MULTIPlicity
in
AGGREGATED
BUILT FORM

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ANDERTON LIFT (immediately north of Northwich, England). To avoid a flight of locks, with their time-consuming passage and loss of water, the Weaver Navigation was connected with the Trent and Mersey Canal by means of this massive lift -- the canal is clearly seen in the trough at top right, and the river is below. Opened in 1875, the lift was originally hydraulically operated, each caisson (of wrought iron, 75 ft x 15 ft 5 in.) being supported by a ram 3 ft in diameter, most of the effort required to raise a boat the 50 ft being derived from overfilling the top caisson relative to the bottom one (one was always at the top in those days when the other was at the bottom). Each tank full of water weighed about 252 tons, and the system worked well for twenty years, until scoring of the rams made replacement necessary. In 1907 the lift was reopened using electric power (with a 30 h.p. motor), most of the weight being counterbalanced by the cast iron weights working over the pulleys shown. The lift is a reasonable alternative to either the flight of perhaps ten locks, which would have been needed instead, or the troublesome transshipment of goods, which had been necessary before it was built.
Multiplicity in Aggregated Built Form

by
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abstract

Although the economic efficiency of industrial construction technologies based on long production runs of similar manufactured components is well known, strict dimensional considerations and repeated use of a limited number of formwork types tend to result in "built-modules" of excessive uniformity. With respect to building form, these technologies offer little flexibility in realizing more pluralistic design solutions. The designer's input can be reduced to applying idiosyncratic skin treatments to a building framework which, by its repetitive nature, designed itself before leaving the factory.

If, however, the initial design of these systems is both formally and structurally reconsidered, assembly generating much greater ranges in the aggregate form will be possible. Thus, the input of the designer will be dramatically enhanced. Given this shift in attitude, the rethinking of the structural and formal behavior of the components can help determine the ways in which the systems may be assembled.

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Title: Professor of Structures
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intensification · transformation
Social [economic and political] problems inevitably affect architecture and design -- producing for the moment a great deal of confusion over design's reasonable purpose and direction. There are swings to a (presumably) more comfortable past -- the whole nostalgia movement in home decorating; there is Post-Modernism, which reduces architecture to supposedly witty and ironic skin treatments; there are manifestations like "Memphis" in furniture and accessories, which I find easier to take than architecture for some reason -- probably because the latter smells of pure fashion, supported by a large infusion of hype from a press starved for news.

Dressing table designed for the Memphis Furniture Company, Milan by Michael Graves.
George Nelson's dismal perception of current design and architectural practices is unfortunately not far off the mark. However, in defense of Post-Modern's "supposedly witty and ironic skin treatments," one need only review economic and political trends which appear to direct builders and developers toward mundane and superficial solutions to habitable built form. Economy dictates that buildings no longer need function for extended periods of time. It is desirable to receive a payoff from an initial investment as quickly as possible; longer-range planning is out of the question owing to global economic and political fluctuations. Given this fast-paced calendar, what is left to design is a building that is physically, structurally, and formally minimalist. The use of the least material and labor is paramount. What then remains for the architect is only the possibility of some inexpensive and superficial treatment to a predesigned (by supposed economic necessity) box. In many instances, a designer's formal contribution to architecture is merely painted graphics on an object's surface which will probably need to be replaced after a relatively short period (about the same time that the building can be expected to pay
for itself and hopefully be resold). Thus we have disposable architecture, not unlike cheap plastic tableware that is used once and discarded.

EXPERIENTIAL ARCHITECTURE

Maurice K. Smith residence, Harvard, MA.
What is lacking in that approach to building is any minutely open-ended relationship between buildings and inhabitants that involves a range of perceptual and emotional interactions. Fundamental to the concept of "experiential" architecture is the platform that architectural design decisions be open enough for the inhabitant to become involved with the design, and to make changes and adjustments necessary to fit individual lifestyles without interfering with the integrity of the whole. The architect's real task is the development of processes and systems for decision making. The assemblage of a larger, positive framework able to accommodate a variety of "infill" becomes the overall organizing principle. This fresh approach is clearly a reaction against the neutrality of the International Style and the more recent decoration trends attempting to render the physical environment more human. If it is truly cost which inhibits the approach advocated, more careful attention must be given to low-cost industrial forms and materials.

