GROUND ZERO

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ABSTRACT

This project speculates how the conception and production of the architectural artifact might respond to the profound transition and convergence of biological sciences and electronic technologies. The thesis is a study of how one might investigate and implement systemic methods, relational strategies and natural phenomena into the process of design and how one might look at the architectural artifact as a biological phenomena and architecture as a magnificent contrivance of the natural world. The thesis was approached from a Darwinian perspective which was the generative force and the conceptual basis of the research and the design.

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I would like to dedicate this book to my parents, James T. Fisher and Kathy S. Fisher. I would also like to thank Tara DeLisio for her support and inspiration, Randy Thornhill for introducing me to Darwin, William J. Mitchell, Andrew Scott, Peter Testa, and Terry Knight, for their sound and thoughtful advice, George Stiny, Chris Luebkeman, and Alexander Tzonis for their inspiration, Adam Balaban for his assistance, and all of my family, friends and teachers. - Derek Fisher

Contents

Introduction

Summary of Question

How might the conception and production of the architectural artifact respond to the profound transition and convergence of biological sciences and electronic technologies. This thesis is a study of how one might investigate and implement systemic methods, relational strategies and natural phenomena into the process of design and how one might look at the architectural artifact as a biological phenomena and architecture as a magnificent contrivance of the natural world.

Why is it Worth While?

The Architect, by his arrangement of form, which is a creation and extension of himself, effects our senses and emotions. An architects effective use of information brings meaning to form. The relationships which he creates give us a measure of our organization and position in accordance with the world. What he creates represents our physical and symbolic understanding of life. What he constructs gives us a means to learn and wonder. We are in the midst of a society with the capacity to manipulate all living things on earth, all organisms, ecosystems, geological and meteorological systems which are becoming connected to the new bio-information system. Architects have built upon the primordial instinct for shelter of every human being, the establishment of highly adaptive regional societies, the development of mass produced industrialized society, and are on the threshold of an evolving interface with the responsibility of assisting in the management and construction of large scale systemic transitions that will reshape this foundation. The emerging physical expressions may elucidate values of human aesthetics toward architecture and display that beauty is a promise of function in the environment that we have evolved and which architecture is evolving as an extension of our behavior and an augmentation of our knowledge, beliefs and technology.

SOURCES
natural selection replicators
signs and language
genetic
TARGET
convergence
exosomatic
cultural
outside the body
biosphere/noosphere
EVOLVED
AUGMENTED
SYSTEMIC
ADAPTATED
STATEGIC
HERITABLE
INVENTED
TRANSFORMED
NOVEL
PHENOTYPIC
GENERATIVE
EMERGENT
SYNTHETIC
ECONOMIC
MULTIPLE LINEAGE SYSTEMS, ANALOGS AND SOURCE DOMAINS

State of the Art

Convergences

I believe that the state of the art in design is a systems approach and it's unpredictable emergence will be something greater than the sum of it's parts. The state of knowledge and of technology has always had irresversable transitions with the occurance of great convergences.

> "The bionic convergence has been in gestation for centuries, because the study of life has always been the product of convergences. People who are in search of new understanding of such things as plants and animals, or microscopic life, or the ecology of large systems always use whatever mechanicl and intellectual tools happen to be available at any given time. Biologists are either hindered or helped by the state of technology, including information technology, and by the state of knowledge such as mathmatics."
> Walter Truet Anderson

An irresversable transition occured with the modern synthesis of Darwin's idea of natural selection and Mendels discovery on genetics. This convergence of knowledge realized that there was an elegant information system which carried all the instructions for the gestation and development of organisms. This was the dawining of the bio-information era and the beginning of a more profound convergence of biology with electronics, of the biological revolution with the information revolution. Systems that utilized electronic devices to assist humans in the performance of difficult and intricate tasks or "bionic" systems, are demonstations that genetic, cultural, and sybolic s

Goonatilake explains (1991) that there are three lineages of information each with its own speed of evolution; each is more adaptable than the one that came before it and each new lineage transforms the one that preceded it and created it. It is clear that the last of these, the exosomatic lineage consisting of artifacts and most notabley the computer, is evolving at neck breaking speed. This change brings with it a host of new rules in the biological evolution of species and the ecological working of the planet itself because of the intricit relationship of the three lineages. This development has led to new technologies and the creation of new fields and industries such as bio-technology, bio-remediation, bio-mining, bio-materials, and bio-energy. The complexity theory has also found practical application with the implementation of current knowledge and technology. There a shift in the boundary between what was given and what is made with a replacement of inorganic with organic and vice-versa. Long standing dualisms and dichotomies, such as the organic and rational traditions in architecture, may be seen as crippling to clear thinking because of much new understanding of natural phenomena.

Digital Design

State of the art conceptions and processes in architecture have begun to shift in response to the bio-information era. Digital design media increasingly allow architects to control the entire process of a project from design to production. Rapid prototyping and CAD/CAM technhology increasingly make possible the fabrication of complex physical artifacts reducing a designer's dependence on standardized, mass-produced construction components. Wireless linkages will make possible virtual design studios where experts may collaborate from practically anywhere in the world. The use of satelite and remote sensing technology make available rapid accesss and connection to mapping and monitoring of environmental and geological information (Mitchell, McCullough 1995). Computational design theory is also providing understanding and application of procedures which resemble both the simplicity and the complexity of natural phenomena. Apparatus and procedure of computation are becoming more ubiquitous and the understanding fields such as shape grammar render a more fluid exchange of information from the mind, eye and hand of the designer. Generative algorithms investigate generating processes paralleling a wider scientific search for a theory of that is similar to morphogenesis in the natural world. Smart artefacts containing computational matter as well as structural, photosynthetic and plain matter are moving into the realm of architecture.

Nonlinear Systems

The convergences and electronic technologies mentioned above along with a growing number of research and development in fields such as Artificial Life aid in the production of architectural artifacts in which precise expression is environmentally dependent. The monitoring and gathering of geological, meteorlogical, and ecological information and the responsive use and shaping of material to create architectural form may now be treated as a part of a complex living system. Architectural assemblies with long term stable strategies can be adopted that respond to natural process of life.

Todd (1994) explains that "Living machines are fundamentally different from both conventional machines and standard biotechnolgies... what they present, in essence is the intelligence of a forest or a lake, reapplied to human ends. Like natural ecosystems they engage in a process of self design. The rely on biotic diverstiy for self repair, protection, and overall system efficiency. Living machines are capable of reintegrating wastes into larger systems and breaking down toxic materails, or in the case of metals, recycling them. These systems further have abilities to respond and change with variations in inputs. Although the task is set by the designer, when the living machine is left to develop its own immense complexity it may establish biotic relationships not seen in nature and therby expand its options of diversity. When they adapt to new, contained environmental conditions they have the potential to evolve unprecedented relationships".

Review of Relevant Topics

I began developing the thesis from two different directions. The first was the implementation of computation in the conception and process of architectural design. The second came from within the area of "sustainability" in the context of architecture . The later of the two emphasized establishment of more complex and intelligent relationships between design and the environment by adopting successful long term strategies. Some of these strategies emphasized climatic issues and the derivation of form in response to the natural forces of the more specific environments. Darwinism was the issue with which I attempted to unite the two areas into a single topic of which the thesis has researched.

Spanning of Many Traditional Fields

I have selected from many disciplines, the theories and thoughts that I believe offer special insight into design possibilities, that fit the facts and predict new ones, and that are substantially and consistently becoming accepted points of view to age old questions. My goal was to weave these ideas into a cohesive picture using two even bigger ideas that are not mine: the computational theory of design and the theory of the natural selection of replicators.

The industrial revolution led to a compartmentalized approach to production and problem solving with secretive and linear characteristics. This centralized mindset has proven to be a dead end approach for human progress and survival. It struke me that a highly interdisciplinary approach, drawing upon research from across the academic and scientific spectrum, would provide the possibility of sharing expertise from various fields to share knowledge resulting in more intelligent strategies for long term success. My goal was to implement significant themes that are prevalent in many disciplines such as evolution, ecology, ethology, artificial intelligence, genetics, material science, and phylosophy.

Ideally the thesis would have been made up of a team of graduate students from specific areas. The interdisciplinary approach of the thesis without actually having participants from these areas had its risks. In most cases I have not gone into detail of the various issues enough and my somewhat naive attempt at a synthesis of such diverse and prolific subjects is clumsy at best. I have tried to summarize the main issues in a coherent way so readers may clearly follow the approach taken. I have also provided references and a bibliography that will assist in further inquiry. The hope was that by looking beyond conventional boundaries of the architectural discipline one might find a new way of seeing and producing architecture.

The Darwinian Paradigm

The Darwinian Paradigm and the theory of natural selection has transformed and illuminated our traditional view of humanities place in the universe. Darwin's main idea was that life has been generated over billions of years by one algorithmic process or another producing a single branching tree of life. The mechanism driving this process was natural selection which explains the adaptive complexity or complex design in existence. The condensed version of evolved life is as follows. A few billion years ago small chemical formations combined in the primordial soup as a replicator. This replicator was the product of laws of physics and chemistry and the composition made copies of itself and its copies made future generations and so forth. However, replicators use up valuable resources and replication requires energy. The primordial soup was finite in energy and material, so the replicators had to compete for valuable resources. Errors sometimes occurred in the duplication process, leading to variation, often causing inefficient use of resources and lower probability of replication. Once in a while errors in duplication produced better replicators which then became prolific over the generations (Pinker 158). Since descendents accumulated any errors of previous generations, including ones that produced protective membranes and supports, manipulators, catalysts for useful chemical reactions, and other features for what we call bodies, the result was well engineered organisms with better longevity, fecundity, and copying fidelity. (Dawkins 158)

When looking at Darwinism for insight and understanding one must take a position and decide what might be done, if anything, with this new understanding. The misconceptions of Darwinism in the past have stemmed from the perversions of the Social Darwinist of the 19th century in committing what has been coined the "naturalist fallacy". The "survival of the fittest" Herbert Spencer proclaimed, "is not just Mother Nature's way, but ought to be our way". This bad thinking professed that it is "natural" for the strong to vanquish the weak, and for the rich to exploit the poor. This point is, as Darwin himself warned against, that you can not derive "ought" from "is", as the Social Darwinists attempted to do. (Dennett 461, 1995)

This brings up the relevant question of why "ought" a designer think of architecture from a Darwinian perspective and what "is" to be gained from it. The morality of these questions may be of importance, however I have chosen to investigate the logical application of the theory and to separate the scientific from the ethical issue. From a designers perspective the process of evolution by natural selection can give rational insight in different ways. At the turn of the century and at other times in the past architects have been influenced by the themes provided by Darwin's theory of evolution.

> "Forms of nature and also human creations were seen as parts of the continuous system of reality. Charles Darwin's Origin of Species (1859) attributed to the elements of this system functions, making the theory particularly interesting to architects because of the obvious analogy of the relation of parts to the whole. In Ludwig Forster's Allgemeine Bauzeitung, the major German-language architectural and engineering magazine of the late nineteenth century, the organic concept of development inspired many

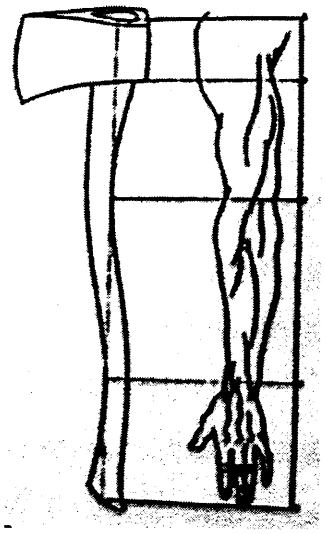
> articles on the evolution of space [4] and on the importance of technology for culture.[5] Albert Hoffmann's study of the development of the Ionic order [6] was based on his acute analysis of the transformation process of forms specific to wooden construction and its sequential adaptation in different cultures. Even the legitimation of the architectural use of iron I-columns was based on Darwinian principles. Georg Heuser, writing on iron frame structures, criticized, with some irony, Semper's notion that human culture had always been enhanced by "the haze of carnival candles," that according to Semper, the "denial of reality, of the material, is necessary if form is to emerge as a meaningful symbol, as an autonomous creation of man" [7] Instead of the decorative coverings of the structure, instead of Semper's Phantasieformen, inspired by church incense or the perfumed vapor of a lady's boudoir, "works of art obey the general process of evolution that also rules in nature... In art there are general laws in force, similar to the ones set up by Darwin for nature." [8] In 1890 Heuser started a series of articles on Darwinism in art and technology ("Darwinistisches uber Kunst und Technik"). Here, acknowledging Semper's obvious interest in classification and natural selection, he developed a theory of trial and error applied to building construction: the elements of style basically follow the development of building technology systems of vaulting, the structural frame (figure 4.1). The modern iron frame is proof of Darwin's remark that mankind has the innate inclination to drive natural selection to an extreme.[9] (Akos Moravansky, The Education of the Architect 113, 1997)

This passage mentions a systems approach, the relation of parts to the whole, transformation processes, the cyclically repeating developmental process of trial and error, and the fact that architecture and artifacts in general may be seen as a continuous extension of reality, and it provides some of the main Darwinian principles that have influenced design. As architects continue to draw inspiration from the Darwinian perspective there is a need to clarify where one is looking at architecture literally as a part of nature, where one is implementing analogies and metaphors to assist in the creative process, or where it is a source of inspiration.

Literal Extensions

When looking at architecture as a biological phenomena and a literal extension of nature one must begin with the premise that buildings are artifacts suitable for attaining some end, from sheltering the elements to attracting and keeping people in a casino for hours on end. Architecture is the application of knowledge about cause and effects among objects to bring about goals. Architecture is a product of civilization and culture, culture is a product of mind, mind is what the brain does. The brain is a product of natural selection and an information processor that is organized into mental organs, each specialized at interacting with one arena of the world. The logic of each organ module is specified by our genetic program. Their operation was shaped by natural selection to solve problems that our ancestors encountered in our evolutionary history as hunters and gatherers. The problems of our ancestors, such as finding shelter or a mate, were subtasks of one big problem for their genes, maximizing the number of copies that made it into the next generation. (Pinker, pg. 21 1997). This does not mean that everything we build is under the control of some

underlying, unchanging, and immutable program or switch board from the past or that we should try to understand everything that we do as an adaptation. Ever since the beginning of civilization architecture has been guided by the evolution of culture and the experiences and insights of thousands of designers and inventors and this makes it more difficult to find direct adaptive needs for the environments we design. However, artificial environments are constructed, modifyied, and judged according to behaviors and preferences inherited from our distant past. Understanding and unmasking psycological adaptations and bias that underlie behavior can inform designers.



As artifact, architecture can be seen as an example of the phenotypic expressions of our genes. Dawkins states that (pg. 207, 1982), " There have been only a few studies of the genetics of building behavior in any animal, but there is no reason to think that 'artifact genetics' will be any different, in principle, from behavior genetics generally". And he adds a logical point: "once we have accepted that there are genes for building behavior, the rules of existing terminology imply that the artifact itself should be treated as part of the phenotypic expression of genes in the animal". This may be a difficult step for one to take unless one follows the causal chain of reasoning presented by Dawkins. Nevertheless, the point is that architecture is an extented phenotypic expression of our genes and a part of a network of interlocking fields of replicator power.

Building behavior may often be motivated by the desire to gain and display status. Whether conscious or not, the strive for status is a part of human psycology. Just as jewelry and nice cars display wealth, architecture is often a symbol of status within societies. For example, the facades of Palladian villas demonstrated the social rank of the family. Two fueding families that were in a struggle of power set thier villas on opposing hillsides and used the architecure as a demonstration of dominance and prestige. As one looks at architecture in terms of status he may find that there is often a hidden agenda behind the decisions made in design and planning. An understanding our evolutionary history also reveals more subtle issues than than the attainment and aquisition of power or status, which may help to describe building behavior .

