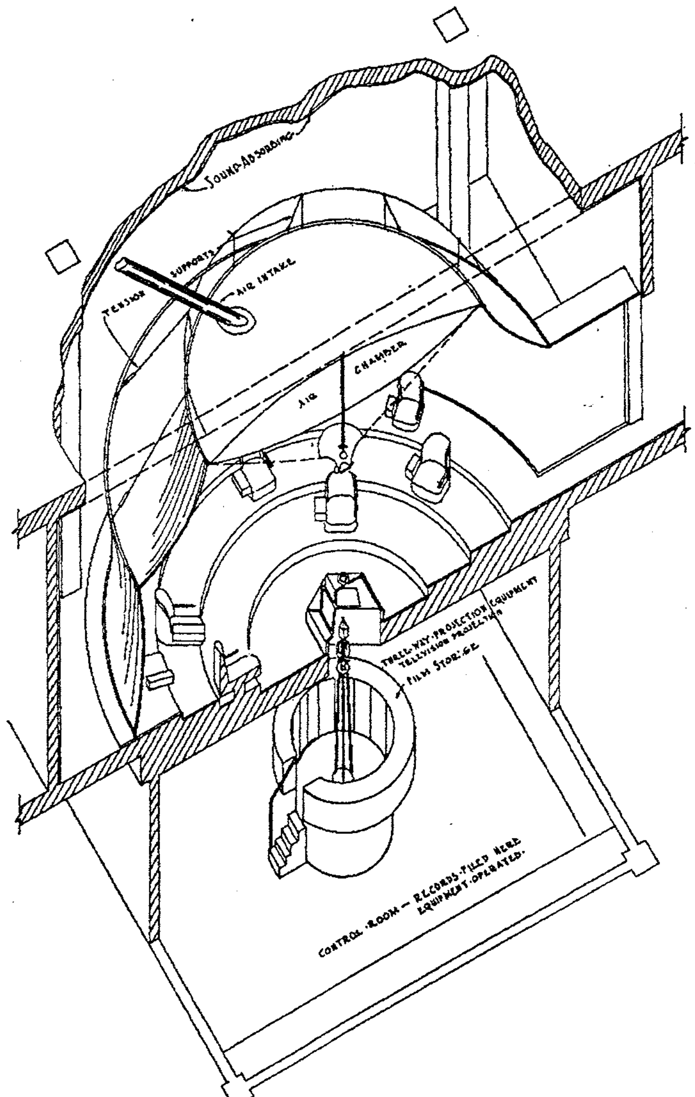


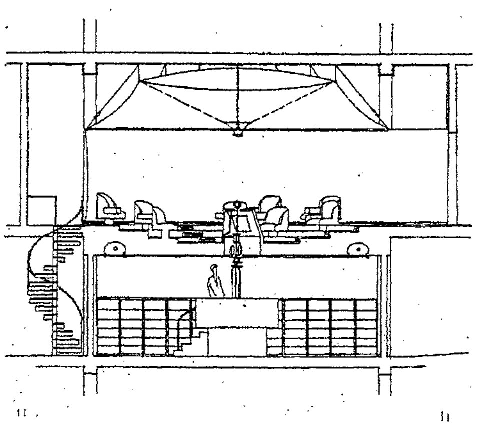
Fig.4.24 Axonometric of Fuller's Industrial Conning Tower, Source: *Shelter*, November 1932, p.65.

A mechanical layout for the new "industrial conning towers", showing how, with currently available mechanics, information routing and correlating activity in general may be expedited with a hitherto incredible acceleration, accuracy, and lack of human effort. For instance, it is suggested that all industrial headquarters be equipped with a conference room, to be designed as the 4D "Hoop Skirt" for broadcasting stations as compounded with the latest mechanics of movie headquarters, that all conferences may be recorded by film, visually and orally. The duplication to be eliminated by such mechanics is extraordinary. Conferees who tend to recite acknowledged history, convergent in the specific conference involved, may rapidly be enlightened by a talkie, quite interestingly runnable in a few moments, as the net result of hours of conferences in which there is multitudinous lag for cigarette lighting, banalities, etc. There could be mechanical hook-ups of industrial unit production headquarters by teletype, telephoto and television with central publishing headquarters of industrial units, who in turn would be tactically hooked up in like manner with information sources such as Bureaus of Standards, Navigation, Department of Commerce, etcetera or corporations such as Standard Statistics, Consumers' Research, Science News Service, etcetera, as well as university hook-ups.

The conning tower is free of private records, superfluous accounting, check-up methods, etcetera, as the "bridge" of a giant liner or dreadnought, with simple "log" or "continuity notes" of O. D. Economic and elemental mechanical indicating and reporting systems of universal interest are incorporated, such as intramurally integrated ticker services, weather forecasting instruments, economic traffic indicators, elemental availability indicators, storage indicators, storage pile-up indicators, dominant news indicators, harmonic trend indicators.



· ISOMETRIC -- CONFERENCE ROOM ·



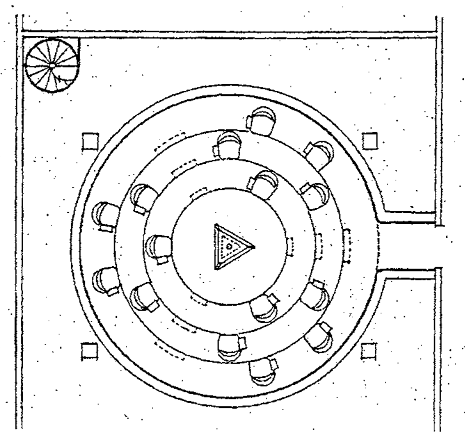


Fig.4.25 Fuller's charting skills for Fortune 10th anniversary copy. Source: Fortune, February 1940, Vol.XXI, #2.

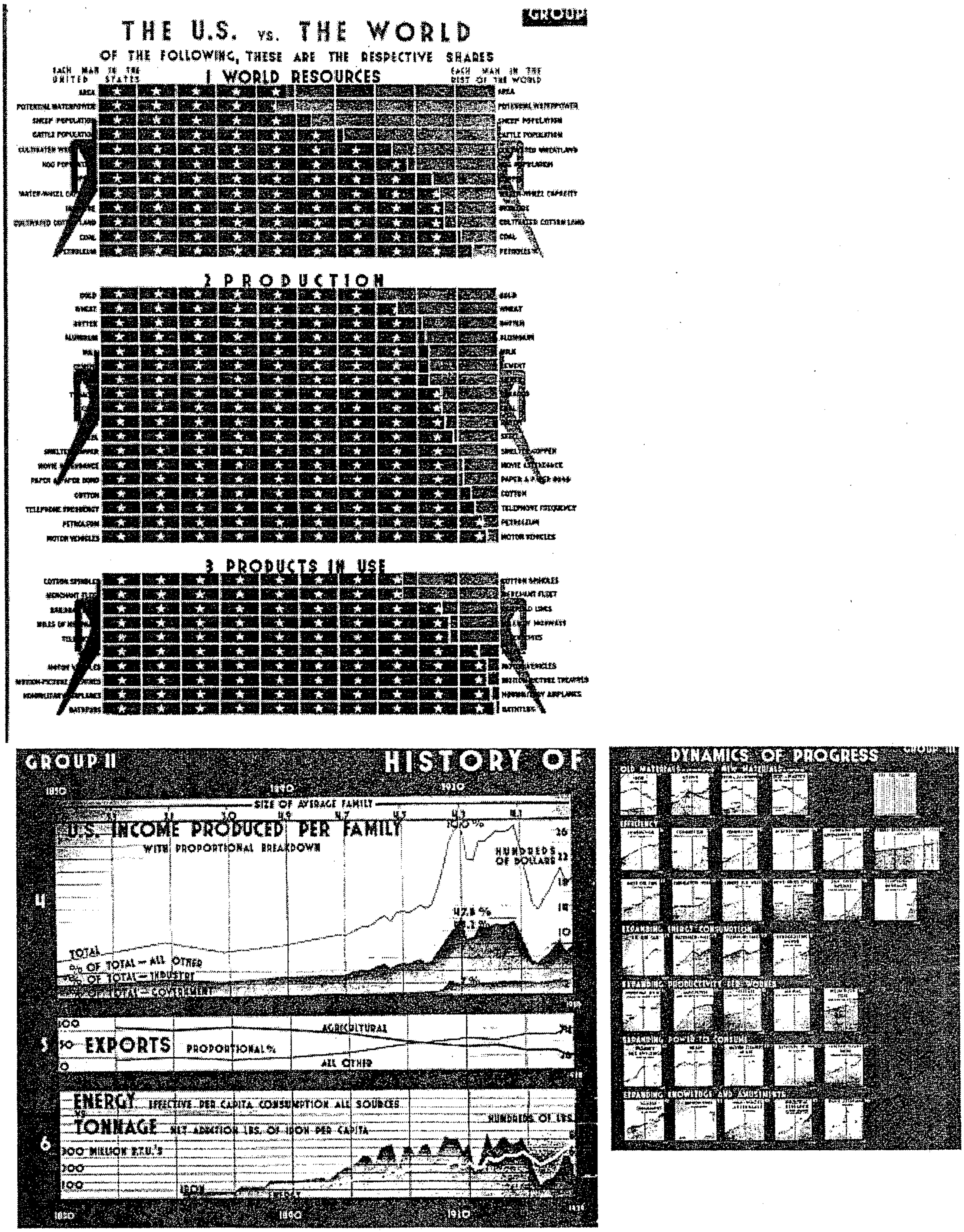


Fig.4.26 .1 Indhlu Project, University of Natal, May 1958. Source: BFI-Photo S-11-1.; .2 46'-D Bamboo Dome, Long Beach State College, Calif. Source: BFI-Photo [?].