A couple in front of their habitation in Martina Franca.
Although political norms and socio-economic intentions dictate the direction architecture takes, society is not so restrictive as to intentionally close down fresh possibilities of learning about and experiencing the physical environment. The fact is, no two people or situations are alike. Placing a society in an environment of inadequate multiplicities and definitions contradicts the notion that variety and self-identity are important factors in life. It is hoped that the built physical environment may generate a common bond between all individuals within a society, and not merely become a neutral background for it. The built environment may then participate and interact with its users. It can generate a pluralistic order by offering a maximal range of partial definitions and polarities.

Postignano. The start of the annual church procession.
If it is possible to generate buildings from a pluralistic range of definitions, the powerful self-identity of each individual may easily be accommodated by the enormous variety and multiplicity in the physical environment. If this assumption is correct, there should be no need to build or repeat a boring singular norm. Moreover, the conventional non-pluralistic approach to design inevitably leads to the nihilistic application of superfluous graphic attempts which generate at best a two-dimensional formal variety.

Maurice K. Smith illustrates the case for pluralistic form in the following excerpt from an interview in *The Journal of Architectural Education*:

We can develop a "friendly collage" attitude, which allows respectfully that people are also different and their differences can be built. We don't need to find a reductive common denominator. Once we believe that, we have a critical measure, and it's clearly wrong for a school to have a dozen identical classrooms, because all those people in them -- students, teachers, what they're doing and where they are -- are different. Difference itself becomes a positive virtue. And every possible difference sets up more optional associations...
Once the argument for plurality in the built environment is accepted, the next step is how to arrive at a comprehensive understanding of specific formal qualities that would result in a demonstrably qualitative experience. We must not lose sight of the fact that we are concerned with architectural form, and that some degree of continuity and repetition is essential to the understanding of the end product. What is needed
is a built physical reference -- (or more literally, a framework) that is the initial round of formal and use definition. This framework would be similar to the armature of a sculptor in that there would be enough strength of form to provide an overall organization but not enough to become heirarchic. This first round of decisions must support subsequent decisions while not overpowering them.

Primary or initial form decisions are equated with access for practicality's sake. Here it is important to distinguish between access and circulation. Circulation implies a system which operates within a building or some other close built system. By definition, access is more open ended; it allows for the interconnection of independent systems and organization within those systems.
Since access is a primary element of formal organization, it follows that some predictability and repetition must occur if for no other reason than orientation. However, this is not to say that access is a singular system. The access may be built of repetitive elements which, if properly deployed, should add up to an unpredictable whole. Tuscan and Iberian villages are a good example. There are dimensional and formal repetitions in the individual dwellings, yet additive assemblage of the basic units does not lead to a predetermined continuity. There is a flexibility in addition and aggregation which allows larger moves and continuities to remain independent of the rules by which the smaller moves have been made. Thus, while the access is built from smaller repetitive moves, it still retains a distinctly different identity. This concept of allowing individual systems to retain their own unique identities is that of self-stability.

The success of Moshe Safdie's Habitat also depends to some degree on the principles of self-stability and aggregated continuities. The placement of precast dwelling units, which are by definition self-stable, depends on some larger organizing Habitat, Montreal.
principles (i.e. larger continuities). Safdie has introduced a framework (built access) that apparently conforms to the direction and overall form of the dwelling aggregation. Out of structural necessity, he has created a heirarchic primary system which doubles as access, but is not so formally stable as to become independent of the precast dwelling units, and vice-versa. The result is that the primary access is only intensified by the registration of the precast units. Neither of the two systems are really independent from each other in this respect, and thus a heirarchy has been created: one system is structurally and formally dependent on another. Were either of the systems truly self-stable, this interdependency need only occur at will.