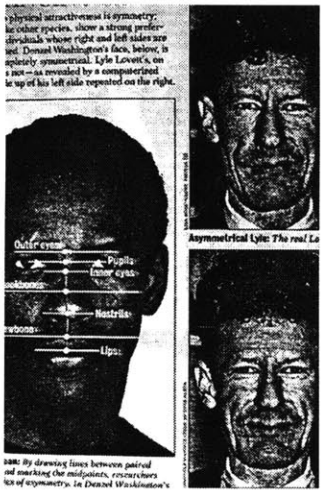
For instance, one may ask, Is beauty in the eyes of the beholder? Symon states (1995): "Beauty is in the adaptaions of the beholder. This may be a question asked by a professor in biology at the beginning of a semester. And this may be a good question to ask in the field of archtecture, as architects are focused on heightening sensation in general and in generating beauty experiences in the minds of people in particular. Could understanding beauty from a Darwinian perspective not assist in making more beautifull buildings ?

Monroe Beardsley's *Aesthetics* (1958), suggest that "the form of an aesthetic object is the total web of relations among its parts." Le Corbusier, for example, proposed a system based on Fibonnaci sequences and the golden ratio. Claude Perrault, in his architecture treatise (1683), distinguished positive beauty, which derived from formal and material qualities, form arbitrary beauty, which followed from fashion, cutom, and usage. Henry Home, a british philosopher (1761), proposed a distinction

between intrinsic beauty, which derived directley from formal and material qualities, from relative beauty, which was related to some end purpose and consideration of the works role relative to other things. Kant (1790) distinguished between free beauty, derived from entirely formal matter and free of all considerations of function, and dependent beauty, derived from adaptation to some purpose of knowledge of ends (Mitchell pp. 34-36, 1994). In Darwinian terms Mies's famous saying, "form follows function " may be better stated as "beauty in form is a promise of function". Attractiveness certifies biological quality.

Though there is no way to objectively define aesthetics, a Darwinian approach to aesthetics can inform designers of the built environment. As Thornhill (1998) writes, "Beauty experiences are unconsciously realized avenues to high fitness in human evolutionary history. Ugliness defines just the reverse. Greenough (1958), in reference to architectural structures, defined beauty as the promise of function. The Darwinian theory of human aesthetic value is that beauty is promise of function in the environment in which humans evolved (i.e., of high likelihood of survival and reproductive success in the environments of human evolutionary history)". This means beautiful experiences that we have now, as we contemplate buildings, landscapes or surroundings, as we gaze at a painting or geometric patterns, as we look at a persons face or body, and as we listen to music, are actual discoveries of how our human ancestors felt about various aspects of their environments.

As Sigmind Freud's theory of the unconscious and the defense mechanism of the ego, such as repression, projection, denial, and rationalizaton emphasized underlying aspects of mind, the Darwinian-adaptationist point of view is that ques of utility are not consiously percieved just as most mentation is not felt. Thornhill states that "the utility in art is subliminal, but present to the extent that it is judged as beautiful. The analysis of famous architectural structures, which provide evolutionarily historical cues to refuge, ease of exit from refuge and monitoring the outside environment (Hildebrand, 1991), ...strongley supports that the art has unconsciously percieved cues to utility in human evolutionary history. The beauty reward is the physiological reward for having processed ancestral cues of promised evolutionary function, and promotes further acquisition of information about the habitat" (Thornhill 557, 1998).



Studies on human beauty reveal that we judge each other by rules we are not even aware of. For example, symmetry has much to do with human beauty and selection. Humans and many other animals, such as peacocks and scorpian flies, size up the health of prospective mates by checking for minute asymmetries. Organisms that have bilaterally symmetrical external forms move in straight lines. If this where not the case, they may go in circles. Achieving symmetry is so improbable and difficult that any disease or defect can disrupt it (Pinker, 1997). High levels of symmetry are demonstration of immune system quality which is proportional to reproductive success. This does not mean that we should accept symmetry as one of a few universals principles of beauty that will work equally well for architecture, landscapes, all bodily form and so on. Making decisions or selections of habitat and mate are specific problems that involve different aesthetic domains and information-processing mechanisms. High attribution of symmetry in architecure may rather be a demonstratation of

anthropomorphism derived from adaptations for aesthetic value in human bodily form rather than a direct result of an adaptation for aesthetic value of landscape features. This brings us from looking at architecture literally as a part of nature to the implimention of Darwinian analogies and metaphors to assist in the creative process.

Analogical Extensions

In a Darwinian context an analogical process might be one in which architecture is considered a form of artificial life, subject, like the natural world, to principles of morphogenesis, genetic coding, replication and selection. Finding an equivalent formal system to model different natural systems requires an encoding of the natural system into the formal system and visa-versa. The aim of an evolutionary design may be to achieve in the built environment the symbiotic behavior and metabolic balance that are characteristic of the natural environment. However, when using analogies form science one must be aware of the difference betweeen the creative and discovery processes.

> "On the one hand, there is design work that homes in on a best move or forced move which can be seen to be a uniquely favored location in Design Space accessible from many starting points by many different paths; on the other hand, there is design work the excellence of which is much more dependent on exploiting and amplifiying the many contingencies of history that shape its trajectory, a trajectory about which the bus company's slogan is an understatement: getting there is much more than half the fun". Dennett (pp. 140,1995)

Though atypical of scientists, architects engage in journeys without difinite destinations: solutions to problems without specific answers in design space. Also, in science actual idiosyncratic choices made along the way may be disregarded, leaving no trace in the final, the right answer. However, according to Holyoak and Thagard (1996) analogies used in science are invaluable in the discovery, development, evaluation, and expostion theories. For example, artificial selection performed by breeders, who exploited the inherent variability in animals and plants to choose desired features leading to new breeds, aided Darwin in developing explanations and in arguing for the acceptability of the theory of natural selection.

The goal of this research was to generate a personal position on explicit application of analogies between artificial and natural systems and to develope an understanding of its purpose in the design of architectural artifacts. In doing so I began by specifying areas that I beleived to be intersesting in terms of relating computational design theory and the theory of natural selection to the architecural arifact. I have described and elaborate on these topics of form, function and beauty; systemic levels of composition; strategy; and movement; in the following chapter which attemps to analize possible analogies between artificial and natural processes of form generation.

Electronic Technologies

The conditions of producing architectural assemblies in partnership between designer and electronic technologies was considered and practiced throughout the thesis. There is no doubt that electronic technologies have and will continue to alter many aspects of life, including design. Mitchell writes: "This revolution has spread throughout the world in just a few decades. It has been an order of magnitude faster than the Industrial Revolution, and two orders faster than the agricultural Revolution. Just as the Industrial Revolution replaced human muscle power by energy-consuming machines, the Computer Revolution is replacing human brain power by information-processing machines." The development of these technologies have established new and rapidly growing fields such as Artificial Life which penetrates so many different disciplines, it is still too early to grasp what AI actually is. The goal here was to begin establishing a position and an understanding of the means and conditions that will be inherent in the production of architecture in the digital era.

In the industrial age we have seen architects designing and constructing with tools and making processes that specialized in extending powers of mass production and preventing the physical and continual control of the individual. This tradition of production led to the common execution of simple parts and repetitive components. Representation through media pertaining and involving right angles and perpendiculars such as plan, section, and elevation have directed and developed design ideas. Limits imposed by a process of construction have touched every facet of the built environment. These leftover industrial era conventions have separated the intent, imagination, and intellect of the architect from his skill, power and control.

The capacity of the computer as a metamedium allows for investigation and simulation of many tools and allows architects to rapidly and simply analyze multiple iterations of proposals and to assess their implications at an early stage and to refine and detail them at a later stage. 3-dimensional modeling in the computer and physical modeling may now be more directly transferred. Rapid prototyping processes permit fabrication of more accurate, non-repetitive, and complex physical forms and also allow for the development of geometric models from constructed physical models. The organic process of growth and form can be transformed into code and conversely be expressed back in the physical environment. Many conventions imbedded in the process can be directly manipulated to deliver the intent of the architect. This approach allows for devising solutions and crafting form out of inventiveness rather than remaining within an existing tradition or canon of architecture.

Mitchell predicts "that there will be a de-skilling of designers - a development closely analogous to the de-skilling of craftsmen that took place in the Industrial Revolution of the nineteenth century." The position I have taken in the thesis is one of partnership of designer with computation in order to develop a relation in which one may use the attributes of the computer to accelerate and extend what I hope may be regarded as the intellectual and imaginative ideas of the thesis. As more nonlinear approaches to design are adopted, digital machines will assist in in from, display, and produce the complex interactions of architectural synthesis.

Sustainability

The industrial revolution's view and processes imposed single cause and effect relationships of linear thinking on the world. As this standard, consumptive and universalizing process manifested itself, the sense of locality has inevitably faded from architecture in most regions of the world. Where indigenous cultures once approached their design with the depth that touched every aspect of the life they now adopt unnecessary and trite gestures and devices that are an admission of alienation from the genius of their particular landscape. Industrialized making process and products have ignored the complexity of natural living systems and this closed loop process is a limited strategy.
Architecture must now allow the intense flow of energy in and out of its systems. Instead of a closed form we must now have multiple coexisting forms of varying comlpexity where there are strong mutual interactions among the components of architecture in which their precise expression is environmentally dependent.

Relatedness of Phenomena

The exploration of these phenomenons was an aim to establish the reunification of archtiect ure with craft and the convergence between an information society and a sustainable society in order to create the potential for designing in the next millenium. By harvesting the information of nature and using current technologies, architects may have more direct control to shape approcpriate manifestations of form in response to the physical phenomenons oi nature. The organic process of an environment may be expressed in contemporary culture as abstract, atificial, physical, and natural.

Research Question

What is the conception, process, and understanding of the architectural artifact from a Darwinian perspective and how might architects develope strategic relations between natural and artificial systems using this approach.

The development and conceptualization for the thesis began with the belief that one must establish new patterns and a new framing of a question in order to go beyond any existing illusions. In design space exists the empty set, which contains all the possible design worlds. The first thing was to establish a context for the design world through the research of new scientific paradigms and biological phenomena. In structuring the question I began establishing components that would describe it. By establishing mental relations and assemblies of the components I could begin to describe the action and mystery of the question. In describing the design world, I established what one might call principles of action: action at the milieu, action at a distance, and action of the multiple.

Action at the Milieu:

C. S. Lewis spoke of a phenomena that he observed of people who in trying not to fall off of the left side of the horse would fall off on the right. I describes a situation that one finds at points of bifurcation. In nature there is something called an ecotone, which is a transitional zone between two adjacent ecological communities exhibiting competition between organisms common to both. I believe that these ideas are synonymous with the Hegelian dialectic process of thesis, antithesis, and synthesis. At the interface of different realities is where synthesis of great importance lie: at the thresholds of contradictions, at the middle state. While embarking on the thesis, I beleived this notion is appropriate.

"The Middle is by no means an average: on the contrary, it is where things pick up speed. Between things does not designate a localizable relation going from one thing to the other and back again, but a perpendicular direction, a transversal movement that sweeps one and the other away, a stream without beginning or end that undermines its banks and picks up speed in the middle." Deleuze/Guattari

Action at a Distance:

The next description of my question was that of abstraction. This query came about from multiple thoughts and experiences. For example, in the process of glass blowing one must distance himself from the material that he is shaping; this is done with a blow pipe. There is also the seperation that one has from the unconscious or subliminal realizations of adaptions which underlie our phsycology. These underlying abstractions are packets of information which shapes and evolves form within the biosphere and the noosphere. The physical and bahavioral form of organisms are shaped by their particular genome. Finally, Dawkin's idea of the extended phenotype (1982), which states that the effects of genes upon the world are not just within the individual body in which the gene sits but effects , demonstrates action at a distance. Architecture may also be produced from a distance.

Action of the Multiple:

Multiple refers to the elements of our design world and the emergent, complex, adaptive and strategic relations that are extapulated from it. The relations and mapping of such systems as the natural and artificial, the genes of an organism, organisms in a society, or the techtonic assemblies of architecture reach particular states or phases through manipulative skill. When looking at assemblies as multiples, the composite body or building goes invisible and we see the underling relations which reveal and how systems have coevolved through conflict or selfishness, symbiosis, manipulation, and arms races.

Points of Query and Discussion

Analogical Process in Creative Design

Examples of analogical thinking, such as Darwin's analogy of natural and artificial selection, the use of analogy for invention in design and explanation in science, and past architectural analogies that implemented Darwinian ideas, have all benefited from looking at what is already known in order to make a connection for the purpose of solving the unknown. The extraction of relevant analogs from the vast exisitng knowledge is where the construction of creative and generative analogies begins.

Extracting tracings of complex reality requires a shift from implicit reaction to explicit thinking. Inappropriate extractions, such as physical attributes in many cases, often evade one from finding and mapping the relations that lead to a "mental leap" in discovery or invention. As Holyoak and Thagard state (1996), "In analogical decision making the optimal system mapping depends on having matching facilitation relations between the source and the target analogs: it is important to find cases in which similar actions facilitated similar goals". They propose similarity, structure, and purpose of analogs as helpful to facilitate understanding in a new domain.

In searching for source analogs for the purpose of inspiration in creative design, the mapping of analog structures may not be as crucial as the purpose of using the analog. Also, the creative process can gain more form looking at multiple source analogs for inspiration, understanding, and decision making, rather than drawing from a single analog. One may derive the strongest possible justification when multiple source analogs are mapped to the target at the system level (Holyoak and Thagard, 1996).

With the purpose of establishing new understanding in the domain of architectural design I have established three relations that I are significant causes in making artificial artifacts analogous to natural phenomena that are provided by the Darwinian paradigm: form, function and beauty; systemic levels of composition; strategy, organization and adaptation; and movement. These are generally derived to map natural systems to artificial assemblies in a generative processes for producing novel form.

Newsweek · June 3 · 1996

The Biology of Beauty

What Science Has Discovered About Sex Appea

23

Form, Function and Beauty

We have learned from Darwinism that beauty adaptations are special purpose, not general purpose. This means for instance, that becuase symmetry is a measure of human beauty it does not necessarily mean that it is a measure of beauty in habitats or built form. This leads to the realization that there will be many aesthetic rules, and they will be highley specialized in application. Superficial thinking might lead one to think that there are a few principles of beauty that work well for all domains. With this in mind, lets do it anyway. The analogy one may draw is that of architecture as organism, and the purpose of the analog is to derive beauty. Therefor, if a building is similiar to an organism it's beauty may be measured by its level of symmetry.

However, unlike organisms, buildngs, with some exceptions, are not required to travel. But similiar to organisms, architectural artifacts are a part of a lineage and they do have an ontogeny. When symmetry is used in describing facial beauty, it is obviously bilateral symmetry that is meant. However if one takes an early meaning of *symmetri*a according to Polyclitus, one would be describing a form in which all the parts have a dimensional relationships with the rest in an appropriate system of ratios. As mentioned earlier, symmetry is very difficult to achieve in nature because disease or defect can disrupt it. Symmetry is a demonstration of a well functioning morphological system. Principles of morphonenesis that require relations of all parts may provide a more functional artifact of design if it has responded well to environmental demands. The aspect of the analogy is that the beauty experience of architecture is a promise of function as is the perception of facial beauty. This puts into question existing views of formal, utilitarian and associative aspects of beauty being different things.

DNA REPLICATING ITSELF

REPLICATORS
algorythms
level of natural selection
immortal germline replicators
competeing for a better venicle

GENOMES
&
ALGORYTHMS

MERGERS

REPLICATORS - ANY ENTITY IN THE UNIVERSE OF WHICH COPIES ARE MADE

It is fundamental to the idea of a replicator that when a mistake or a mutation does occur it is passed on to future copies: the mutation brings into existence a new kind of replicator which 'breeds true' until there is a further mutation.