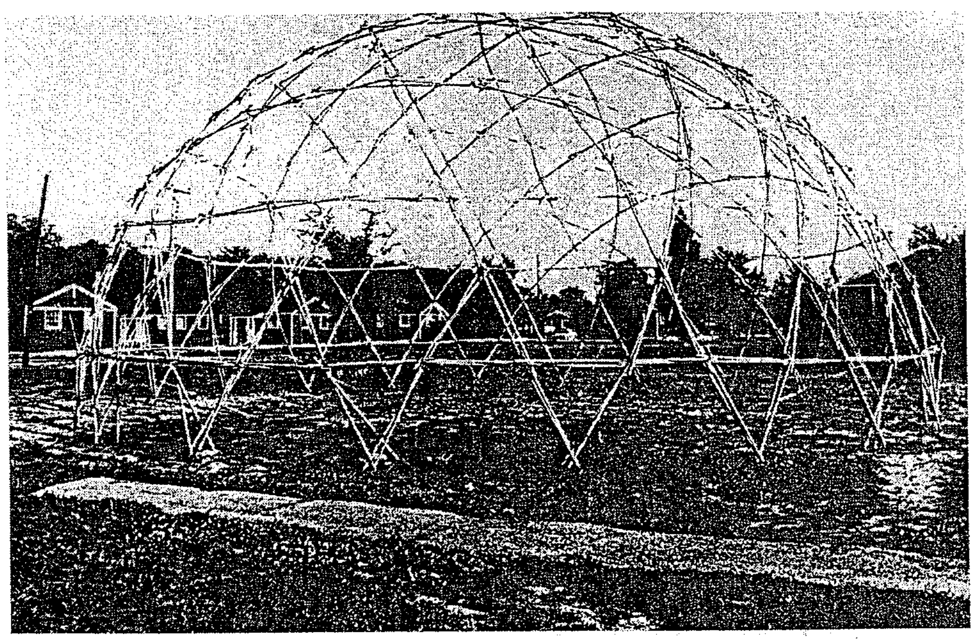


Fig.4.27 Dome over Mid-Manhattan. Source: *Newsweek*, July 1959.

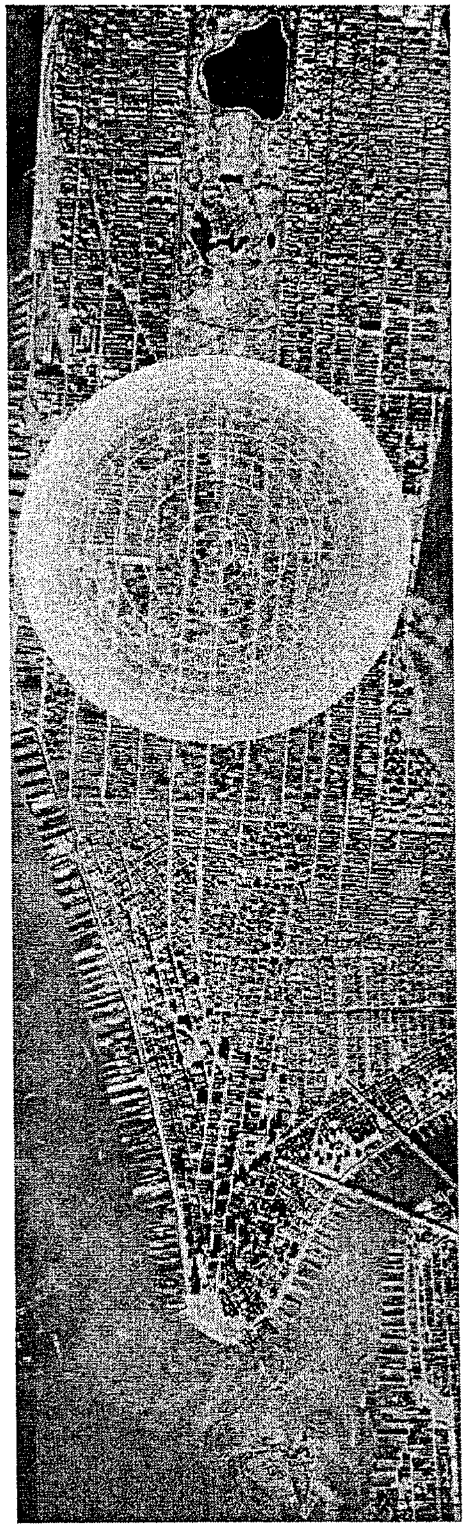


Fig.4.28 "Bridge City" by David Sides and Fitzgibbon of Synergetics Inc. Source: MoMA Exhibition, *Visionary Architecture*, September 1960.

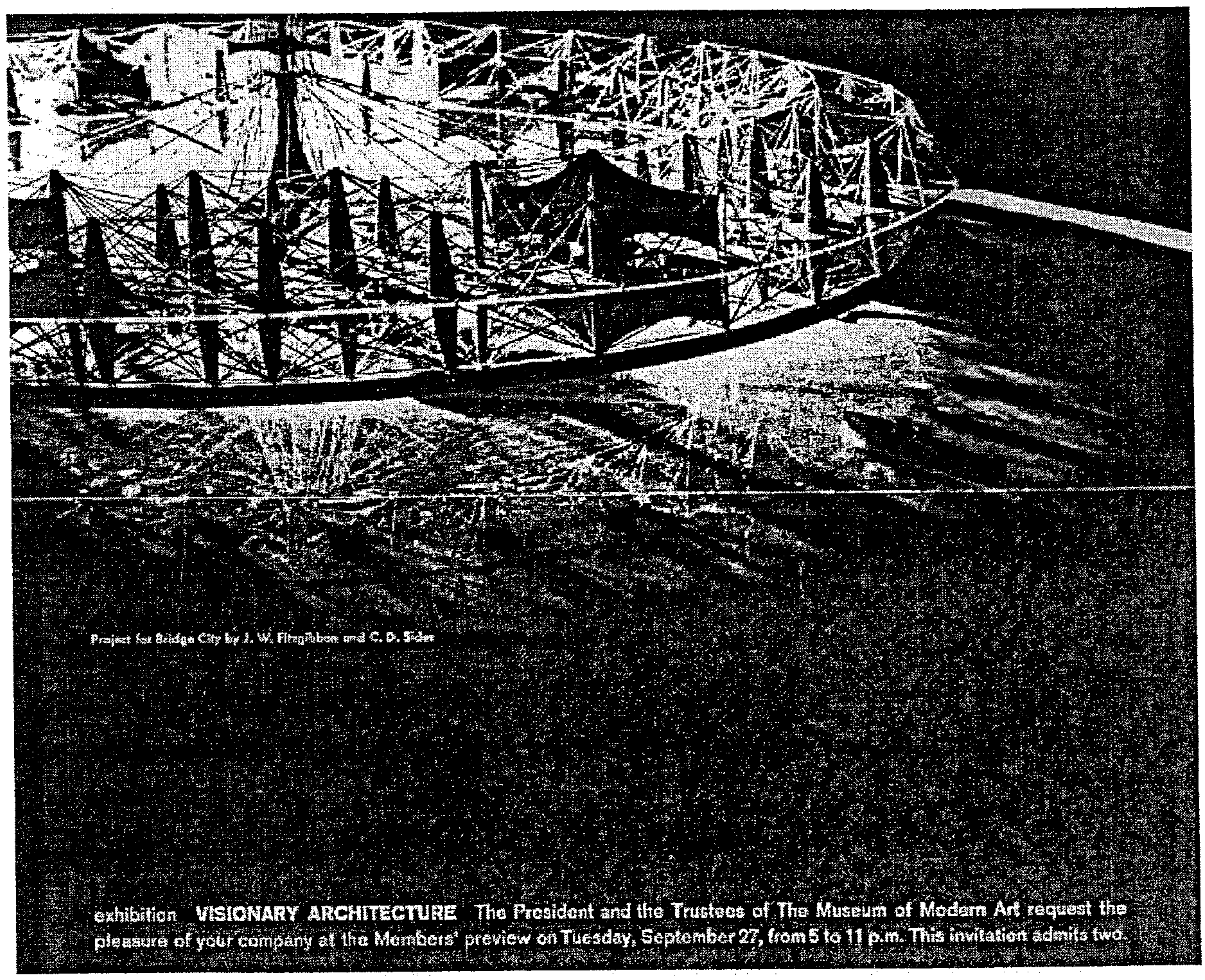
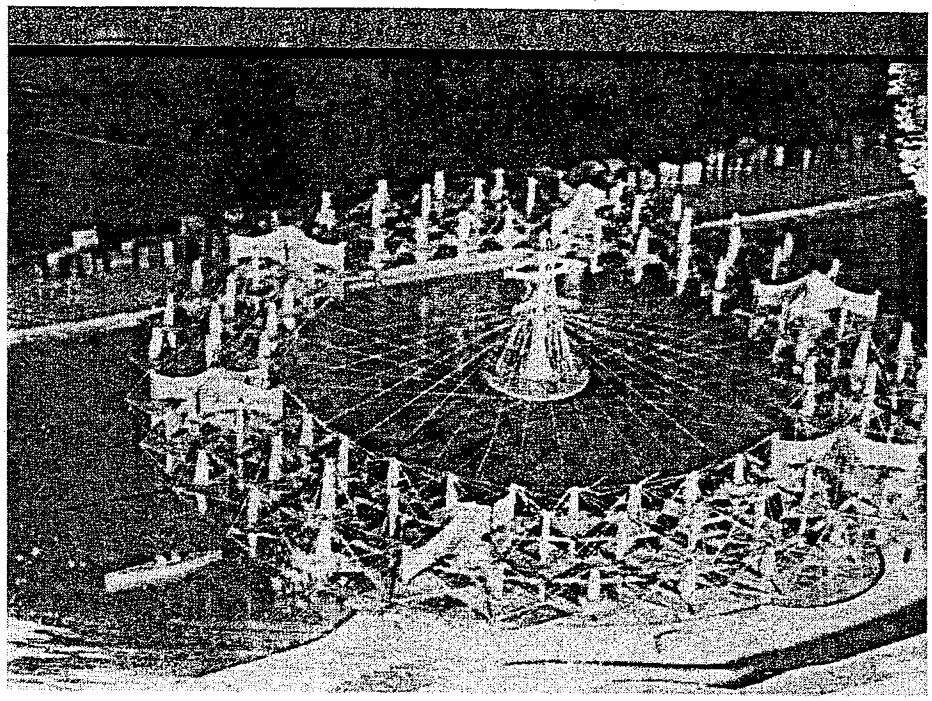