... If we are designing ... housing for 500 people, part of the proposition includes enough recognizable definition so that the rest of the built landscape can reciprocate.

Through the lineal aggregation of self-stable additive growth forms, the designer may create an environment not only rich in formal variety and multiplicity, but one which can have larger, more recognizable continuities as well. Large
definitions* and continuities are crucial for two reasons: (1) Without access continuities, orientation within any habitable structure is difficult. The larger moves prevent the overall aggregation from becoming maze-like. (2) In order to arrive at any sort of interaction with the natural landscape, built or natural, large scale continuities are essential. If the larger definitions are easily recognizable, then they may participate in an additive manner with similarly sized definitions in the landscape.

*Large built definitions are substitutions for "landscape" realities. What remains to be determined is how big is enough?
Of all the primary objectives in this thesis, the emergence of formal variety from inherently repetitive building processes is paramount. The formal failure of many industrialized building technologies does not lie within the physical system per se but with the singular deployment of its parts. Regularity and monotony result from the use of only one process. Many of Mies van der Rohe's buildings are exemplar of this misunderstanding. Although the Mies buildings are very direct, they offer neither the possibility of formal interaction with the environment nor any attempt to create habitations which are more than a single designer's obsession with a singular building system. Mies' glass boxes are just that -- complete object definitions randomly "lowered" onto any landscape.
Walter Förderer's folded concrete wall chapels are similar to the Mies buildings in their singularity, with one important exception: they don't always make completed spatial definitions, which allows for the possibility of interaction with other forms. Although the physical form of Förderer's chapels rises from only one material and one process, the intentional incompletion of room-sized definitions allows for and implies that there is more to the building than what is literally cast in concrete. From the exterior, Förderer's buildings appear to be only the beginning of a larger structure. Their formal incompleteness implies that more (or less) could be built. (The Protestant Centre at Monheim resembles a habitable elevator-service core.) On the interior, the recognition of the reciprocal interaction of other self-stable forms (citizens in this case) with the built-form only occurs because of a deliberate non-completion of space on the architect's part. It is this duality of concern that gives the Förderer buildings their life and interaction with the environment.
By taking any singular system and deploying components of that system in a "formally literate" manner, it is not only possible to arrive at pluralistic building form, it is, more importantly, possible to induce participation of the built-form with the environment.
By intentionally not completing spatial and built definitions, the participation of many different formally stable partial definitions is possible. Multiplicity, by definition, implies differences -- or at least the condition which allows for the coexistence of manifold and various parts. If multiplicity and plurality in built form are to be achieved, even through the utilization of a single building system, then arrangements of different forms is required. Assuming that each collection of forms in an aggregation is self-stable (existing in its own right), then these forms can best coexist reciprocally. The aggregation of two or more formally dissimilar systems is not a contradiction if they are so deployed. George Nelson writes:

Western religion lives with the complication of gods living along with devils, and much of Christian theological speculation has been devoted to the question of how God in his infinite goodness can permit the existence of evil.
Habitants and users are a subset of "formally stable partial definitions." Eastern religions have attempted to resolve this paradox by accepting the existence of polarities. The idea is that so-called contradictions exist in harmony with each other. Moreover, one cannot survive without the other. The visually reciprocal form of the yin-yang symbol illustrates this relationship.

Both attitudes (East and West) can be applied to the design process. In the West, current trends lead to the expectation that science and technology might be a solution to the ailments of society. Although numerous technological breakthroughs seem to resolve many difficulties, they generally do not come without cost. The side effects of technological milestones create difficulties that are often more severe than the original problem. When corrective action is taken, the process often repeats itself until the problems are so great and many-faceted that a simple solution is no longer possible. As a rule of evolution, the problem moves from simplicity to complexity.