EVOLUTION - DESCRIPTIVE - ALGORYTHM - COMPUTATION - SHAPE GRAMMAR

GENOME

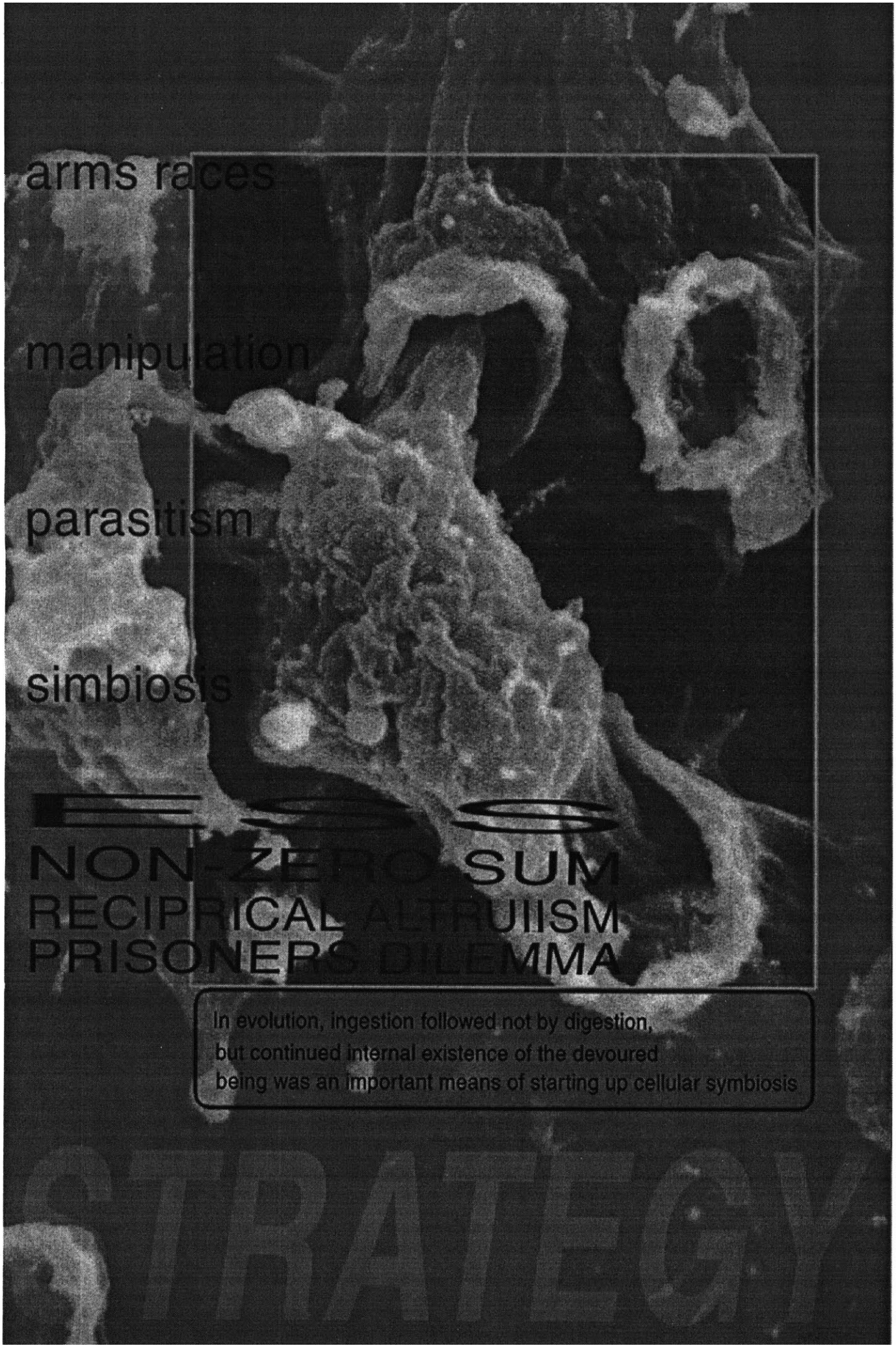
any heritable information for which there is a favorable or unfavorable selection bias equal to several times the rate of spontaneous change

Systemic Levels of Composition, Organization and Adaptation

Understanding design in depth requires knowledge in many levels. Analogous to natural lifes fundamental levels of structure: the molecular level, the cellular level, the organism level, and the population ecosystem level, a building at any of these levels is a complex adaptive system exhibiting behavior that emerges from the interaction of a large number of elements from the levels below. Nature and architecture involve a multi layer, multi systemic interaction that can be described as a stratification of the abstract, the extant, and the novel.

0.	the molecular level	---
I.	genetic level: replication	gene, meme, code/ information
II.	organism level: morphogenisis	Individual artifact/ physical
III.	population level: environment	climate/environmnet/exosymatic
IV.	---	fourth level:synthesis

There is no form in elementary particles of matter - ie points (level 0.), so the relationships between constituent parts can be described by finding higher level particles such as lines (level I.) Level one of the analogy describes the genetic level of building or the level of replication, which describes the combinations and relations of all basic components.
The organism level is analogous to the individual building that we are used to describing in architecture (As A..... believed, a description of lines might be an appropriate architectural description of theis level). In Darwinian terms these would be the vehicles that carry replicators. Replicators are the information packets guiding the morphological process. In literal terms Dawkins (1984) would call these extended phenotypes of the genes, which constitute our physical and behavioral form. The population level (III.) maps over to the environment and the level of extension, interaction, and feedback that the architecture is a part of.


arms races
manipulation
parasitism
simbiosis
NON-ZERO-SUM
RECIPRICAL ALTRUIISM
PRISONERS DILEMMA
In evolution, ingestion followed not by digestion,
but continued internal existence of the devoured
being was an important means of starting up cellular symbiosis
STRATEGY

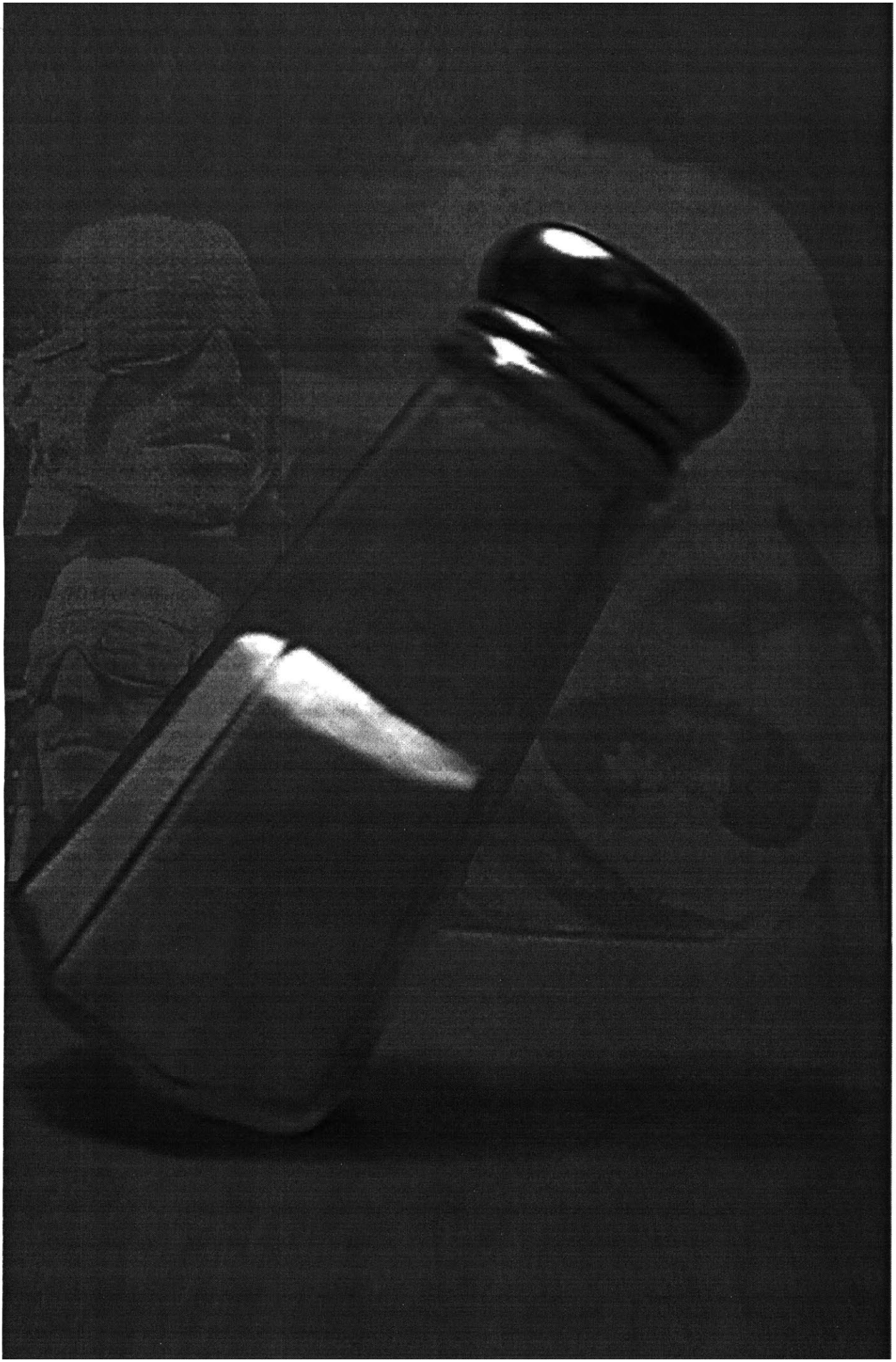
Strategy

Analogous to nature and as a literal extension of nature, architecture may respond with intelligent design strategies. Often architects have sought to create an architecture that fits their view of either a very ordered world, as seen with many utopian visions, or a very chaotic world, seen in some deconstructivist work. By avoiding simple dichotomies and integrating the two approaches, drawing on the best of both, one may move beyond the centralized mindset of control and the mindset of disorder. A more creative strategy fuses opposites and brings unity to disparate parts; nature does this while minimizing costs and maximizing benefits.

Natural systems operating through natural selection, develope environmental stable strategies, an ESS, through evolutionary time. Arms races, symbiosis, reciprocal altruism , coevolution, manipulation, and unification are some of the means of reaching an ESS. Natural systems operating at the level of the individual organism, often aquire a developmental stable strategy, a DSS, through the individuals lifetime.

These states or phenomena found in nature are about the relationships and organization of complex systems. Architecture as a comlex system may find form by subscribing to some the organizational methods of natural systems. Architecture uses energy, material and time to produce and operate. Therefor the literal ramifications on an ecological level will increase the quality of architecure and of future life. Developing analogs from these phenomena and applying them to the ontogeny of architectural form will provide higher organizational states and more interesting results with increased benefits at a lower cost.

For example if one takes the lessons from prisoners dillema, a strategy exercise developed by game theorists (see ....,) he may see how strategy can be implemented in design as it is in nature. Prisoners dillema is an example of how beneficial it may be to establish situations of reciprocal altruism. In nature there are many examples where an individual induces the effectors of another individuaol to work against its own best interests, and in favour of the interests of the manipulator (Dawkins 1982). In an environmental stable situation the manipultation may be reciprocated, maybe in different shape or form, causing a relation that benefits the sum in a way that the parts alone could not benefit. A simple example of this is seen in the battle of the sexes, where one finds difference and equality



Movement

Form in nature is a product of movement. Static forms have histories that reveal the flow and movement of their morphology. Kinesthetic forms have the same and also reveal movement that may be directly percieved. Form flows in lines of the least resistance at the moment a force acts upon it.

> ...some "fail to realize that animals carry baggage from their evolutionary ancestors. Readers young enough to have had sex education or old enough to be reading articles about the prostate may have noticed that the seminal ducts in men do not lead directly from the testicles to the penis but snake into the body and pass over the ureter before coming back down. That is because the testes of our reptilian ancestors were inside their bodies. The bodies of mamals are too hot for the prodcution of sperm, so the testes gradually descended into a scrotum. Like a gardener who snags a hose around a tree, natural selection did not have the foresight to plan the shortest route". (Pinker, p. 166, 1997)

Degrees of development in nature and in organisms operate at differential speed, rate and relation depending on the level that you are observing. Movement through time is relative to the medium that it is operating. Biological movement operates over millennia because of the replicating DNA that it must flow through in the process of natural selection. Cultural movement occures over years. Ideas that take form may be transformed through exosomatic movement, that may take form in books or digital media, which may change in a matter of seconds. Memory, history and moment.

I want to switch emphasis from the individual building as a focal unit of functional discussion to become aware of how much we take for granted when we look at architecture as a collection of discrete individual buildings. Just as looking at the individual organism through a Darwinian perspective has changed our concepts of their assemblage so must our diagrams shift to transform architecture.

"We look at life and begin by seeing a collection of interacting individual organisms. We know that they contain smaller units, and we know that they are, in turn, parts of larger composite units, but we fix our gaze on the whole organism. Then suddenly the image flips. The individual bodies are still there; they have not moved but they seem to have gone transparent. We see through them to the replicating fragments of DNA within, and we see the wider world as an arena in which these genetic fragments play out their tournaments of manipulative skill. It happens that they have 'chosen' to do so largely by molding matter into large multi-cellular chunks which we call organisms, but this might not have been so". Dawkins, *The Extended Phenotype.*

PARADOX: THESIS ANTITHESIS: SYNTHESIS

"Selection versus constraint is a phony dichotomy, as crippling to clear thinking as the dichotomy between innateness and learning." Daniel Dennett

TRIPARTITE DIVISIONS AND CONVERGENT TRACINGS

INFORMATION	PHYSICAL	EXOSOMATIC
ORDERED	GRADIENT	DIFFUSE
CODE	SUBJECT	REALITY
INATE	EXPERIENCE	ENVIRONMENTAL
THESIS	ANTITHESIS	SYNTHESIS
ABSTRACT	NOVEL	EXTANT
GENETIC	CULTURAL	EPHEMERAL
MICRO	MILIEU	MACRO
REPLICATORS	INDIVIDUAL	ENVIRONMENT
BOTTOM-UP	TOP-DOWN	COMPLEX
SUBSYSTEM	SYSTEM	METASYSTEM
DESIGN STANCE	PHYSICAL STANCE	INTENTIONAL STANCE
RULES	REPRESENTATION	BELIEFS
HEREDITARY	MORPHOLOGY	ECOLOGY
GENOTYPE	PHENOTYPE	EXTENDED
PHENOTYPE		
DAWKINS	D' ARCY	MACDONOUGH
NATURAL SELECTION	SELF-ORGANIZATION	MULTI-LAYERED
RIGID ORDER	LOOSE ORGANIZATION	ENTRAPY
BOTTOM-UP	INTEGRATION OF INPUTS	TOP-DOWN
EXACT	ANEXACT BUT RIGOROUS	INEXACT
REPEATABLE	IRREDUCALBE	NONDESCRIPT

RIGIDIFIED TERRITIORIES AND BI-POLAR UNIONS

LOGICAL	-	PERCEPTUAL
PARTICULAR	-	GENERAL
SELFISH	-	COOPERATION
MONISM	-	PLURALISM
ARTIFICIAL	-	NATURAL
STATIC	-	KINESTHETIC
INATE	-	SENSORY
FUNCTION	-	FORM
DETERMINED	-	ENVIRONMENTAL
INHERENT	-	LEARNED
NATURAL	-	CUSTOMERY
FORMAL BEAUTY	-	ARBITRARY/BEAUTY
NATURAL BEAUTY	-	CUSTOMERY BEAUTY
DEPENDENT BEAUTY	-	FREE BEAUTY
PARTICULAR	-	GENERAL
IDEAL	-	REAL
ORDER	-	CHAOS
AUTONOMOUS	-	RELIANT
MIND	-	MATTER
SOLID	-	VOID
EVERLASTING	-	EPHEMERAL
MATERIAL	-	EVANESCENT
LIGHT	-	SHADOW
THICKNESS	-	THINESS
WEIGHT	-	WEIGHTLESSNESS
OPENING	-	CLOSURE
NATURAL	-	IMAGINED
EXPLICIT	-	IMPLICIT

SUBSYSTEM THESIS:

Analogy

The subsystem is the information processes of abstract assemblies. At the subsystem inferances of explicit high level relationships are established, constructing a general code or assembly. If this code has a purpose it is a mechanism with the means operate and may be called an algorithm. The purpose of an algorithm in nature and in architecture is to build things. Darwinism demonstates that nature operates under the subtle algorithic process of natural selection. Natural selection is mindless, indefinite and involves the random jostling of during stages of reproduction. Architecture is directed design, however many great architects demonstrate effective use of chance. The chance of natural selection is the random jostling of genetic information and possbile mutation. An assembly of genetic code in nature is called a genome and is synonimous with human computation that may be described as abstract, formal and explicit mental assembly.