Fig.4.29 "Bridge City" by David Sides and Fitzgibbon of Synergetics Inc. <u>Source</u>: MoMA Exhibition, *Visionary Architecture*, September 1960.



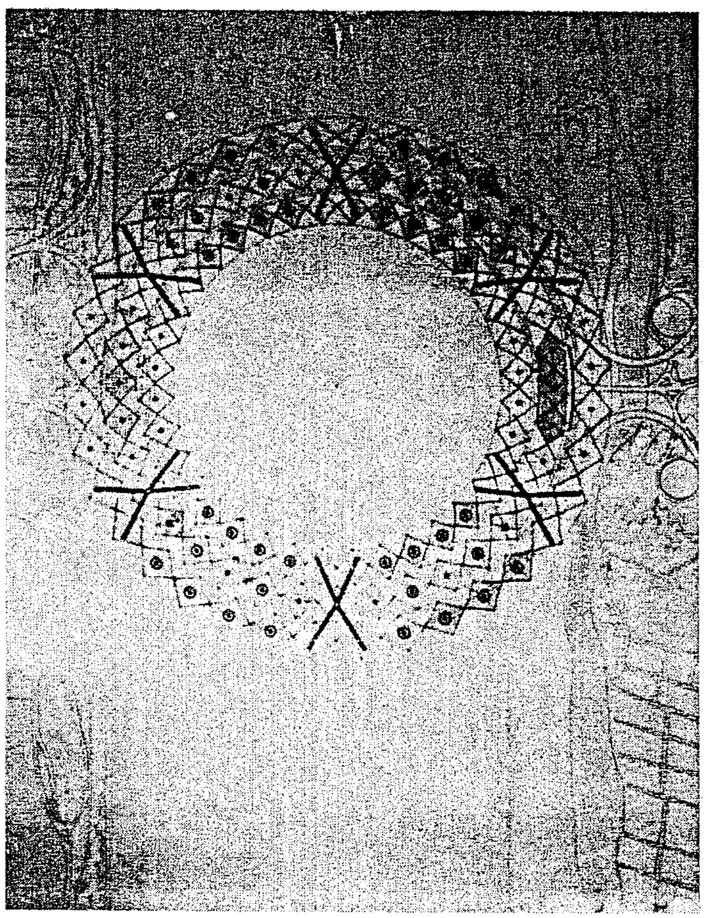


Fig.5.01 Montage, Fuller on a "geodesic raft." Source: 21st Century Online Magazine, (http://www.21net.com).

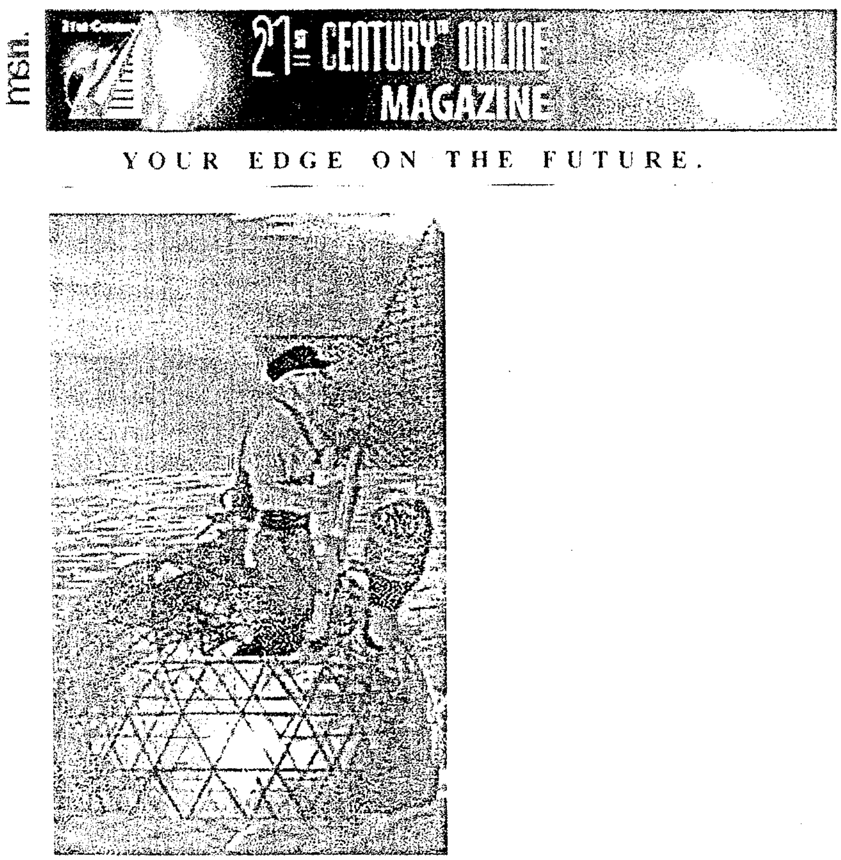


Fig.5.02 Geodesic structures as throw-away architecture. Source: Archigram 3, Autumn 1963.

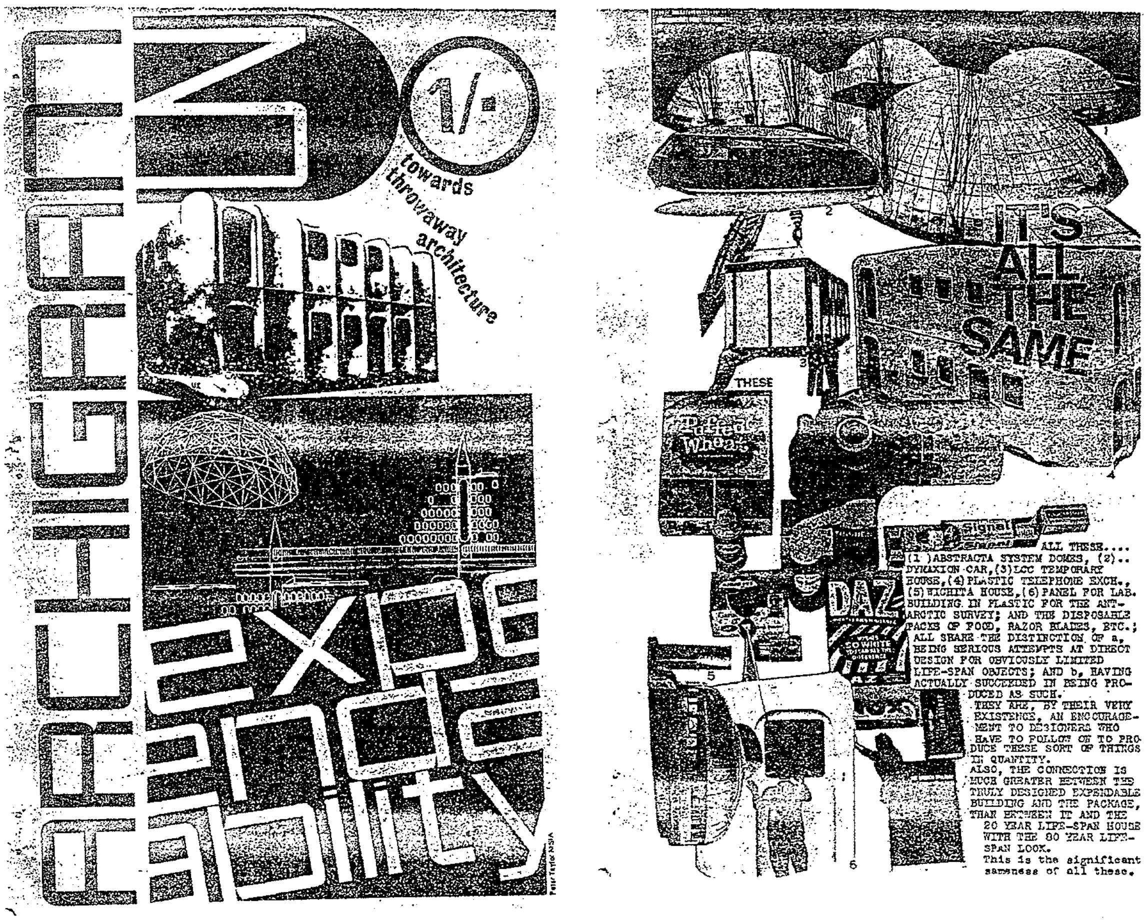


Fig.5.03 Cover design of Pier Angelo Cetica's proposed book: R. B. Fuller: Uno spazio per la technologia, Padova: Cedam, 1977, based on "The Dymaxion American," originally Time(cover story), Vol.83, No.2, January 10, 1964.