Honen-in. Interlocking joint used to joint wood and stone. Near Ginkaku-ji, Kyoto.
The present conception of the universe starts with some hydrogen atoms drifting aimlessly in a bottomless void. Some fifteen billion years later these have evolved into 92 elements, planets, about 20 amino acids, art, science, contraceptive pills, Grateful Dead and Ronald Reagan. Our very survival may depend on our ability to deal with these contradictions.

As a design process, "Built Form" addresses the yin-yang principle by allowing different and independent forms to coexist harmoniously in space. Continuities of space help to build the larger definitions which can bring together seemingly polar or contradictory forms. If space between independent forms is organized in a manner allowing reciprocative continuities to unify those forms, then a readable and understandable multiplicity of form is reached. The resultant built form is a continuity of differences that is interacted with by both the environment and the user.

The underlying assumption for this thesis is that formal richness and variety may be achieved through the aggregation of more than one industrialized building technology. It is clear that industrialized building technologies themselves do
not contain enough information to create habitable form. It is not enough to consider only the structural or physical properties of any building process. Habitable form may only be achieved with a comprehensive understanding of form itself.

Without an understanding of some basic formal principles, even an aggregation of self-stable systems cannot be successful. If the designer becomes infatuated solely with building systems and construction processes, then those particular systems or processes will run uncontrolled throughout the resulting structure -- even in those having more than one type of building component. Structural principles and physical components provide only limited clues toward a successful habitation.

For example, consider a habitation built entirely from cast-in-place (cip) tunnel formwork. The process involves placing reinforcing bars around a greased formwork. The concrete is poured, cured, and after twenty-four hours the formwork is slipped out horizontally and set on top of the hardened shell. The process is then repeated. One attempt to break the monotony and inflexibility of the
resulting building is to widen the formwork at one end, which assists in its release from the cured concrete. If this process is exaggerated, the linear aggregation of units will become curved and some variation can thus be induced. However, this does little for the overall building form besides allowing the building to curve, snake-like. Attempts to express this structural modification of a building system only contributes to the construction process and add little or nothing to the building form. Without territorial and directional definition, there can be no useful built form, only a singularly monotonous structure.

Given the availability of a multitude of industrialized building technologies which are repetitive, some form language is required to aggregate the self-stable chunks of building. A formal "vocabulary" and set of rules are outlined in the following sections.
3. FORM BEHAVIOR and RECOGNITION

When working with self-stable building forms, a field organization is always employed. If a conventional grid system is the overall organizer of individual parts, then those parts are subject to a hierarchical arrangement (dependent on subdivision) and subsequently cannot be considered self-stable. Not only is a grid system hierarchic, but the notions of direction, territoriality, and slack (the space between stabilities) cannot be adequately addressed. These concepts embody the fundamental principles which will result in a workable aggregation of self-stable building components.

Katsura Palace. Main view of the garden.
There exist two distinctly different directional systems: habitable and processional. A processional directional system relies on the building up of a single spatial direction with the addition of relatively parallel components (0 - 15) in a neutral field. An intensification of directionality is achieved by allowing the initial components to move at will parallel to the desired direction, i.e., avoiding the registration of components normal to the main direction will reinforce it.

A street or racetrack may be considered examples of processional directionality.
Habitable directional form may be considered an attempt to intensify a primary direction by the registration of perpendicular components to the primary directional component. When working in such a manner it is important not to work against the direction of the established field and thereby allow the perpendicular direction to dominate. If both directions are of equal strength, then there is in effect no direction. In this sense, a directional field's components should be heirarchic. Therefore, to retain or intensify the primary direction with a habitable directional form, the perpendicular components registered to the initial form must "slip" in the same manner that processional "slip" occurred in the first example.