Form, Function and Beauty

Abstract assemblies may be considered beautiful, just as an idea may be considered beautiful. However, these models may be invisible or hard to percievable. The form is embedded in information such as, algebras that may generate form through the execution of a computation. The subtle structures may be discovered in nature and are called adaptations. A particular species has a general DNA code which contains the direction for creating the adaptations or "knobs of evolution". These nobs exist in all the members of the species. They may be called nobs because they may be finetuned and the particular intanciation vary across a spectrum.

Level of Compostion

Systemic composition of information processes, can be desribed as top-down in that they are general and highly abstract. However, an architectural computation may be bottom up if specific elements are combined in an additive processes or composition. A simplification may be to say that the replicators are assemled to form DNA are bottom up in that they may be added or removed from generation to generation. However, concantination between all the established components may be the actual case. The interesting thing about this level of compostion is that the abstraction enables high level relations to be established in the notation in a top-down approach. This enables the differnces of objects to become malleable toward the overall structure rather then having rigid individual parts.

Strategy

Uniting the old dichotomy of natural or artificial both algorithmic processes. Though there are differences with the technology and that of natural processes there is much similarity.

Movement

Movement of replicators or information packets through evolutionary time may take millenia to change much. However, artifial replicators may change in milli-seconds. The convergence of computation with natural processes may enable the “immortal germline replicators” to be altered in a matter of seconds in the next decade.

SYSTEM:ANTITHESIS

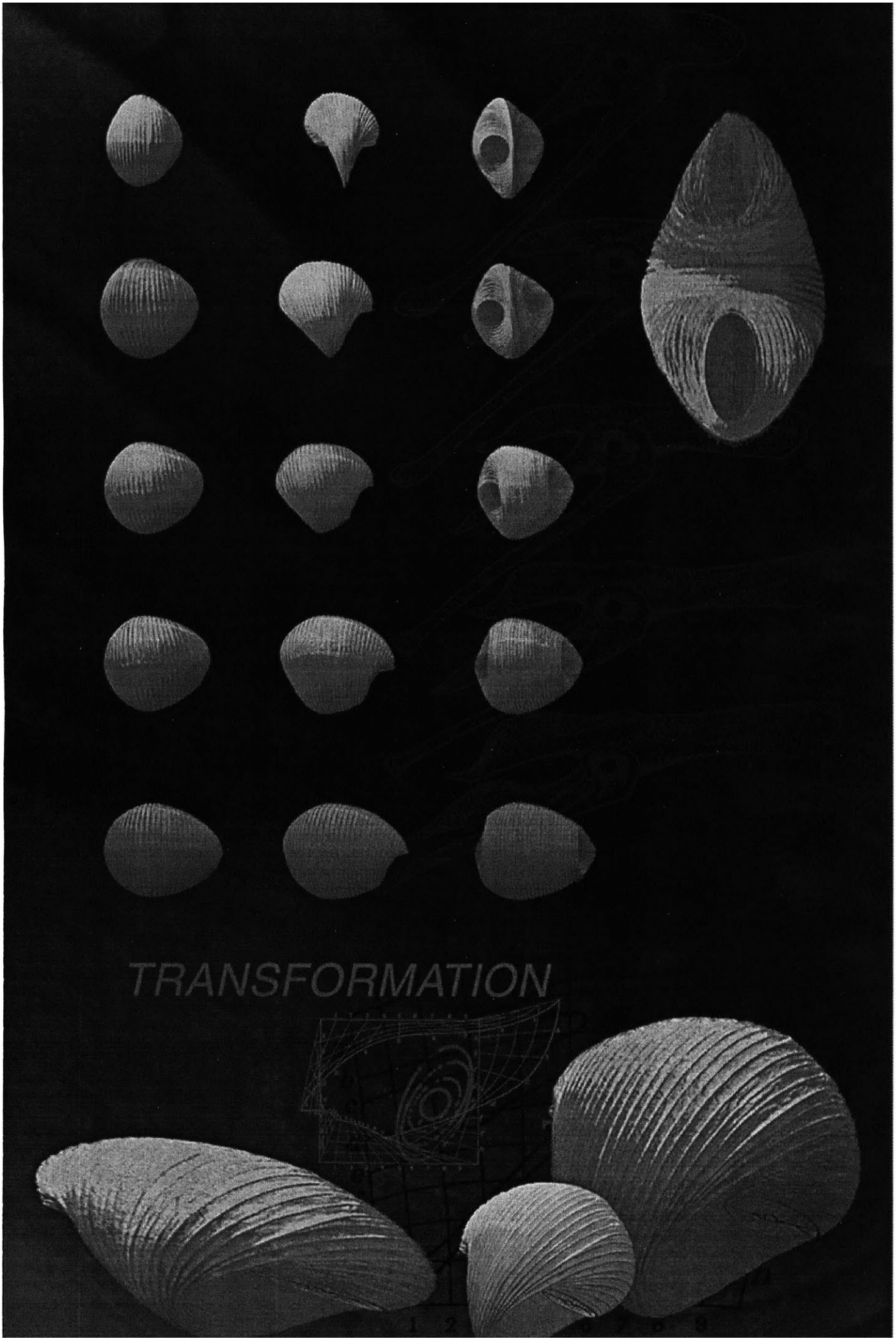
COMPOSITE BUILDING SYSTEM AND ORGANISM
The composite building or organism are extant physical processes, and the morphological process are subject to the laws of physics and thermodynamics. These assemblies may be considered the phenotypical expressions of the subsystem. It is an embodiment of the many mergers that have occured through the history and assemblage of the information processes. These phenotypical expression are situational rather than universal.

Developmental stable strategy may be established through in the course of the assemlies lifetime. These adjustments will not be tranmitted into the code of an organism. In an artificial assemly, outside forces will alter the structure, but the notation will have to be altered .

MACRO-SYSTEM: SYNTHESIS
C. novel - complex living system
not acted upon but interacted with
the environment is alive - living system

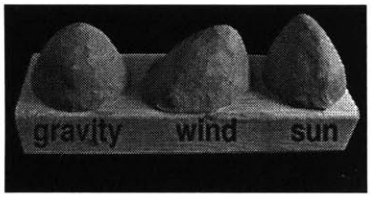
META-SYSTEM: MULTIPLICITIES AND ASSEMBLAGES
UNITY AND VARIETY - ISOMORPHISM AND TEMPERARY EQUILIBRIUMS

D. Assemblage and Fusion of Systems
rhizomes and lines of flight
maps
the tracing should always be put back on the map
the essence of the map or rhizome to have multiple entryways


TRANSFORMATION

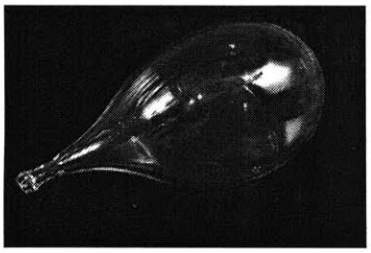
Implementation of Thesis: Design Project

Early Exploration



from mental map to physical model

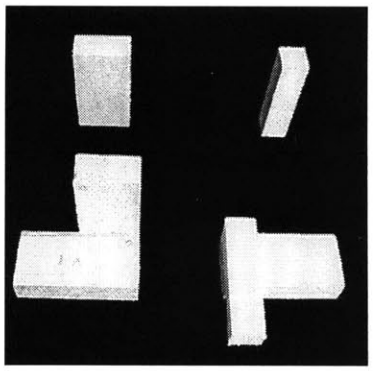
Process



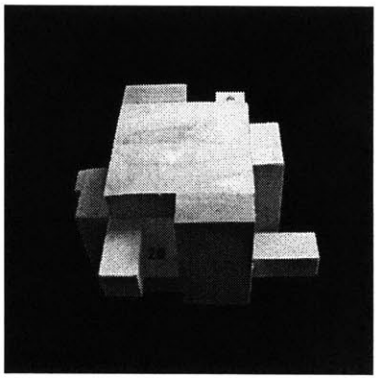
I began with the notion of process as algorithm. This meant exercising various sorts of formal processes that could be counted on - logically- to yeild a certain sort of result whenever it was instantiated. There was a high degree of variance as in the control of the process, depending on the medium of operation.

Action From a Distance

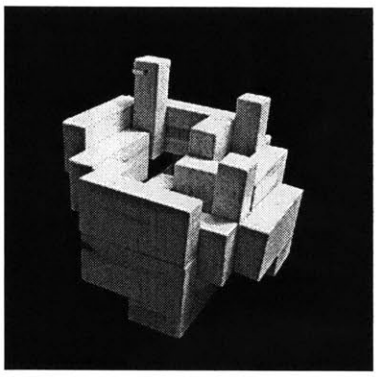
Early non-architecturasl explorations where done with the intention of finding algoritmic ways of generating form. A simple diagramatic blob study was done to look at what simple forms might emerge in response to natural forces acting upon them, such as gravity, wind and the sun (fig. XXX). Next, I produced glass blow objects (fig. XXX). One may say that these represent a process of algorithmic craft in which one must direct the material with repetative procedures that involve the coordination of intent, eye, hand, tool, and the laws of thermodynamics. Glass blown objects have a developmental cycle in which the material is altered and early moves establish the point of departure on the next move and so forth. This process (at least the traditional glass blowing method that I was introduced and practice as a beginner) does not allow replication of the exact object. Techniques are established, adopted, shared and practiced which develops the craft. Blob type forms where explored which are responded to the movement and the force of air, gravity, and heat. The action of the these forces and the action of the artist's moves and intent, bring form to the material.



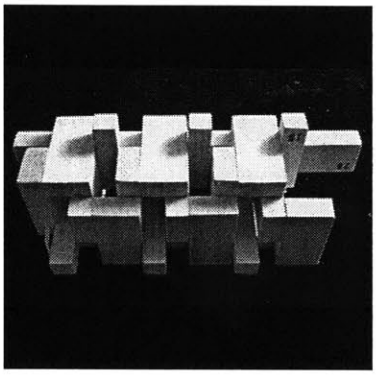
Action of the Multiple

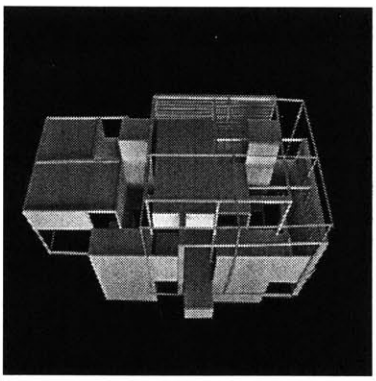


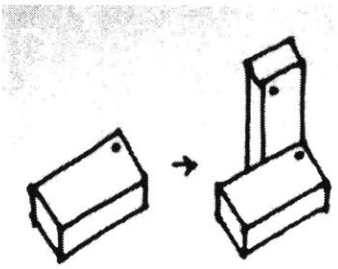
An exploration in shape grammar was done. Just as glass blowing, shape grammar involves the close interaction of mind, hand, and eye. I began this exercise by selecting shapes, relations between shapes, and rules to procede with iterating the established relations. This process is interesting because the relations can be seen in many different ways. The asseblies go through a layering process decision making where design decisions may change the rules without losing the visual, physical and grammatical relation of the parts. The "parts" may also be quite varied becuase of the many dimensions that are accecable to the designer. This process gives one access to 3-dimmensal design spacevery rapidly, with the emergence of complex assemblies based on rules established by the designer.



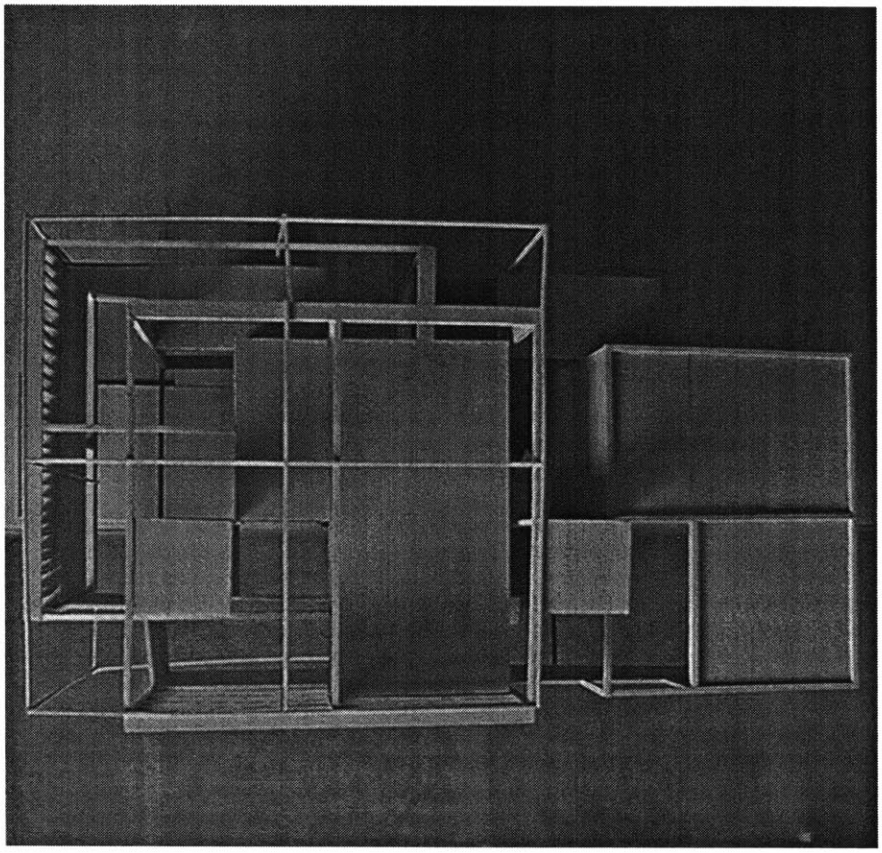
A large class of related algorithms where also studied in hopes that they might be brought together to produce a single architectural assembly. An early attempt at establishing a three algorithms that might converge via the spriral relation that they all had common.

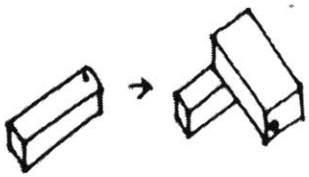




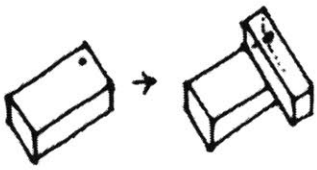


first spatial relation

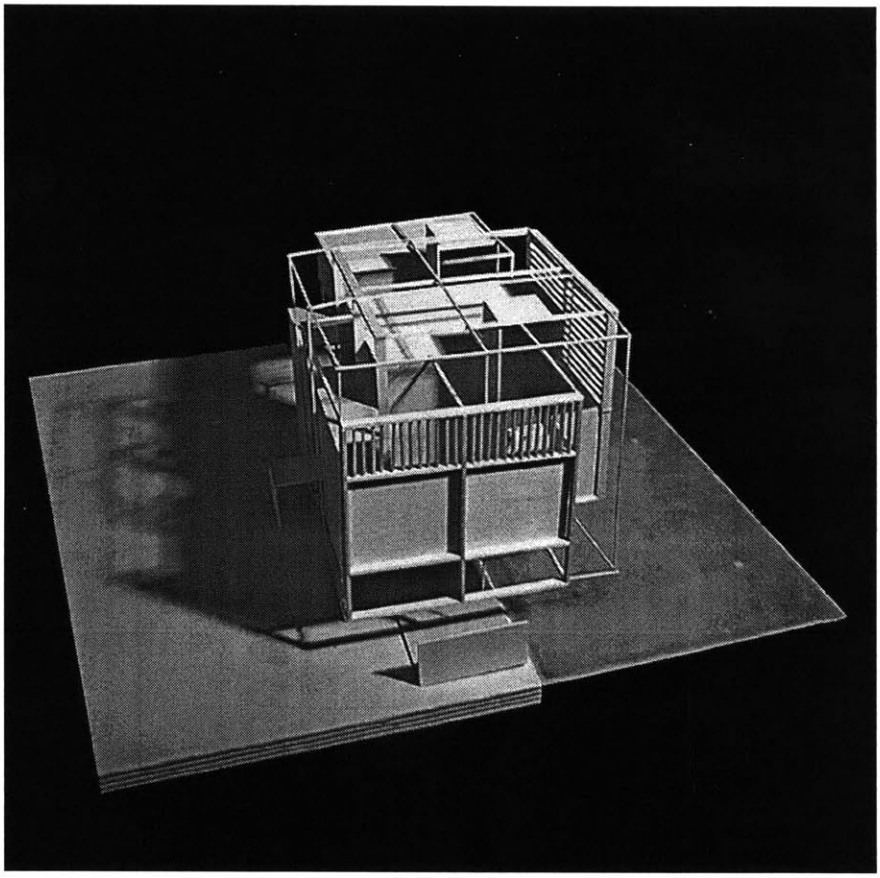




second spatial relation



third spatial relation



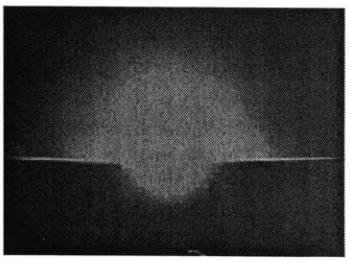
The TRINITY shot was a test to demonstrate the feasibility of constructing an atomic bomb for use in war. It was designed under the auspices of the Manhattan Project at Los Alamos, New Mexico. The design team was headed by Dr. J. Robert Oppenheimer.