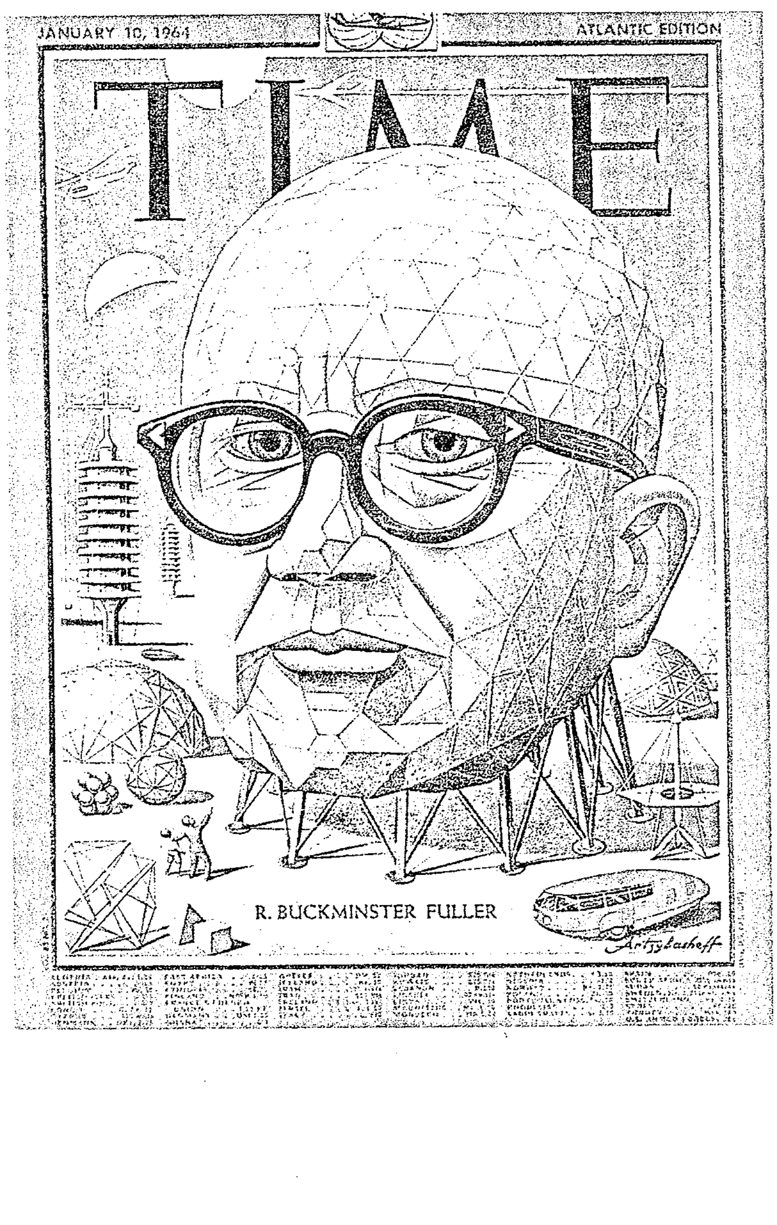


Fig.5.04 Fuller Family on Bear Island, ca.1906. Source: BFI-Photo FA28.

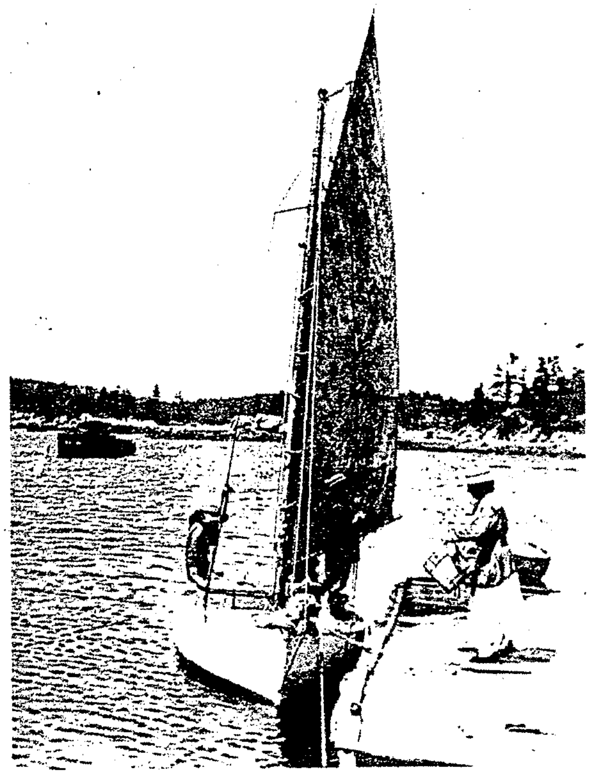


Fig.5.05 Fuller's earliest 1907 contraption on Bear Island — A push-pull boat propeller (Illustrated by Fuller, ca. 1952) Source: BFI-HEv11

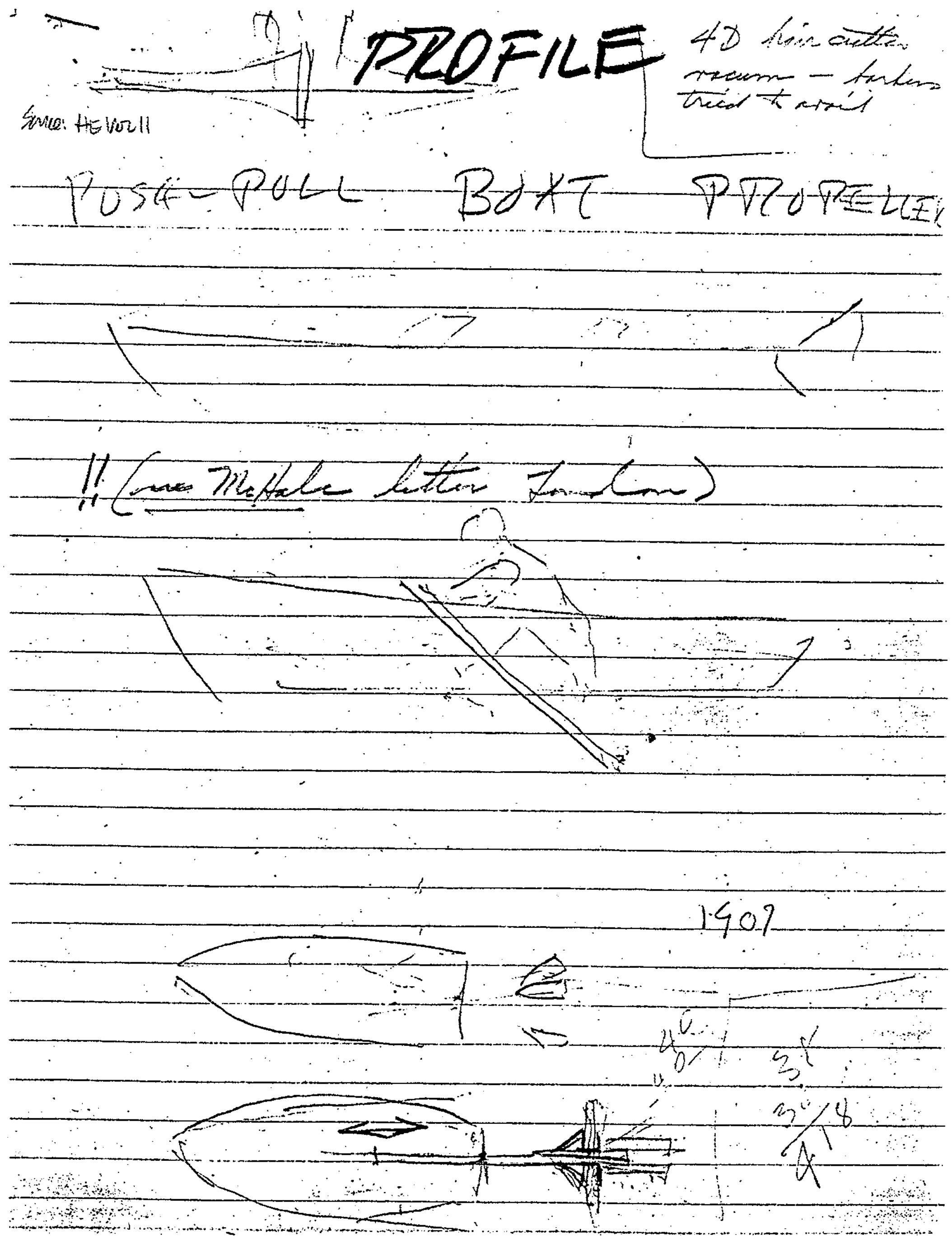


Fig.5.06a Fuller gesticulating the effects of physical forces. Source: BFI-Photo F-3-80 to F-3-83.