In the omni-directional form diagram, neither direction dominates the other. In the second figure, the vertical components are permitted to break and slide along the primary definition, indicating greater importance and strength of the initial direction.

The slipping action of certain components of any directional field allows the field to retain its

Overleaf: plan of Robie House, Chicago by Frank Lloyd Wright.
directional integrity (see following figure). Furthermore, the registration of normal components results in the emergence of some partially closed territories and zones. These territories may be considered habitable. They are privacies which may be connected by the directional access system.

**TERRITORIALITY**

The second principle in developing a working aggregation of self-stable components is that of territoriality or partial containment. A containing form functions in two different spatial modes. First, this element is an "optional" container. It "contains" some space while remaining open enough to allow continuity, or vice-versa, to invite an alternate system to assist in the definition of the territory.
To understand the reciprocal nature of a containment a look at directional field organization is in order. To begin with, a field of four directional zones is established. Were each of the four directional zones built, then this arrangement might be referred to as a "packed" directional field. Packing refers to the interrelation of components, or lack thereof. Without space or slack between the components, no territorial claims can be made. The first step in achieving territoriality is to establish exchange between the initial four zones. This may be done through the lateral displacement of the edge zone in select instances.

"Packing" of wall form at La Alberca.
The diagram illustrates a reciprocal exchange between the non-built space in zones (1) through (3) and built form (dark) in zones (3) to (4). By laterally displacing a small portion of the fourth zone, the contact area between the two zones is increased. Note that the built zone still retains its directionality and registration. To create a territorial exchange between two components another lateral displacement is required. Then, its nature being reciprocating and territorial, the "first" primary self-stable form is defined. The form is stable because it stands on its own yet it is engaging with "external" adjacent space. The diagram embodies the rudimentary principles of self-stable form: direction and territorial control.

It is the reciprocal nature of this particular form that allows it to interact with and to partially contain adjacent space. Independent stable form must work in a reciprocal manner. This results in a formal relationship with spatial continuities, linking numerous self-stable building fragments. Hence the importance of the yin-yang principle.
The intent of the thesis has so far been to arrive at an understanding of formal non-repetition through the use of more than one formally self-stable building system. The second criteria is that these systems rely on repetition of like components for buildability. The issue which has not yet been addressed is that of how space affects the overall form of the project. Although the components of the physical systems may be repetitive, a formally chaotic aggregation could result if the variable building chunks are not deployed in a coherent manner.

Cesares: Windows and doorways appear as formally stable components within dimensionally stabilized wall zones. Note the repetition of window dimensions between windows.
Now that the fundamental principles of a physically deployable part have been addressed, the space between parts may now be "built." "Built space" is defined as the formal component existing between or adjacent to deployed, self-stable parts. The Maine coastline illustrates the reciprocal relationship of the physical built form to built spatial form. In this reference, the self-stable "built forms" are the rocks and the water is the space or slack. Although water tends to register to the land in a manner dependent on the rock forms, the overall form of the intersection is actually dependent on the physical form of the water. The form of the intersection changes with the tides. This analogy illustrates a second, more important principle: the reciprocal relationship of the two forms, demonstrated by their interlocking properties.

Although the rocks along the coastline appear to be the initial self-stable forms to which the "slack" or water registers, due to the reciprocal nature of the water's interaction with the mainland, it may also be considered a formally stable element. In this sense, the water's stability is a result of the interlocking behavior of the two forms -- landscape and water.
The second principle that produces spatial stability is that of dimensional repetition. The following diagram illustrates the manner in which self-stable elements (dark) may be arranged so that the dimensions and form of the space between them retain similar characteristics to those inherent in the original definitions. The heavy lines indicate the repetition of dimension found in both positive and negative form.