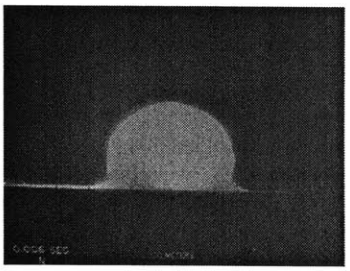
A test site for the atomic bomb was selected from a list of eight possible choices. A remote, desolate area was needed for security and safety reasons. The site chosen was on the Alamogordo Bombing and Gunnery Range in the Jornada del Muerto Valley, some 230 miles south of Las Alomos. The geographic coordinates are 33 degrees 40' 37.9" N / 28' 29.6"W.

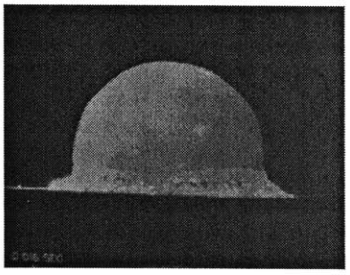
The primary test objective was to determine whether or not a plutonium implosion explosion device would then be "weaponized," that is, turned into a deliverable military bomb. After TRINITY the implosion device was engineered into the Model 1561 Fat Man. This type of bomb was dropped on Nagasaki, Japan during World War II.

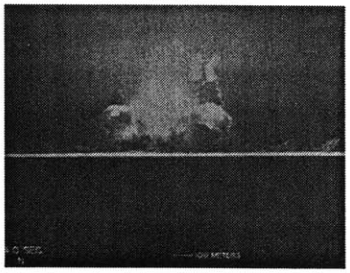
The TRINITY device was detonated at 5:29:45 a.m. Mountain War Time, July 16, 1945, on top of a 100-foot steel tower. The tower was instantly vaporized and became part of the debris that was swept up into the mushroom cloud. The fireball released heat 10,000 times hotter than the surface of the sun. Every living thing within a mile of the tower was obliterated. The mushroom cloud rose to over 38,000 feet within minutes. Soil and bomb unevenly distributed across the country. An inspection of ground zero revealed that the only remnants of the tower were metal stumps of the legs, embedded in concrete. The blast created a shallow crater nearly 2,400 feet across. Desert sand in the crater had been fused into green radioactive glass. This substance was intially name Atomsite, but later the name was changed to Tinitite. The explosive yeild of the device was estimated to be equal to 21,000 tons of conventional TNT high explosive.

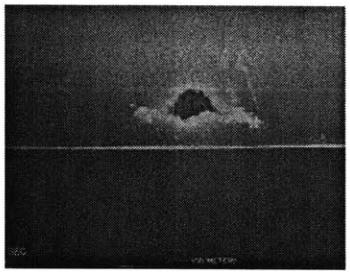
In late 1945, TRINITY Site was surrounded with more than a mile of chain link fence and posted with signs warning of radioactivity. In the early 1950's most of the remainingTrinitite in the crater was bulldozed into an underground concrete bunker nearby. The crater was then back filled with new soil. In 1963, the Trinitite was dug up, packed into 55-gallon drums, and removed by the Atomic Energy Commision. Trinity Site is only opened to public tours twice a year. Radiation levels at the site are 0.5 to 1.0 milliroentgens per hour. A lava obelisk marks ground zero. It bears a palque which reads: "Trinity Site Where the World's First Nuclear Device Was Exploded On July 16, 1945." It was Declared a National Historic Landmark in 1975.

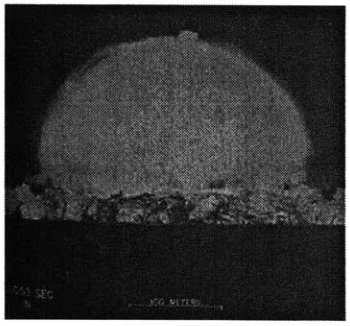


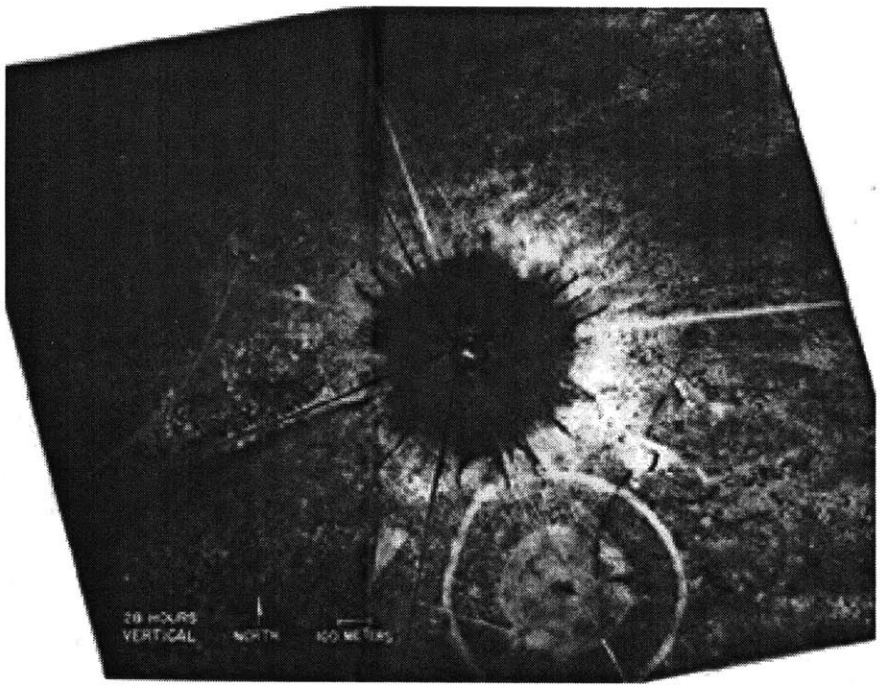


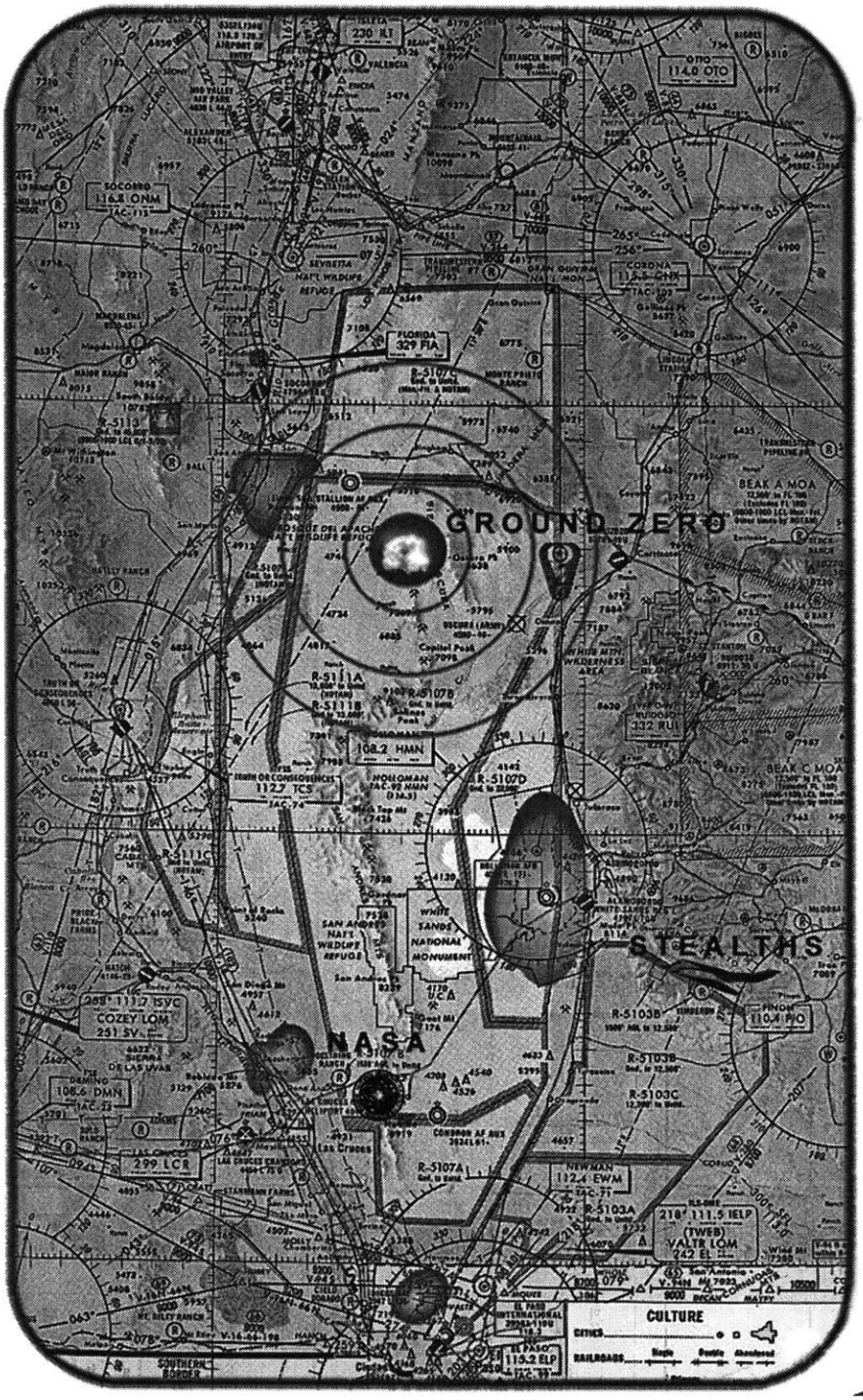


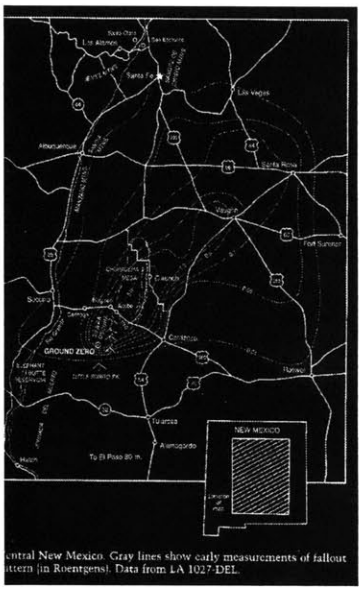








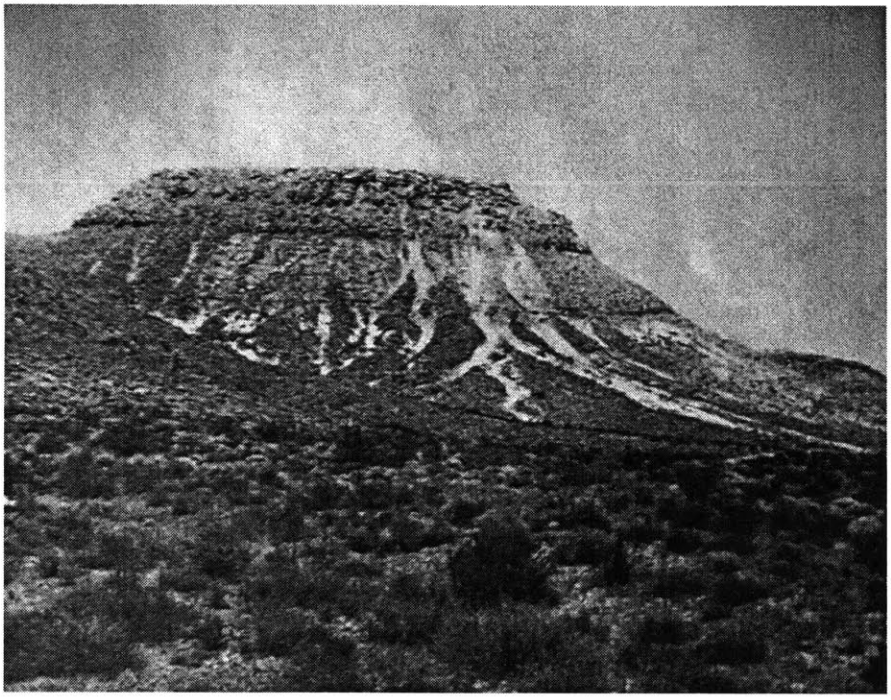

GROUND ZERO
STEALTHS
NASA
CULTURE

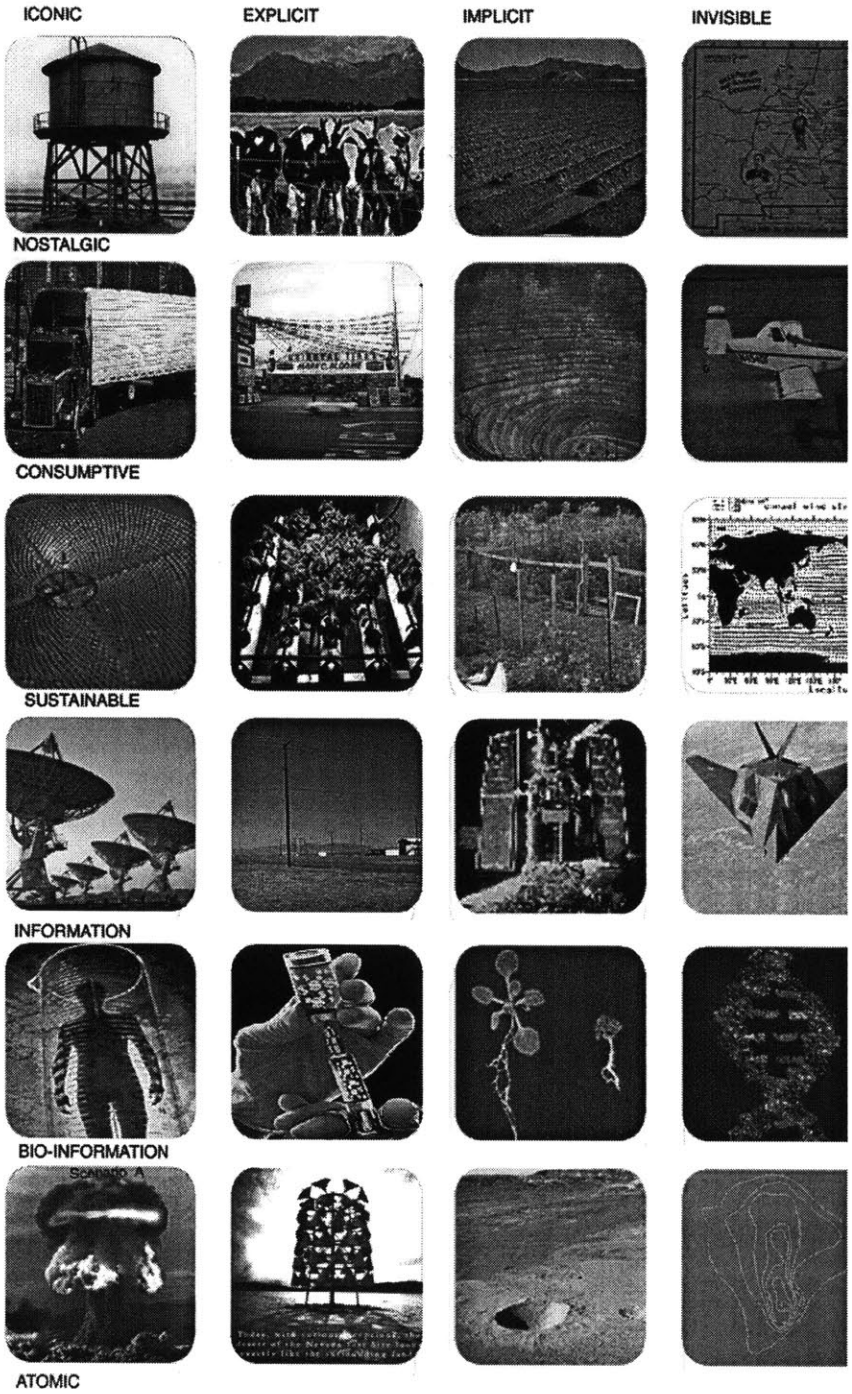


ntral New Mexico. Gray lines show early measurements of fallout attern (in Roentgens). Data from LA 1027-DEL

Fallout-damaged cattle and their offspring.