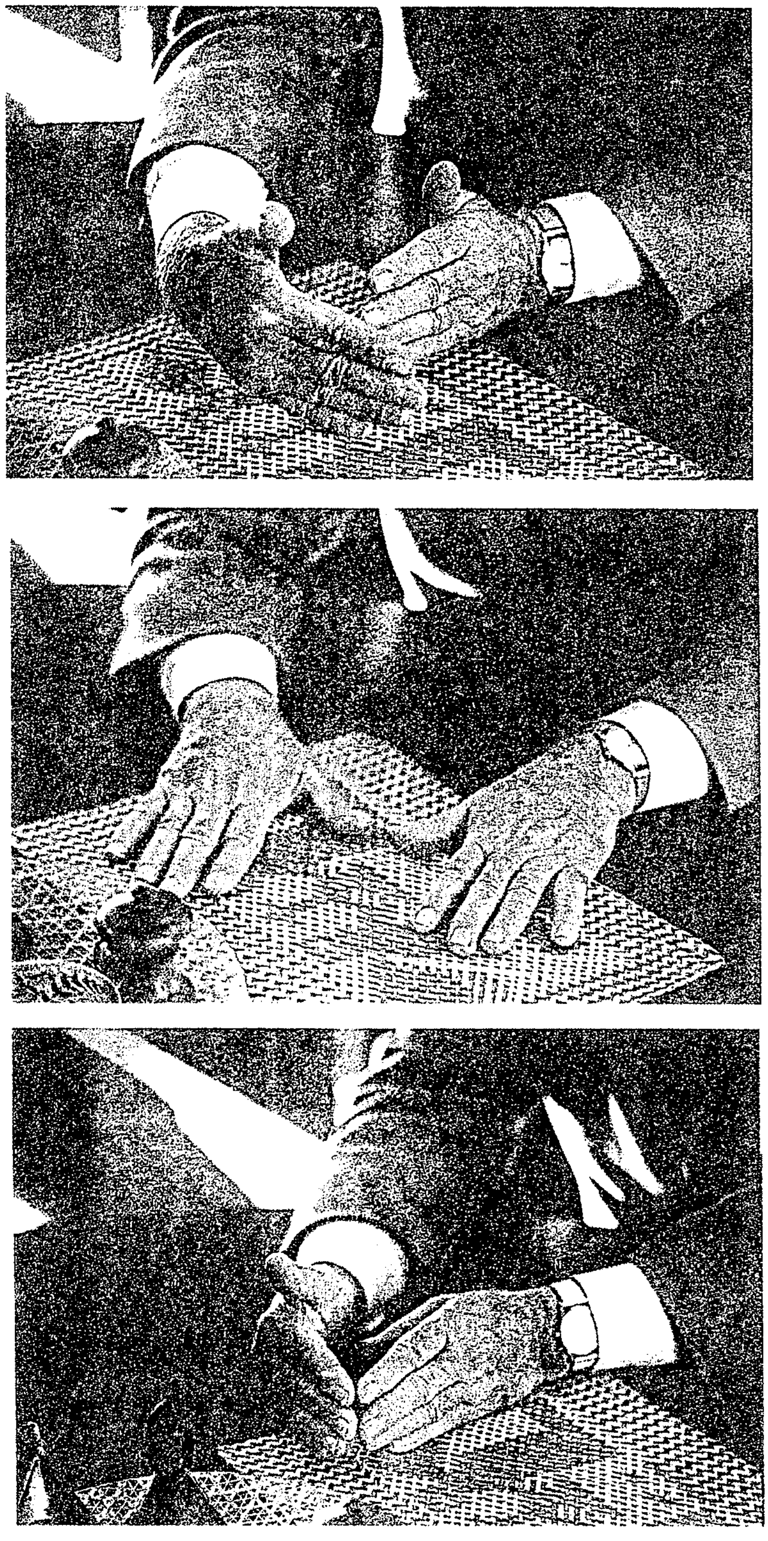


Fig.5.06b Fuller gesticulating & body language, SIU-Summer 1956. Source: BFI-Photo S-6-11, S-6-13..

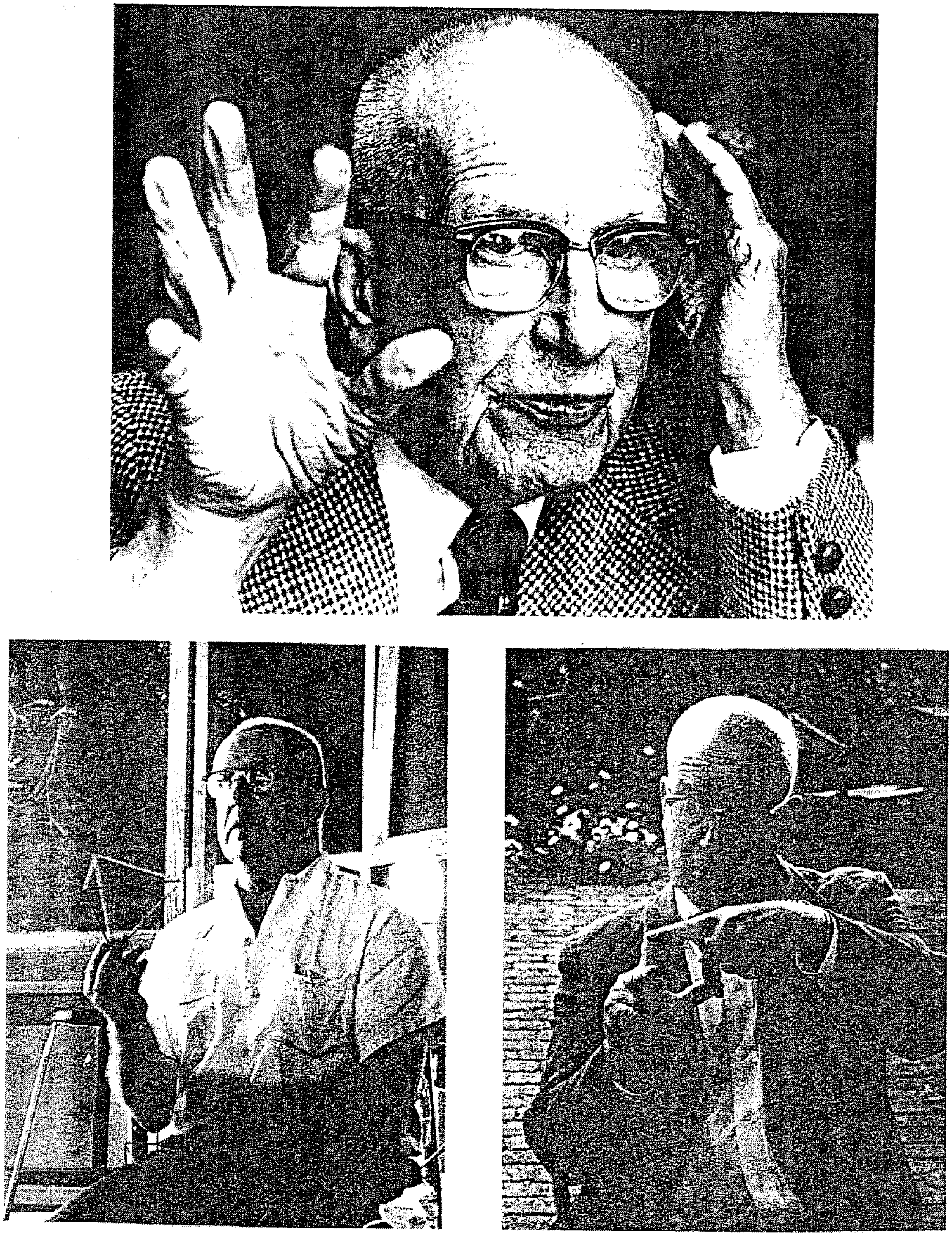


Fig.5.07a Portrait of Fuller. Fuller looking into the glowing geodesic crystal-ball. Source: John Deere Journal (JD), Vol. 12 #1, Spr. 1983.