Although dimensional considerations create similarities between positive and negative form, this particular organization is still defined by the five original demarkations discussed earlier. In other words, all forms -- both positive and negative -- are strictly registered to those demarkations. A hierarchy similar to a one-dimensional grid system dominates the organization. Recall that if a hierarchy exists, it is then impossible to have components existing without reliance on another system. As a result, the fierce registration of forms in the preceding
diagram leads to a "packed" directional field organization, even though the forms are dimensionally stable. There is no slack between the forms.

Operational dimensional stability will not only allow the forms to remain free of a heirarchic registration, but will also allow an "open" field organization to occur. In the following figure, the original demarkations are subject to displacement and/or reorientation based on an initial system of dimensional repetition. The field is thus stabilized.

The concepts discussed in this section represent the fundamental principles used to design a field organization comprised of variable self-stable components. The diagrams are not intended to be taken literally -- they illustrate a process which enables a variety of independent forms to be aggregated into a coherent organization.
Given an understanding of the fundamental concepts of formal behavior, an examination of the physical manipulation of those principles is essential. To begin with, form may be classified into four generative categories. Each of these four groups may be subdivided into two opposing behavioral groups, intensification and transformation. Once the initial generative categories have been established, the intensification and transformation aspects of those categories represent the manner in which the designer may influence the basic principles of form.

"Fairbairn" steam crane built by Stothert and Pitt about 1875.
Continuity

In architectural terms, continuity represents a large definition -- an aggregation of smaller definitions. Continuity exists as the lineal addition of a number of not necessarily similar or identical parts. These parts, no matter what their physical form, are arranged in a manner perceived as a coherent whole. Continuities in self-stable aggregated building form are essential for the understanding of larger definitions of built form. The notion of continuity is the principle that can interrelate incongruous bits.
b. Law or principle of continuity: the principle that all change, sequence, or series in nature is continuous, and that nothing passes from one state to another \textit{per saltum}.

The phrase originated with Leibnitz. In 1687 he laid down as a general principle, that where there is continuity between data, such that one case continually approaches and at length loses itself in another, there will be a corresponding continuity in results or properties. For example, it is a property of the ellipse that all rays from the one focus are reflected from the curve to the other; in the parabola all such rays reflected at the curve are parallel; if there be given a series of ellipses continually approaching the parabola by the continuous increase of distance between the foci, the focal radii of these will continuously approach the relation of parallelism, so as at length to differ from it by less than any assignable amount. This was according to Leibnitz 'a principle of general order', having its origin in the mathematical infinite, absolutely necessary in Geometry, but holding good also in Physics, because the Sovereign Wisdom, the source of all things, acts as a perfect Geometer, and according to a harmony that admits of no addition. In 1702 he referred to this principle as 'the law of continuity', and claimed that it operates in all natural phenomena; and in his \textit{Nouvelles Essais}, he declared it to be part of his 'Law of Continuity' that everything in nature goes by degrees, and nothing \textit{per saltum}.

[1687 Leibnitz Lettre à Mr. Bayle Wks. Ermd. 104. 1690 - Lettre à Mr. Arnauld ibid. 107 Chacune de ces substances contient dans sa nature le mot continuationis series suarum operationum. 1702 — \textit{Repl. aux Ref. de Bayle} ibid. 169's Qu'il ne se rencontre jamais rien, où la loi de la continuité (que j'ai introduite, et dont j'ai fait la première mention dans les \textit{Nouvelles de la République des Lettres} de Mr. Bayle), et toutes les autres règles les plus exactes des Mathématiques soient violées. a 1716 — \textit{Now. Fis.}\ ii. xvi. Tout va par degrés dans la nature et rien par saut, et cette règle, à l'égard des changements est une partie de ma loi de la continuité.] 1753 Chambers Cyclo. Suppl. s.s., An eminent mathematician has supposed what he calls a law of continuity to obtain in the universe, by which law every thing that is executed or done in nature, is done by infinitely small degrees. 1812-6 Playfair \textit{Nat. Phil.} (ibid. p. 272) When bodies, whether solid or fluid, act on one another by impulse or percussion, in such a manner that their action is subject to the law of continuity. 1850 Herschel \textit{Stud. Nat. Phil.} 182 It prevents a breach of the law of continuity between transparent and opaque bodies. 1851 J. R. Young \textit{Math. Dissert.} ii. 24 That the angle changes at once from 90° to zero, is to admit so palpable a violation of the principle of continuity, that, etc. 1854 MacCary \textit{Nat. Geom.}\ ied. 21. 1878 Tait & Stewart \textit{Unseen Univ.}\ (1880) p. xii. We endeavour to show that immortality is strictly in accordance with the principle of Continuity (rightly viewed).
c. Equation of continuity, in Hydrodynamics: the equation connecting the rate of change of density of a fluid within any closed surface constantly full of fluid with the flow of fluid through the surface. 1856 T. W. Webster Equilibrium & Motion of Fluids. 1880 Haughton Phys. Geog. iii. 141. 1882 Minchin Unipl. Kinemat. § 93.