The US Geological Survey used water to erode the topsiol on this hill at the Yucca Mountain in order to study the fracture patterns in the bedrock caused by nuclezsr testing.



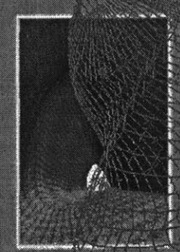

ICONIC
EXPLICIT
IMPLICIT
INVISIBLE
NOSTALGIC
CONSUMPTIVE
SUSTAINABLE
INFORMATION
BIO-INFORMATION
ATOMIC

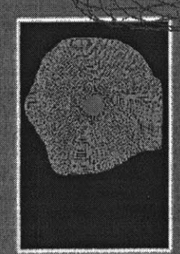

TRINITY SITE
I-25 AND

Design Ground Zero

BRIEF

Technology is increasingly ubiquitous and inescapable. The subtlety of artificial manifestation upon the landscape evade the consciousness of the individual. This condition forces upon us the existence of great tension between our idealogical framework and reality. The design aspect of thesis speculates processes of creating physical manifestations that reveal thier ontogeny as adaptations derived from the extant and ephemeral patterns of the tranfigured landscape and extracorporeal adaptation derived from the paradoxical dichotomies of the site.





BILLBOARD

One Mile

JOURNEY OF THE DEADMAN
jornada del muerto

GZ

OBSERVATION

Jornada Del Muerto

POINT OF INTEREST

THINGS

12

53

5

17

10

81

130

175

46

56

146

85

N

To Albuquerque

Peak

Socorro

San Antonio

380

Stallion Range Center

Trinity Site

Tularosa

Alamogordo

Las Cruces

To El Paso

El Paso

One Mile

TRINITY: 16 July 1945, Jornada Del Muerto, New Mexico (21 kilotons)