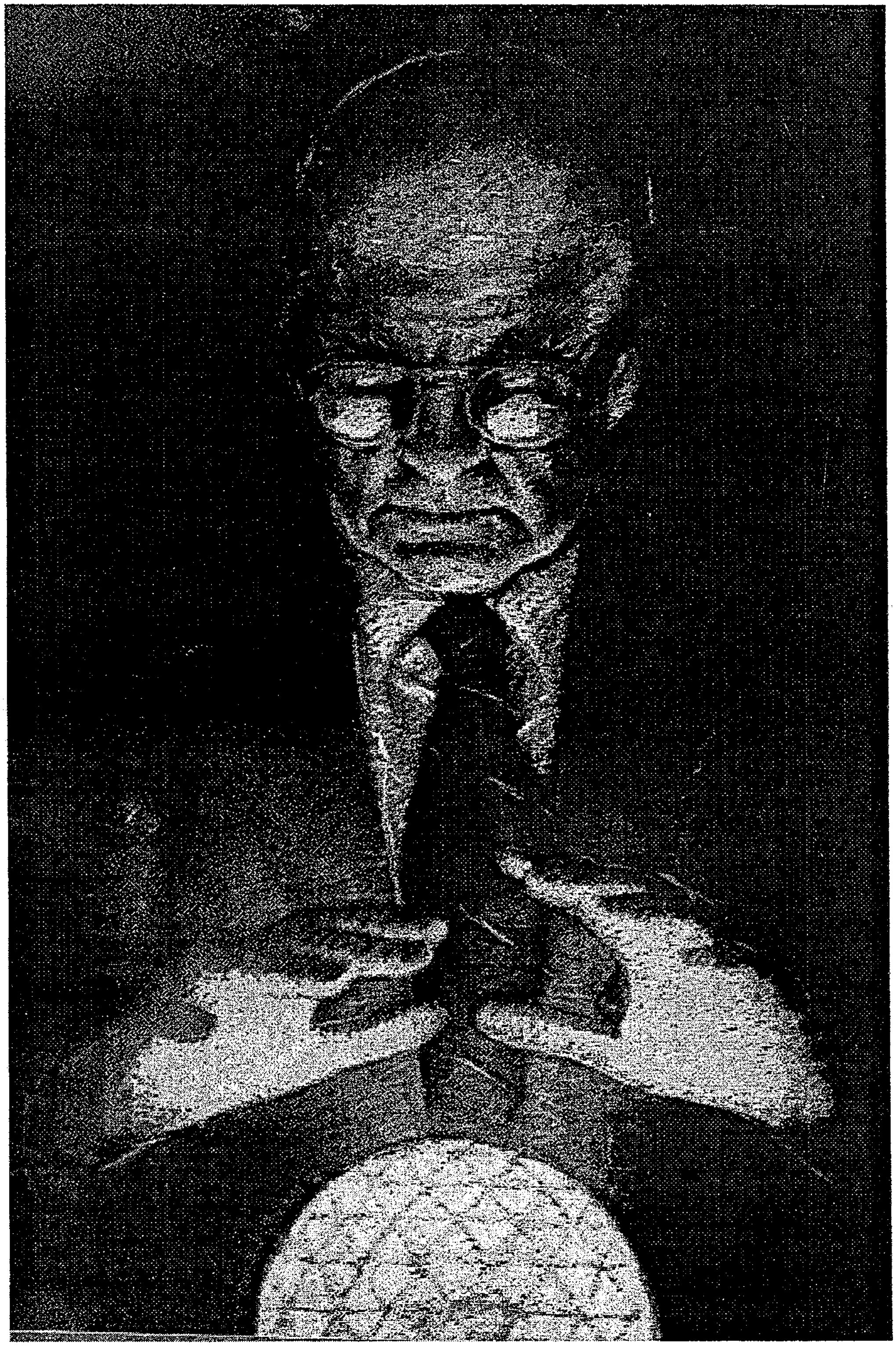


Fig.5.07b Portrait of Fuller. Fuller and his models. Source: "What do you know about Geodesic Domes," in *Better Homes and Gardens*, June 1957.

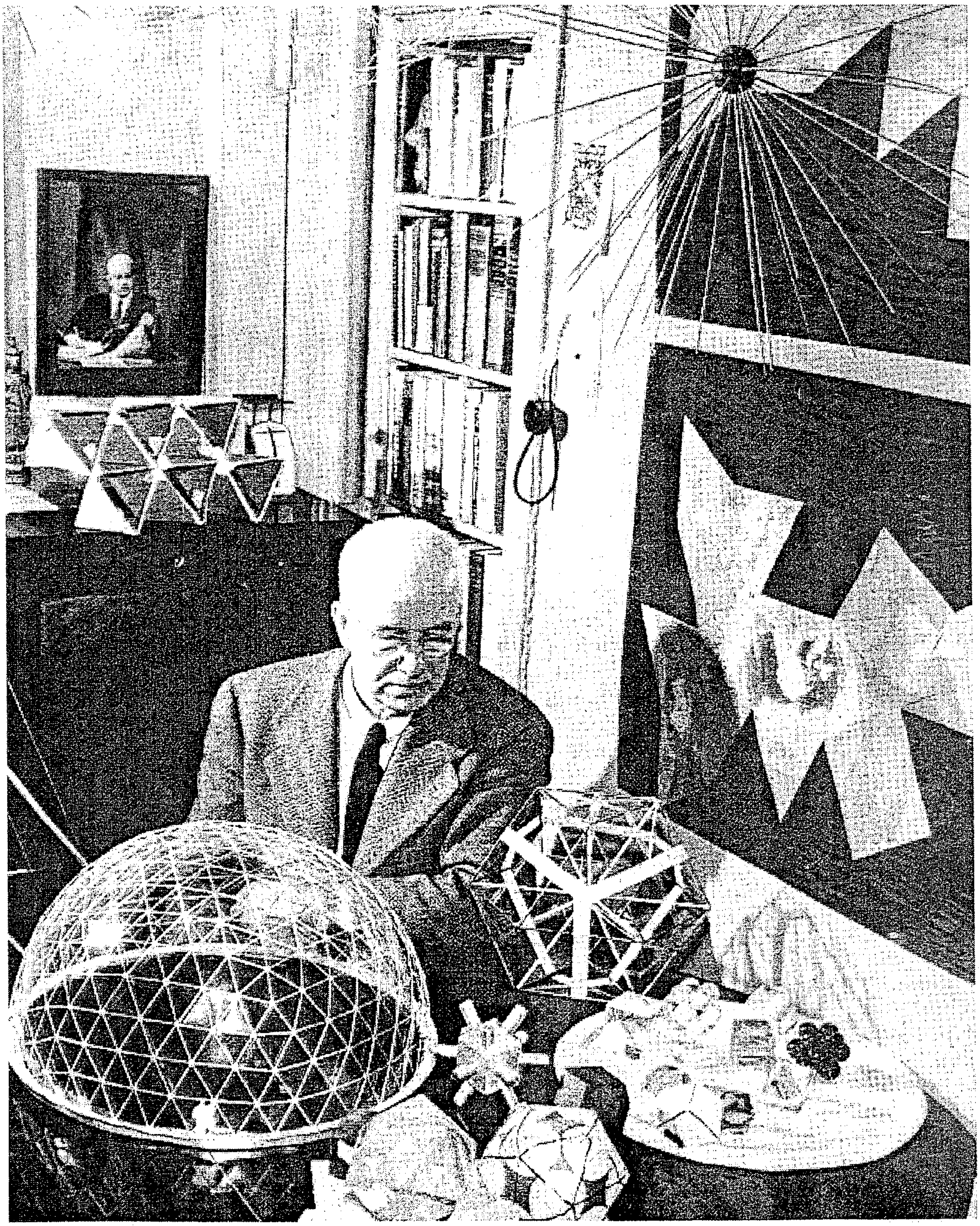
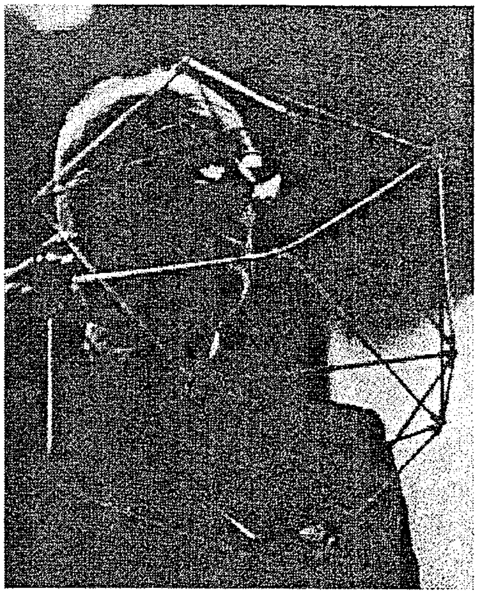
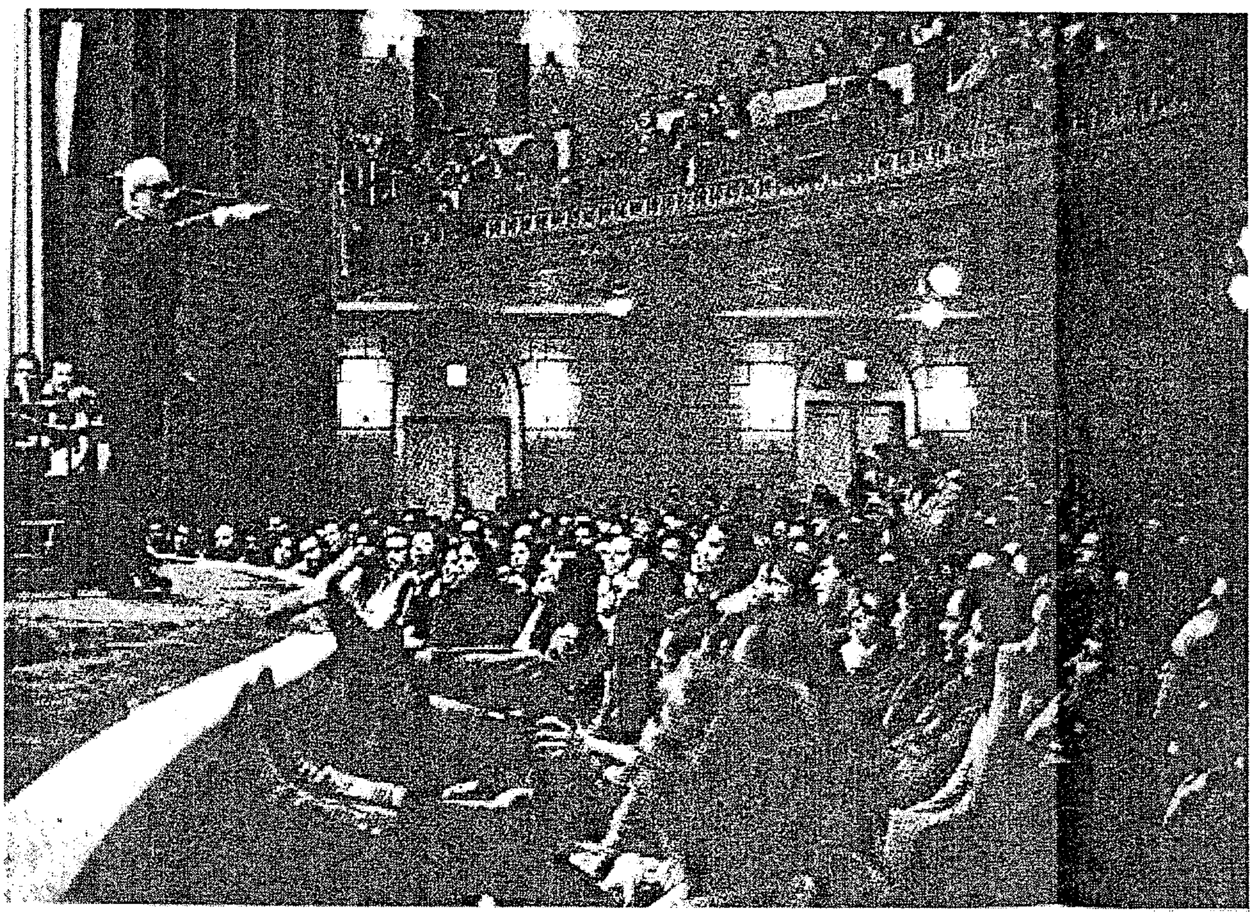