3. The state or quality of being continuous in time; uninterrupted duration. rare.
1648 Sir T. Browne Pseud. Ep. iv. xiii. Wee need not have recourse unto any starre but the Sunne and the continuity of its action. 1850 Mrs. Browning Drama of Exile Poems 1850 l. 27 Their steadfast continuity of gace. 1841 Brewster Mag. ii. iv. 1836 l. 16 A painful disease, which had its origin in the severity and continuity of his studies.

4. quasi-continuus. A continuous or connected whole; a continuous or unbroken course or series. (Of material or immaterial things.)
1681 Holland Pliny ii. 423 Running throughout one continuity without interruption. a 1699 Fotherby Aethiop. ii. ix. § 3 (1672) 965 All magnitudes and continuities are deduced from one original prick. 1844 Milton Areop. (Arb.) 70 When every stone is laid artfully together, it cannot be united into a continuity, it can but be contiguous in this world. 1809-10 Coleridge Friend (1832) 224 A chain that ascends in a continuity of links.

b. A part continuous with something else. rare.
1802 W. Irving Knicker. 1801 l. 26 The New-Netherlands... a continuity of the territory taken possession of... by the Pilgrims, when they landed on Plymouth Rock.

5. Solution of continuity: the fact or condition of being or becoming discontinuous; fracture, rupture, breakage, 'break'. Orig. used of wounds, etc. in an animal body; thence also in other senses.
1543 Thayer. 11. Page's Charms. 1568 12 The heart can not suffer solution of continuity without death. 1661 Bramhall. Just I'md. ii. 14 Schisme is an exterior breach, or a solution of continuity in the body Ecclesiast. 1707 Cases in Hist. & Gard. 77 The Solution of Continuity may hinder the Juice from mounting. 1790 Burke Fr. Ket. 24 With what address this temporary solution of (historical) continuity is kept from the eye. 1877 T. Hall in Daily News 2 Oct. 25 We are brought without solution of continuity into the presence of problems which... entirely outside the domain of physics.
Containment

The family of forms which gives rise to territoriality is referred to as containment. As a general rule, containments may be independent elements registered to larger continuities. The generic form of containment is the "U". With respect to programmatic function, the "U" form is generally considered as a use territory. Use in this sense can only occur if the contained territory is not overly disturbed by movement through access. Therefore, "containments" must aggregate to contribute to a larger continuity. The physical form of a single containment invokes a collective attribute, e.g., a gathering place or public zone.

In "Built Form" theory, containments are considered more flexible if not completed. Total completion of any form results in the inability of that form to interact with other forms in its vicinity except by juxtaposition. Completed containments, then, are "isolated" objects.

Containment (kəntərnənt). rare. [f. as prec. -ENT. Cf. OF. contenement.] The action or fact of containing; holding; restraint; departure, behaviour; CONTENEMENT.