Historical Pl

sun altitude 5.61°
azimuth 112.07°

Fatman Bomb Casing

Footing from 100-ft. Tower

Ground Zero Monument

Shelter Protecting Portion of Original Crater

Removal of Trinitite Prohibited

fallout pattern measured in
ROENTGENS

25

54

380

70

Ground Zero

1/4 Mile Walk to Ground Zero from Parking Lot

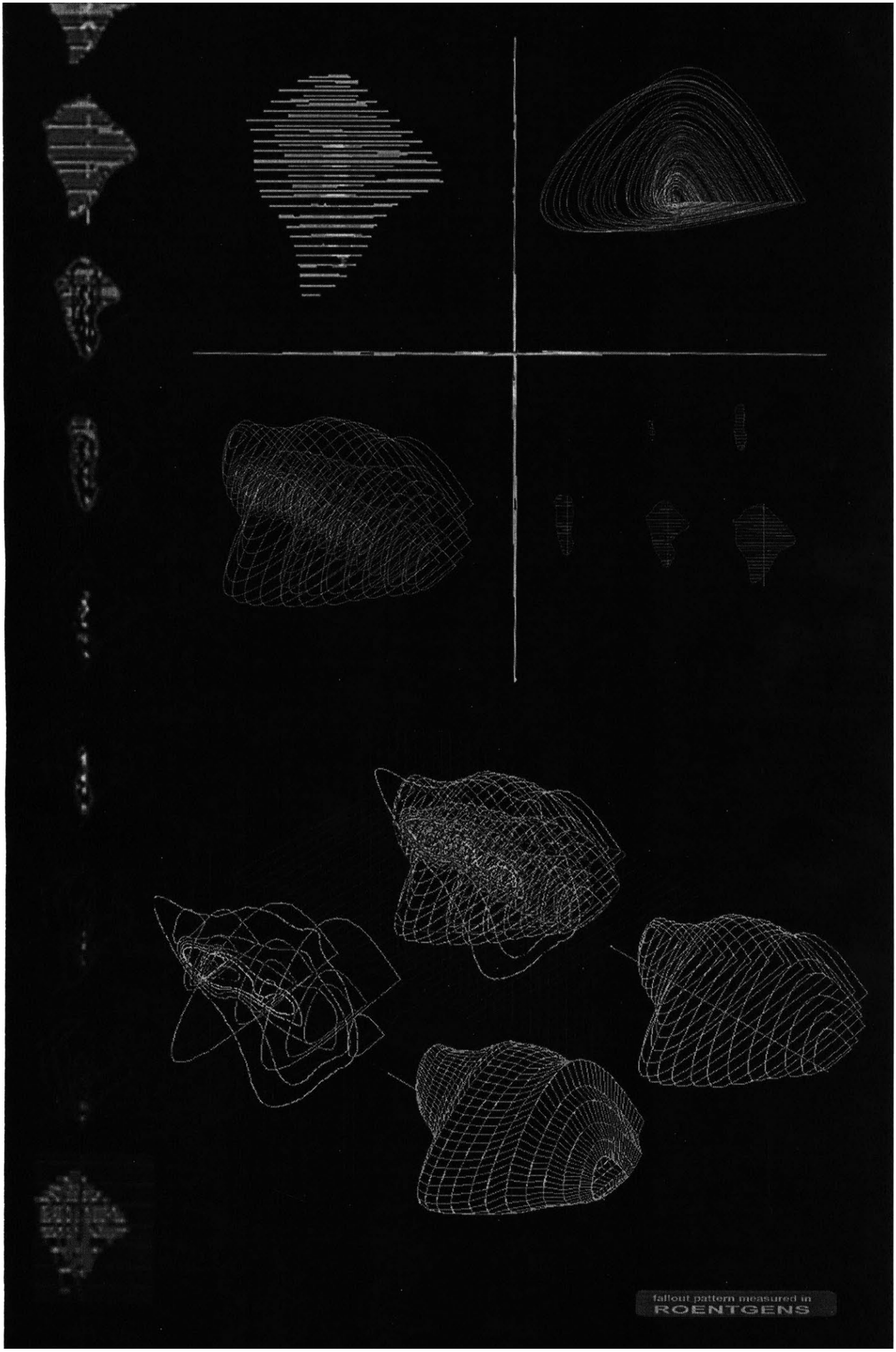
GROUND ZERO

Jumbo Jet Hotels

Parking

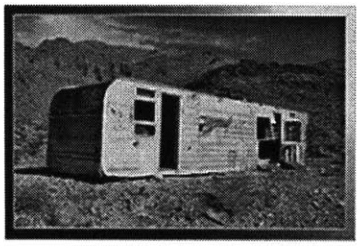
Parking

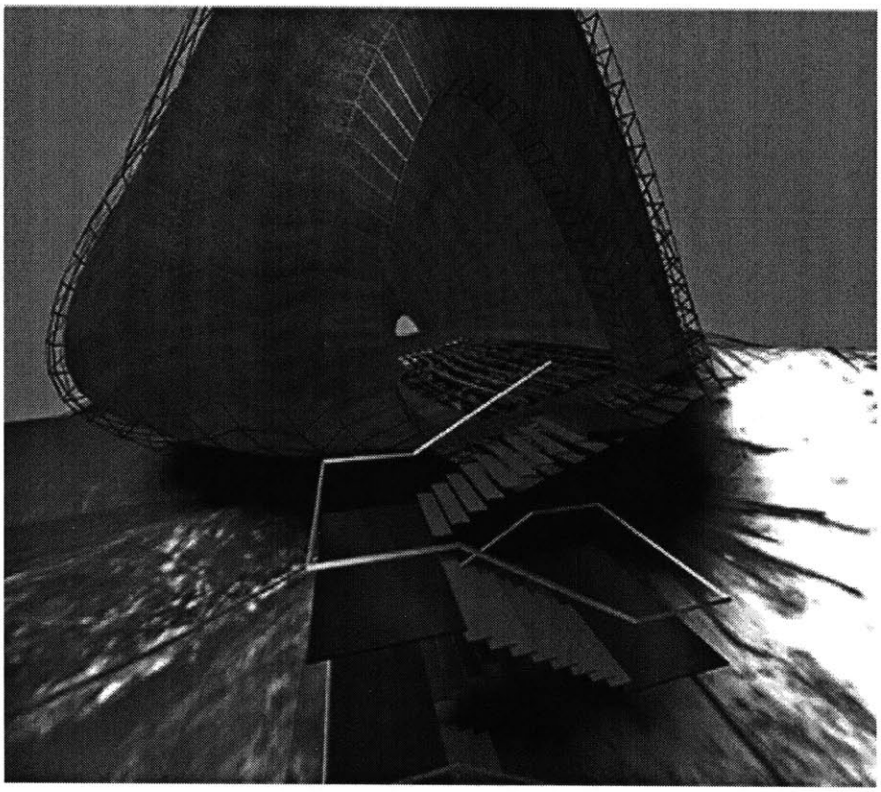
McDonald Ranch Bus

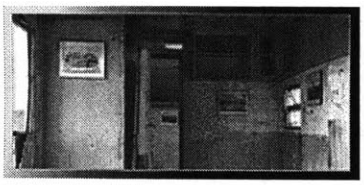

fallout pattern measured in
ROENTGENS

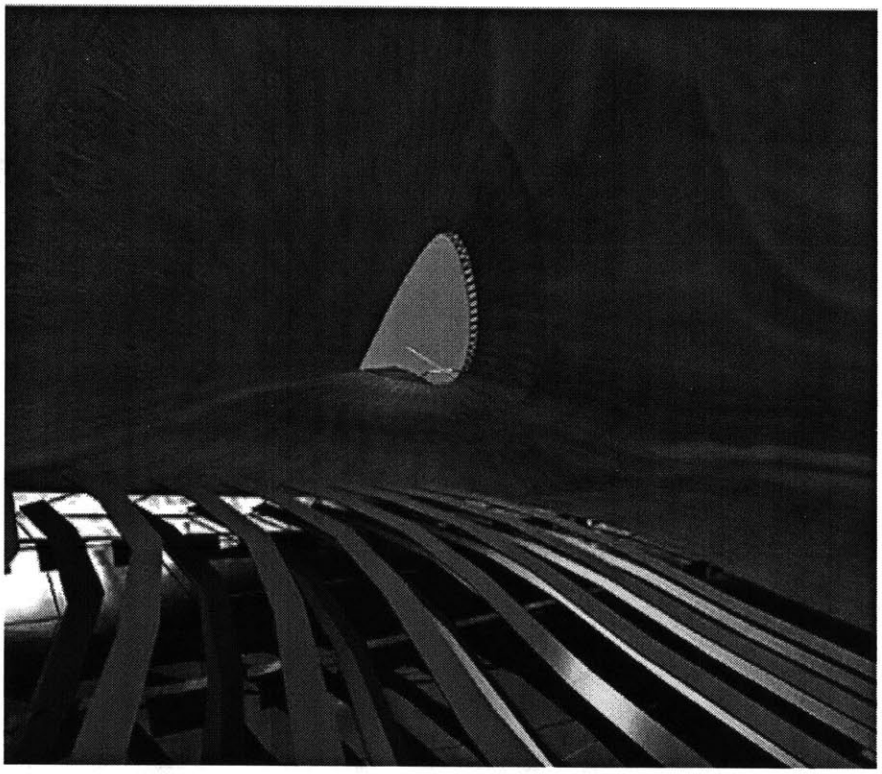

U.S. ATOMIC ENERGY COMMISSION
CLUI
TEST SITE
4 MILES

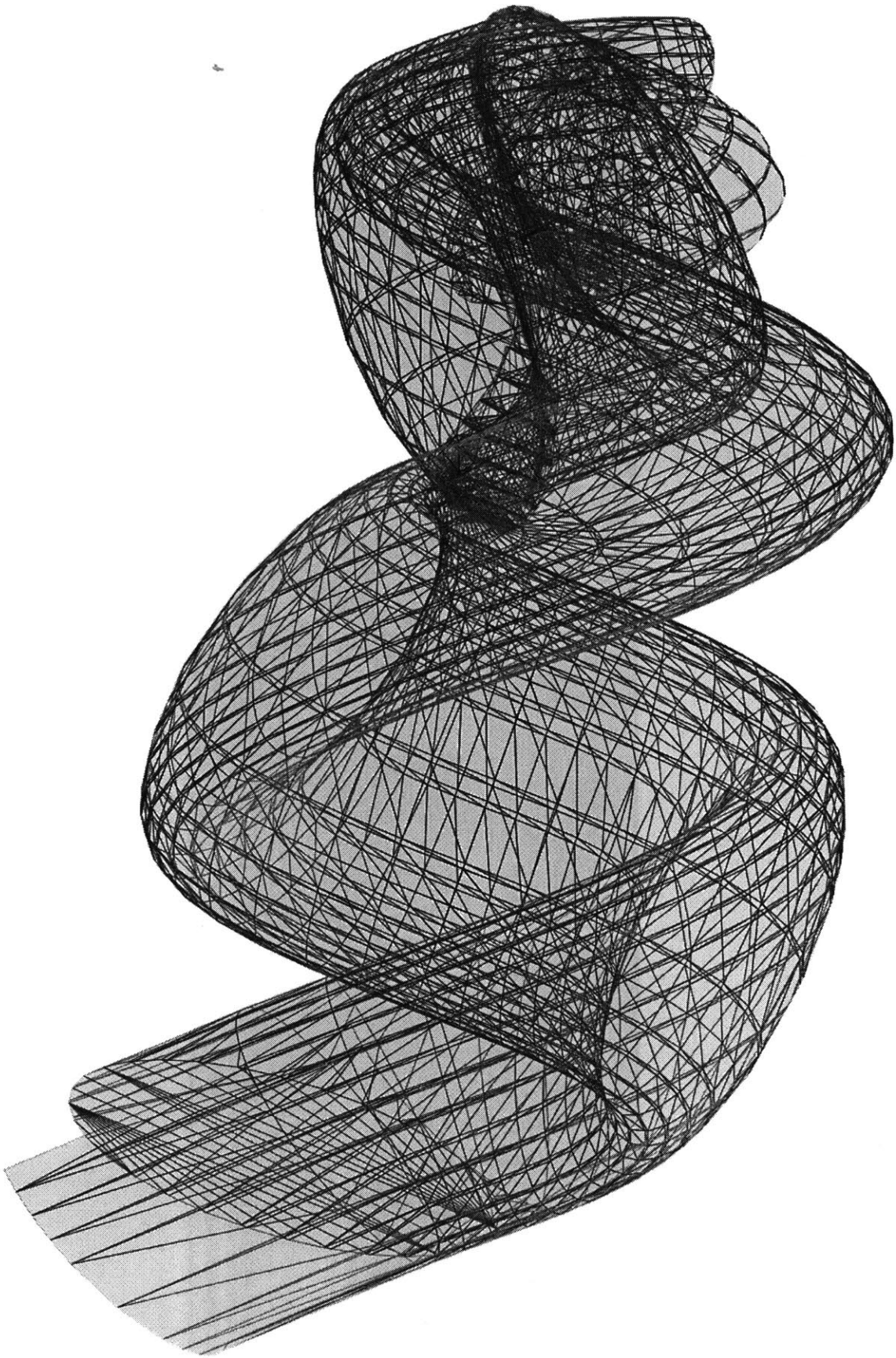
LOUT SHELTER

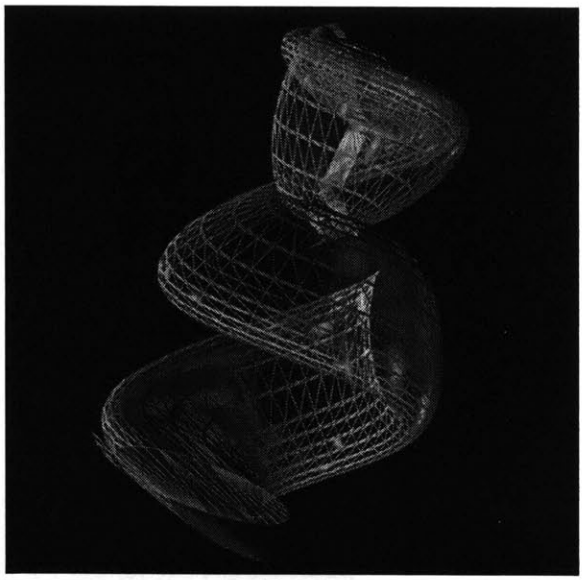


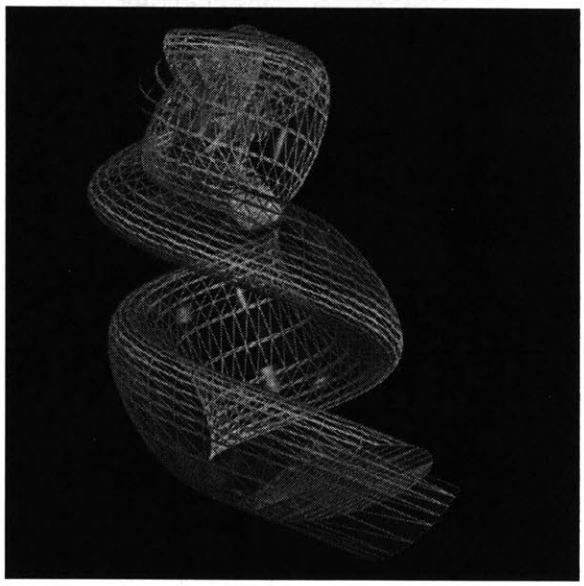


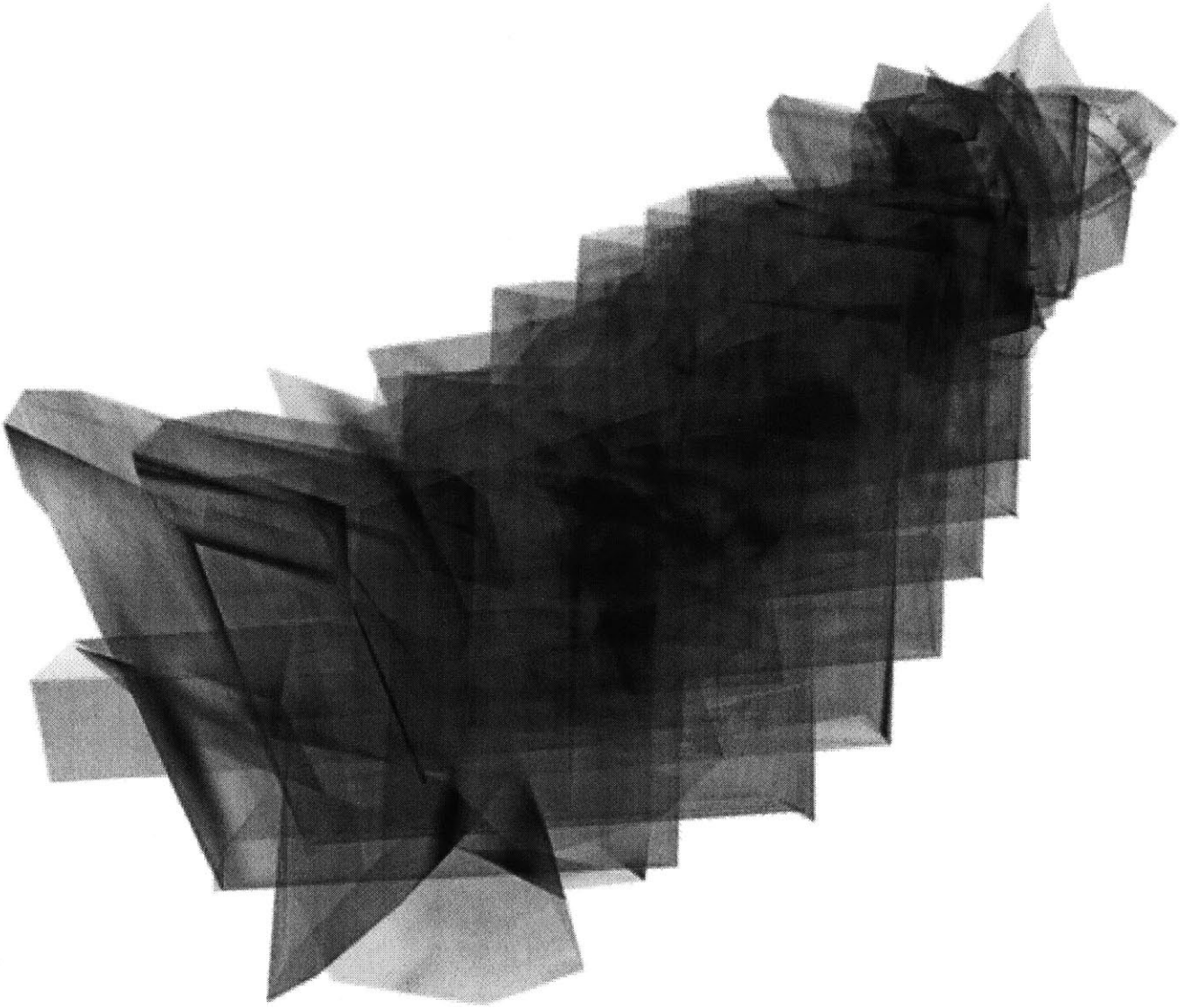


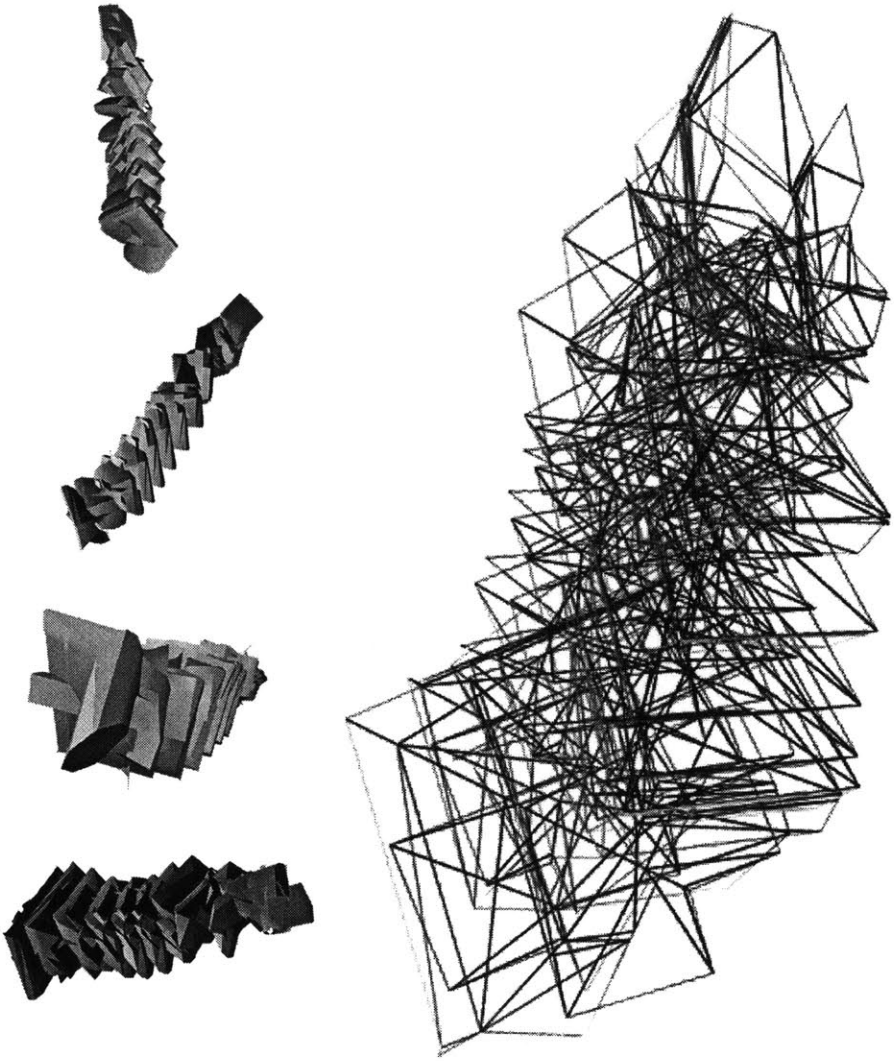


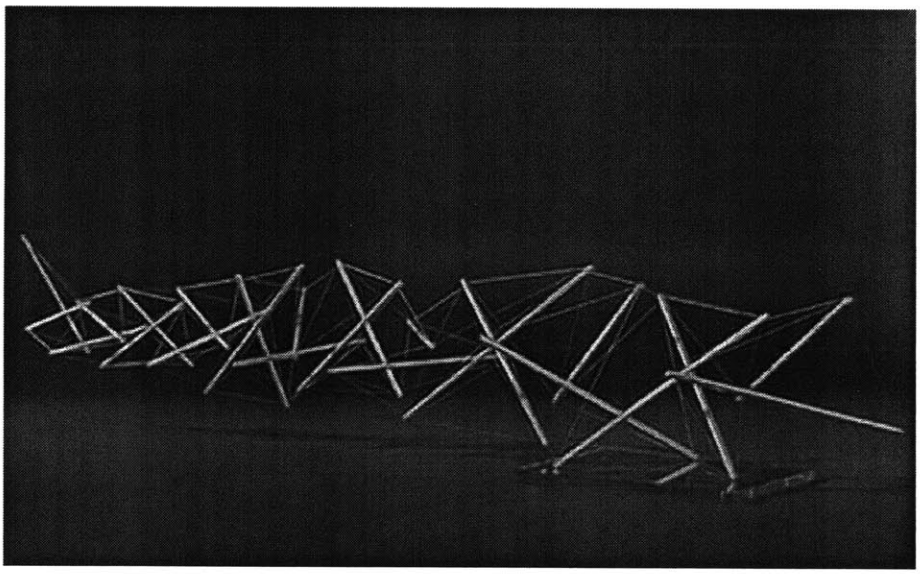


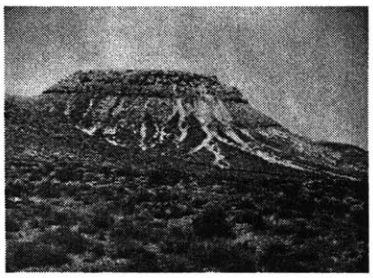


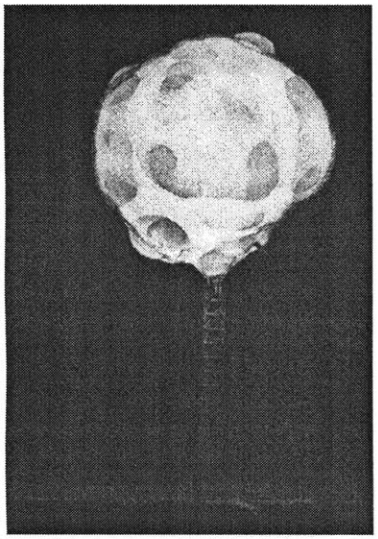


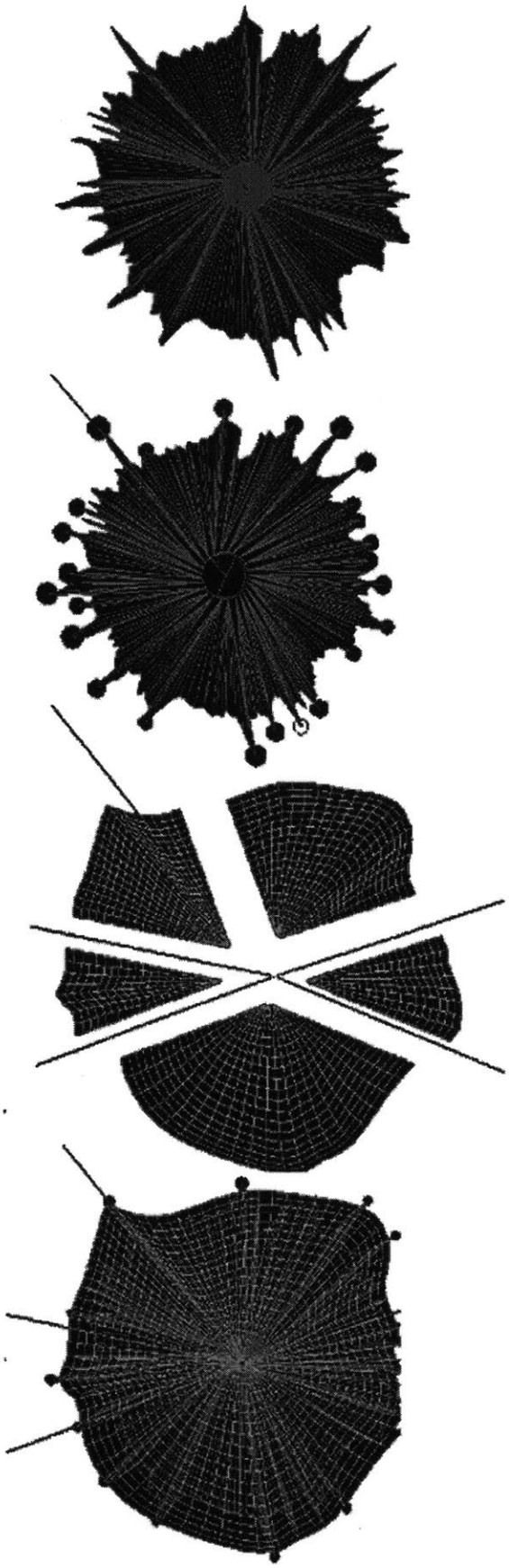


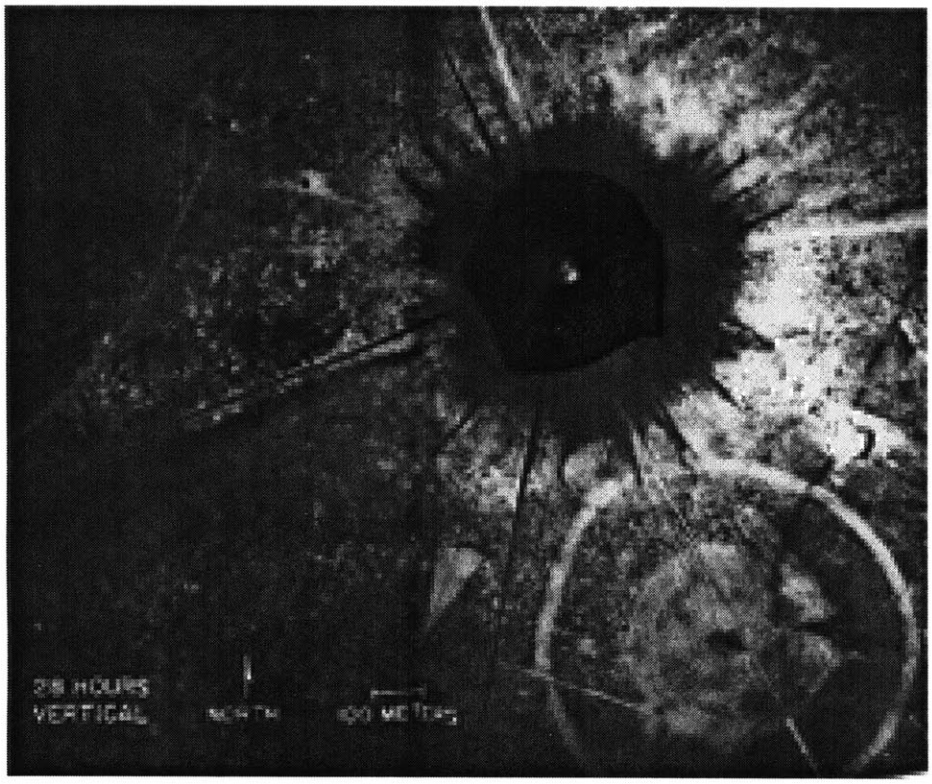


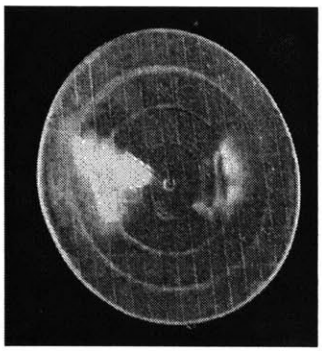


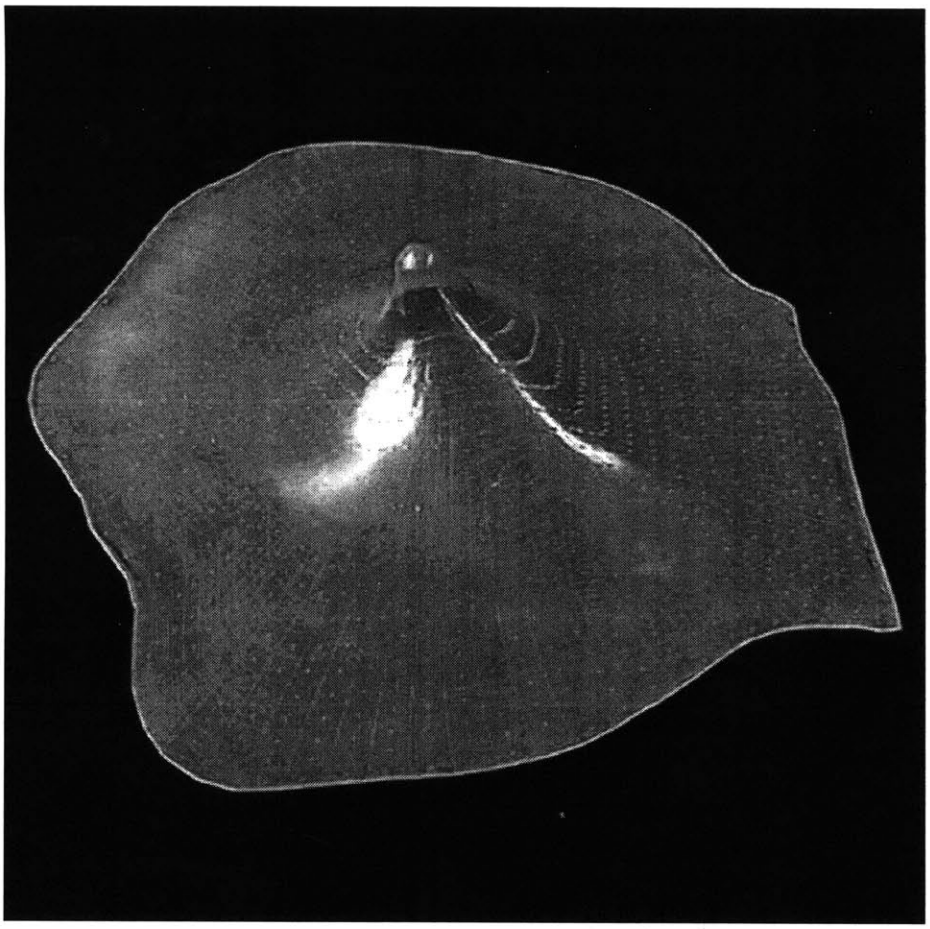


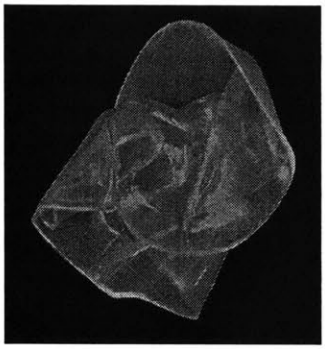


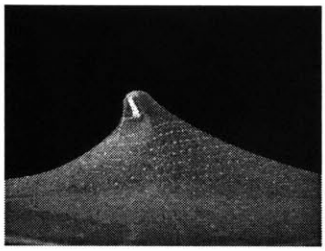


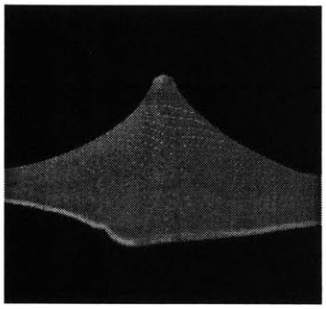

VERTICAL











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Glossary

abstract	apart from concrete existance
artifact	
bifurcate	to divide into two parts or branches. - To separate into two parts or branches: fork . Fork or divided into two parts or branches. A mutations that occur at critical points in the balance of power between physical forces - temperature, pressure, speed and so on - when new configurations become energetically possible, and matter spontaneously adopts them.
coevolution	
dynamic equilibrium	
ESS	environmental stable strategy: a strategy that does well on a population dominated by the same strategy. An ESS is a strategy such that, if all members of a population adopt it, no alternative, `mutant' strategy can invade the population (G 194). Like `altruism' used by ethologist in a special sense, almost misleadingly related to its common usage. It was imported from game theory into biology in the theory of evolutionary stable strategy, where it is essentially synonymous with `program' in the computer sense, and means a preprogrammed rule that an animal obeys. All individuals of a population might follow the strategy `if small flee, if large attack'; an observer would be wrong to call them two strategies: both behavior patterns are manifestations of the same conditional strategy (EP 294)
ecology	the science of the relationships between organisms and their environment
embryology	the branch of biology that deals with the formation, early growth and development of living organisms. The embryonic structure or development of a particular organism
entrain:	To pull or draw along after itself. To carry along in a current.
ethology	the scientific study of animal behavior, especially as it occurs in the natural environment. The study of human ethos and its formation.
extant	still in existancenatural selection
extended phenotype	all effects of a gene upon the world.
gene	a unit of heredity - that which segregates and recombines with appreciable frequency and as any hereditary information for which there is favorable or unfavorable selection...
genome	the entire collection of genes possessed by one organism.
homeostasis	the ability or the tendency for an organism or a cell to internal equilibrium by adjusting its physiological processes.
homologous	corresponding or similar in position, value, structure, or function. Similar in structure and evolutionary origin, though not necessarily in function, as the flippers of a seal and the hands of a human being

interstice	a space , especially a small or narrow one, between things or parts
manipulation	
meme	a unit of cultural inheritance, hypothesized as analogous to the particulate gene, and as naturally selected by virtue of its `phenotypic' consequences on its own survival and replication in the cultural environment (EP 290).
morphogenesis	formation of the structure of an organism or part: differentiation and growth of tissues and organs during development.
morphology	the branch of biology that deals with the form and structure of organisms without consideration of function - the form and structure of an organism or one of its parts
novel	strikinly new, different, unusual
nash equilibrium	
natural arms race	
parasite	
parasitism	
phenotype	the manifested attributes of an organism, the joint product of its genes and their environment during ontogen. - a gene may be said to have phenotypic expression in, say, eye color - the concept of phenotype may be extended to include functionally important consequences of gene differences, outside the bodies in which the genes sit.
phylum	a primary division of kingdom as of the animal kingdom, ranking next above a class in size
schema	a pattern imposed on complex reality or experience to assist in explaining it, mediate perception, or guide response.
solitons	
stratify	To form, arrange, or deposit in layers. To preserve (seeds) by placing them between layers of moist sand or similar material. To arrange or separate into
replicator	an entity in the universe which copies are made active/passive and germ-line/dead-end replicators
teleonomy	the science of adaption. In effect, teleonomy will presumably be the question of units of selection, and of costs and other constraints on perfection.
typology	the study or system of classifications of types that have characteristics or traits in castes, classes, or social levels. degrees of stratification freely self organized loosely bound rigidly bound

Appendix

Algorythm Designed for Thesis

Autolisp Language

```
(command "layer" "new" "spiral" "color" "10" "spiral" "")
(command "layer" "new" "axis" "color" "cyan" "volumes" "")
(command "layer" "new" "vlines" "color" "18" "vlines" "")


(setq lastpoint (list 0 0 0))
(defun dspiral (bpoint revs strad hfac vfac ppr axis
            / ang dist rp ainc dhinc dvinc circle dv)
(command "layer" "set" "spiral" "")

(setq vfac (- 0.0 vfac))
;;(setq vfac 0.001)
(print "vfac = ")
(print vfac)
(setq circle (* 3.141596235 2))
(setq ainc (/ circle ppr))
(setq dhinc (/ hfac ppr))
(setq ang 0.0)
(setq dist strad)

(cond ((= vfac 0.0)
            ;; if spiral on plan