Fig.5.08a Fuller audience at the World Game at the New York Studio, Town Hall Lecture. Source: "Fuller is a Far-out Guy," The Christian Science Monitor (Women Today section), 30 March 1971.



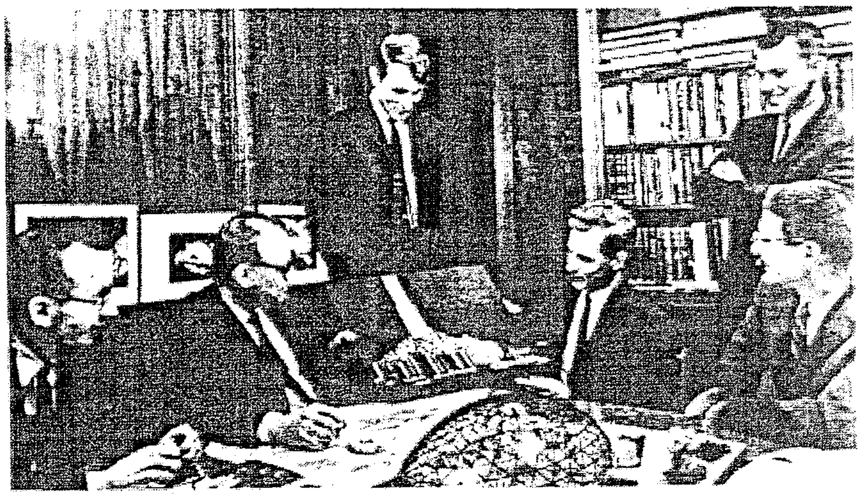


Student rapture at Town Hall lecture, New York

Fig.5.08b Fuller on the lecture circuit. Source: "Buckminster Fuller Retrospective," AD, 12/72, pp.755-761.

Fig.5.09a Fuller's collaborators. **.1:** Shoji Sadao. <u>Source:</u> "Buckminster Fuller's Floating City", *The Futurist*, February 1969; **.2:** Jeffrey Lindsay. <u>Source:</u> "Dairy Farm, circa 1955," *Plastics Newsfront*, Vol.X, No.1, 1955.

Fig.5.09b Fuller's collaborators. **.1:** J. W. Fitzgibbon. Source: BFI-Photo#R-5-1; **.2:** Members of Synergetics Inc., Raleigh-NC. Source: "The Fantastic World of Synergetics," Feb. 1964, NCSC Alumni News, p.5; **3:** Duncan Stuart and his his triacon model, ca. 1953. Source: M. Fitzgibbon's private collection.



The association of architects and designers known as Synergetics, Inc. is headed by James W. Fitzgibbon (left), formerly a NCS design school faculty member, and includes six NCS alumni (left to right): Standing are T. C. Howard and Pete Barnwell. Seated: Bill Ballenger, Dale Blosser, Jim Quinn and Levett Teague.

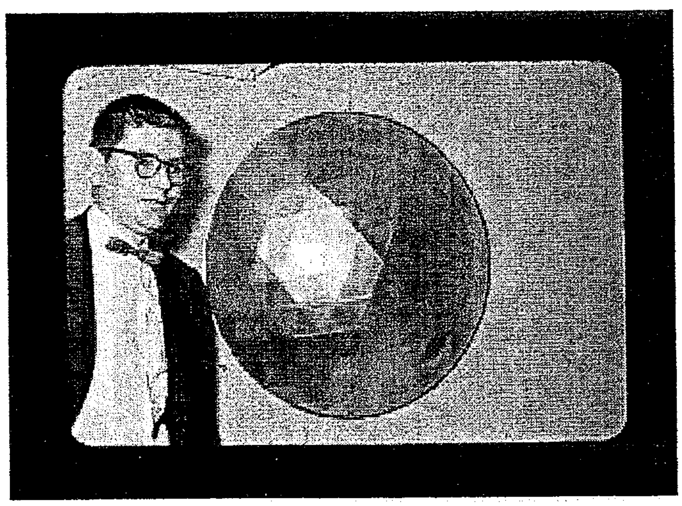


Fig.5.09c People. **.1:** Howard T. Fisher and Robert L. Davison. Source: "Five Questions," Fortune July 1932, p.67; **.2:** Walter O'Malley, Stuart Chase and Henry Kaiser. <u>Source:</u> Current Biography, (1954:495; 1940:163; 1961:231 respectively).

Acme-P & A
CLARENCE M. WOOLLEY
Chairman, American Radiator

Creative Studios, Inc.
BUCKMINSTER FULLER
Architect of the Dymaxion House

Moffett-Russell
HOWARD T. FISHER
Architect, General Houses, Inc.

Ritase
LLOYD R. SMITH
President, A. O. Smith Corp.

Keystone
HARRY S. WHERRETT
President, Pittsburgh Plate Glass

Acme-P & A
CHARLES A. LIDDLE
President, Pullman Car Corp.

Wide World
OWEN D. YOUNG
Chairman, General Electric

ROBERT L. DAVISON
John B. Pierce Foundation

WALTER F. O'MALLEY

STUART CHASE

HENRY J. KAISER

Fig.5.09d People. **.1:** Werner Erhard. Source: The est Graduate Review, Nov. 1976; **.2:** Romany Marie (Andre Marchand). Source: New York Herald Tribune, 23 February, 1961.

The Graduate Review est

NOVEMBER 1976

"If you don't take it out into the world, you didn't get it in the first place. What I got clear about was that it would require an organization – and a particular kind of organization – to take the experience of transformation out into society."
Werner

Werner recently talked with more than 20,000 graduates in eight cities about his transformation at the level of organization and the transformation of the est organization. He was talking about est, and not just about est; as he pointed out, he was talking about the self manifesting itself as organization anywhere, whether it takes the form of est or of any other organization. What he said focuses on the interface and transformation of individual and society and the fundamental role of organization (and transformation of the self at the level of organization) in that transformation.

The Transformation of *est*

GETTING OFF IT AND GETTING ON WITH IT

(An edited condensation of a Graduate Experience with Werner Erhard in August, 1976)

by Werner Erhard

Mrs. Andre Marchand, known throughout Greenwich Village as "Romany Marie."

Fig.5.10 Synergetics as meta-sign. Appropriation by New Age. Source: *Interface*, New England School of Acupuncture, Feb.11-13, 1977. Copy in BFI-CR619.