            (setq dv 0.0)
            (setq dvinc 0.0)
            (command "pline" bpoint))
           (t
            ;; 3D spiral
            (setq dv 0.0)
            (setq dvinc vfac)              ;;(setq dvinc (/ vfac ppr))  ;;;;
            (command "3dpoly" bpoint)
            )
           )

(setq bbpoint (list 0 0 0))
 (repeat revs

             (setq count 1)
             (repeat ppr
                    (print "count= ")
                    (print count)
                    ;; returns a point at specified angle and distance
                    ;; from supplied point
                    (setq rp (polar bpoint
                                   (setq ang (+ ang ainc))
                                   (setq dist (+ dist dhinc))
                                   )
                          ) ;; rp

                    (if vfac
                       (progn
```

```
                    (setq rp (list (car rp)
                                   (cadr rp)
                                   (+ dv (caddr rp)))
                        )
                    (print "dv= ")
                    (print dv)
                    (print "dvinc= ")
                    (print dvinc)
                    (print "-----------")
                    (setq dv (+ dv dvinc))
                    (setq dvinc (- dvinc (+ (/ count 10000) 1)))
                    )
                  ) ;; if
                (setq lastpoint rp)
                (setq bpoint (list (+ (car bpoint) axis)
                                   (cadr bpoint)
                                   (caddr bpoint)))
                (print "car bpoint")
                (print (car bpoint))


                (setq count (+ count 1))
                (command rp)   ;; continue to the next point...

                ) ;; repeat ppr
            ) ;; repeat revs

(command "")                    ; until done.
(princ)
) ;; defun spiral

(defun axis (pt1 pt2)
  (print "------------------------------")
  (print bpoint)
  (print bbpoint)
  (command "layer" "set" "axis" "")
  (command "line"
           pt1
           pt2 ""))

(defun vspiral (bpoint revs strad hfac vfac ppr axis
            / ang dist rp ainc dhinc dvinc circle dv)

(command "layer" "set" "vlines" "")

(setq bpoint (list 0 0 0))
(setq vfac (- 0.0 vfac))
;;(setq vfac 0.001)
(print "vfac = ")
(print vfac)
  (setq circle (* 3.141596235 2))
  (setq ainc (/ circle ppr))
  (setq dhinc (/ hfac ppr))
  (setq ang 0.0)
  (setq dist strad)

  (cond ((= vfac 0.0)
           ;; if spiral on plan
           (setq dv 0.0)
```

```
            (setq dvinc 0.0)
            (command "pline" bpoint))
           (t
            ;; 3D spiral
            (setq dv 0.0)
            (setq dvinc vfac)              ;;(setq dvinc (/ vfac ppr))  ;;;;
            ;;(command "3dpoly" bpoint)
            )
           )

  (repeat revs

            (setq count 1)
            (repeat ppr
                    (print "count= ")
                    (print count)
                    ;; returns a point at specified angle and distance
                    ;; from supplied point
                    (setq rp (polar bbpoint
                                    (setq ang (+ ang ainc))
                                    (setq dist (+ dist dhinc))
                                    )
                          ) ;; rp

                    (if vfac
                       (progn
                          (setq rp (list (car rp)
                                         (cadr rp)
                                         (+ dv (caddr rp)))
                              )
                          (print "dv= ")
                          (print dv)
                          (print "dvinc= ")
                          (print dvinc)
                          (print "-----------")
                          (command "line"
                                   (list (car rp)
                                         (cadr rp)
                                         (caddr lastpoint))
                                   (list (car rp)
                                         (cadr rp)
                                         (caddr rp)) "")

                          (setq dv (+ dv dvinc))
                          (setq dvinc (- dvinc (+ (/ count 10000) 1)))
                          )
                     ) ;; if
                    (setq bbpoint (list (+ (car bbpoint) axis)
                                        (cadr bbpoint)
                                        (caddr bbpoint)))
                    (setq count (+ count 1))
                    (command rp)   ;; continue to the next point...

                    ) ;; repeat ppr
            ) ;; repeat revs
               ; until done.


(list (car bbpoint) (cadr bbpoint) (caddr rp))
```

```
) ;; defun vspiral

;;;
;;;
;;;

(defun C:SPIRAL (/ olderr ocmd oblp bp nt sr hg vg lp aa)
   ;;;;(setq olderr  *error*
 ;;;;      *error* myerror)
 (setq ocmd (getvar "cmdecho"))
 (setq oblp (getvar "blipmode"))
 (setvar "cmdecho" 0)
 (initget 8)                    ; bp must not be null
 (setq bp (getpoint "\nCenter point <0,0,0>: "))
 (cond ((null bp) (setq bp (list 0 0 0))))
 (initget 8)                    ; nt must not be zero, neg, or null
 (setq nt (getint "\nNumber of rotations <3>: "))
 (cond ((null nt) (setq nt 3)))
 (initget 8)                    ; sr must not be zero, neg, or null
 (setq sr (getdist bp "\nStarting radius <0>: "))
 (cond ((null sr) (setq sr 0)))
 (initget 8)                    ; cf must not be zero, or null
 (setq hg (getdist "\nHorizontal growth per rotation <400>: "))
 (cond ((null hg) (setq hg 400)))
 (initget 8)                    ; cf must not be zero, or null
 (setq vg (getdist "\nVertical growth per rotation <0.001>: "))
 (cond ((null vg) (setq vg 0.001)))
 (initget 6)                    ; lp must not be zero or neg
 (setq lp (getint "\nPoints per rotation <23>: "))
 (cond ((null lp) (setq lp 30)))
 (setq aa (getint "\nAngle of Axis <10>: "))
 (cond ((null aa) (setq aa 10)))
 (cond ((= vg 0.0)
          (dspiral bp nt sr hg vg lp aa))
         (t
          (dspiral bp nt sr hg vg lp aa)
          (axis (list 0 0 0)
               (vspiral bp nt sr hg vg lp aa)
               ))
         )

 (setvar "cmdecho" ocmd)
 (setvar "blipmode" oblp)
 (setq *error* olderr)          ; Restore old *error* handler
 (princ)

)

;;;

(princ "\n\tTATLIN:SPIRAL and TATLIN:3DSPIRAL loaded. ")
(princ)

;;;
```

ALL ILLUSTRATIONS BY AUTHOR UNLESS OTHERWISE NOTED