INTERFACE presents

Being with Bucky 1927-1977

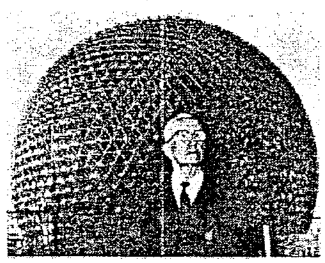
a celebration of 50 years of service to humanity

R. BUCKMINSTER FULLER returns home to celebrate and share with us the 50th Anniversary of his experiment to commit his life to the well being of humanity.

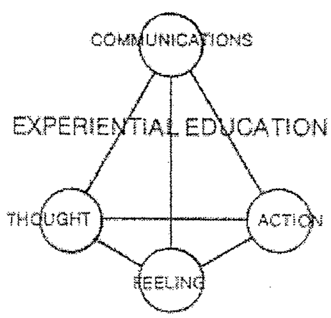
When I was 32, a major change came about in my life. Up to then I had been conditioned, both lovingly and harshly, to live in accord with inspirations, biases, values, concepts, resolves, laws, loyalties and credos evolved by others.

In 1927, I resolved to do my own thinking, and see what the individual starting without any money or credit — in fact, with considerable discredit, but with a whole lot of experience — to see what the individual, with a wife and new-born child, could produce on behalf of his fellow men. I have been in this second stage of my life for approximately half a century now.

I said, "What can a little man effect toward such realizations in the face of the formidable power of great corporations, great states, and all their knowhow, guns, monies, armies, tools and information?" Then, self-answering: "The individual can take initiatives without anybody's permission."



When you see a fresh stream of water working your way, if you scrape the earth a little, the water will run in your preferred path. Humans can participate consciously and competently in fundamental change in ways that are favorable to all life. I could see that where the circumstances are favorable, children can grow while continually regenerating love, affections, thoughtfulness, and competence. I was thus inspired to committing myself to discovering generalized, cosmic principles and reducing them to special case physical tools and practices.



INTERFACE is a nonprofit educational association inspired by the holistic philosophy of spirits like Bucky Fuller. We are dedicated to helping people experience the integrative patterns in their lives. We believe the survival of Spaceship Earth depends on the transformation of human consciousness from a predominantly rational, linear, ego-centered world view to a more holistic, intuitive perspective.

We specialize in communications consulting to institutions and organizations interested in introducing the holistic perspective into their work.

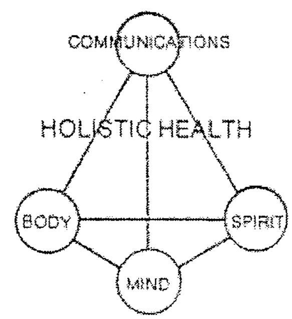
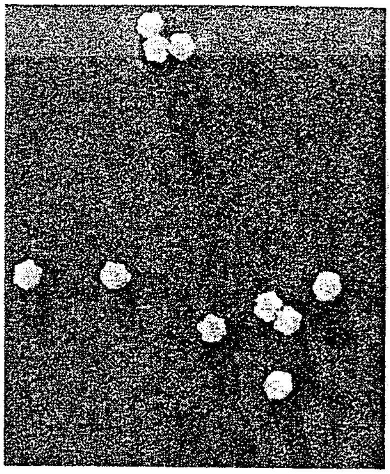
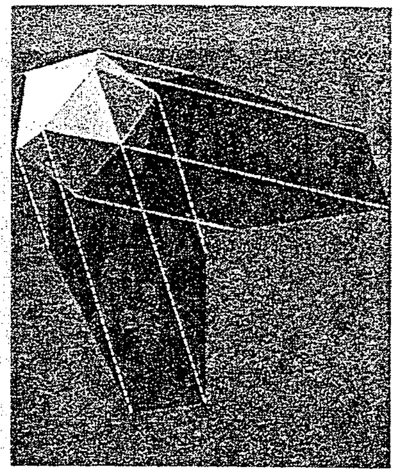
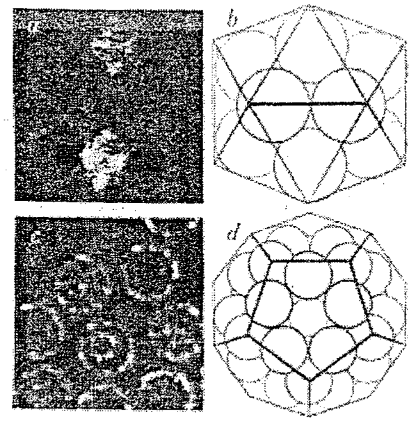
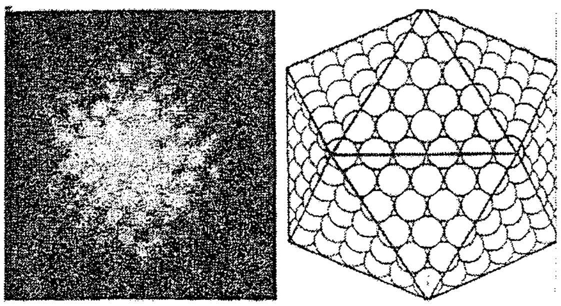


Fig.5.11a Geodesic structuring in viruses. Source: "The Structure of Viruses," *Scientific America*, January 1963, pp.49-57.

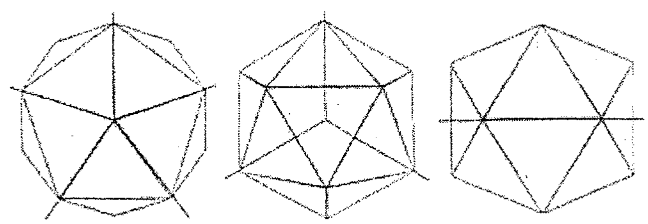




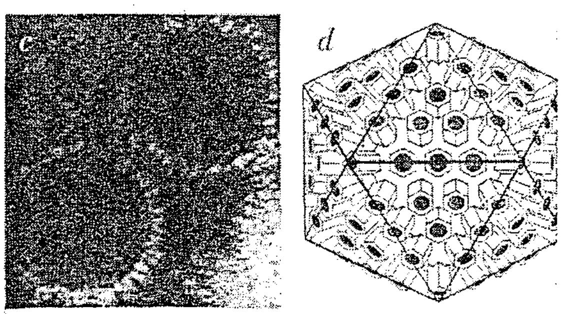




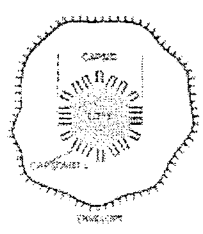
ADENOVIRUS is shown embedded in phosphotungstate, magnified about one million diameters (*left*). The drawing shows how the particle's 252 surface subunits, or capsomeres are arranged with icosahedral symmetry. There are 12 on corners, 240 on faces or edges



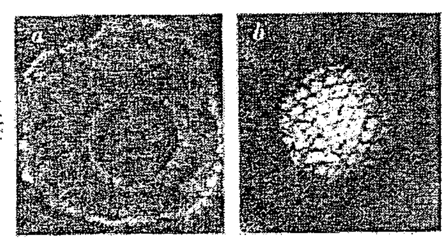
AXES OF SYMMETRY are shown for a regular icosahedron, a figure with 12 corners, 20 faces and 30 edges. Viewed along an axis at any corner, the figure can be rotated in five positions without changing its appearance (*left*). Rotated around any face axis, a regular icosahedron exhibits threefold symmetry (*middle*). Rotated around any edge axis, the figure shows twofold symmetry (*right*).



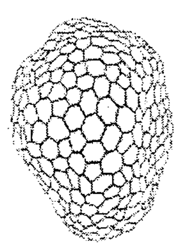
that they are hollow. The drawing (*d*) shows icosahedral arrangement. Micrographs are P. Wildy and W. C. Russell of the Institute of Virology in Glasgow and the auth



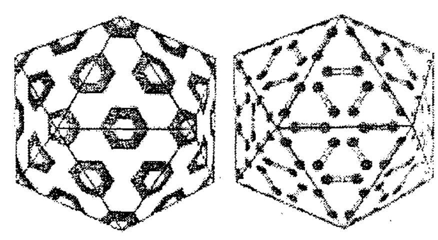
VIRION NOMENCLATURE names principal features observed in electron micrographs.



HERPES VIRUS sometimes has an envelope (*a*). The magnification is [illegible] diameters. The capsid (*b*) is composed of 162 capsomeres. Negative staining (*c*) indicates



RADIOLARIANS, small marine organisms, have skeletons built of pentagons and hexagons.



ALTERNATIVE SCHEMES show how a regular icosahedron containing 42 pentagonal and hexagonal capsomeres [illegible] could be built up from [illegible] small subunits.

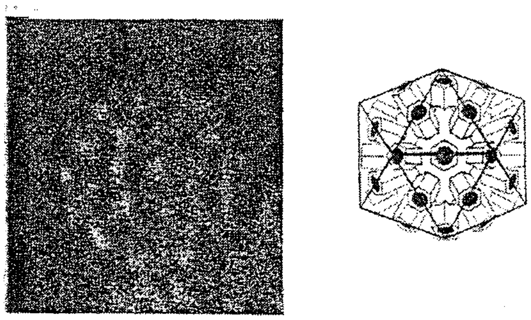


Fig.5.11b Geodesic design in biological structures. <u>Source:</u> Electron-microscopic works of Arthur H. von Hockstetter (Dept. of Anatomy, Faculty of Medicine, U. of Western Ontario) in BFI-[?].