1655 Fuller Ch. Hist. ix. 6/9 A vast summ enough to shatter the containment of a rich mans estate. Time's Storehouse (L.). A good means of virtuous containment, as well in the days of peace as of warre. 1899 G. Meredith Frois II. 40 Revelry in sobriety, containment in exultation.

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Contain (kəntərn. v. Forms: 3 contain, 4 contenien, contenien, kunteyno, (pa. sfp. y-conteyned, y-contynte), 4-6 contenio (chiefly N. and north.), 4-7 conteynere, conteniere, 5 Sc. conten, 6 contenkno, -teyko, N. -teyn, 6 7 containe, -teyn, e, 7- contain. [ME. contenio, contenier, a. OF. contenier (3rd pers. pres. Norman contentie, contenent, subj. conten, -teigne) = I. contentier, -ir, Sp. contener, L. contenere: L. contenire, to hold together, keep together, comprehend, contain, I. con-toger, -tenir to hold.]

I. To have in it, to hold; to comprise, enclose. 1 trans. To have in it, to hold. (Said of a vessel, a space, or the like.)

1382 Wyllie Chr. ii. 13 Wastid cisterns, that contenien [1388 holde] water in mounet. c.1490 Prompt. Part. 91 (MS. K.) Conteynyn, bayyn or kepyn wit-inyn. c.1576 Thynke Ed. Burghley's Cest in Animale. App. 1585 113 In hertill glasse is whote wynne conteynd. 1673 Ray Tour. Low C. 64. The Juices... contained in the Veins of the Earth. 1790 Pope Leg. Crit. 283 So vast a throng the stage can ne'er contain. 1860 Frenchl Serm. Weath. Abs. xx. 225 We were not formed to contain God's truth, but to be contained by it.

b. To be capable of containing; to have capacity for: usually expressed by to HOLD.

1526-34 TindalE John ii. 6 And ther were stondynge there nine waterpottes of stone... containinge two or thre fyrkins a piece. And Jesus sayde unto them: fyll the waterpottes with water. 1530 Palegr. 463 I This pot containeth eight quarts. 1875 Vide Dict. Arts III. 1190 In the Wear the best coal is put into tubs, these are waggons without wheels, containing each 53 cwt.
iv. xvi. Tij b. Icosaedron is a solide Figure, under twentye equall equangle triangles conteynd.

1594 HUNEDELL

Exerc. 1. v. t. axiom xiv. Two right lines do not contain a space. *Ibid. t. i. note. A Rectangle contained under two right lines given. *Ibid. xi. def. ix. Like solid figures are such as are contained under like Planes equal in number. 1823 H. J. BOOCOKE Intrd. Crystallogr. 123 The new figures would be contained within 24 isosceles triangular planes. 1875 T. WILKINSON

Aske how many times 9 is conteynd in 29.

1594 HUNEDELL

Exerc. 1. v. t. axiom xiv.

1726 BROWNE

Euclid

I prop. xlvi. note.

A Rectangular contained under two right lines given. Ibid. xi. def. ix. The new figures would be contained within 24 isosceles triangular planes.

1875 T. WILKINSON

Aske how many times 9 is conteynd in 29.

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Exerc. 1. v. t. axiom xiv.

1726 BROWNE

Euclid

I prop. xlvi. note.

A Rectangular contained under two right lines given. Ibid. xi. def. ix. The new figures would be contained within 24 isosceles triangular planes.
Mosaic in the entrance hall of the Alsdorf Rathaus by Schaffrath.
2. To have as part (or the whole) of its contents or substance; to comprise, include.

1340 Ham. Pr. 2. viii. 155 As[mic] space as be see and [the] mareys contenien and ouergon. c 1391 — Astral. 1. § 7 The space bytwene contenieneth a Mile-wey. 1398 Trevisa Anth. De P.K. ii. v. 1493 — of all the figures of the same lengthe the cercle is moost and most contenyth. c 1425 Wyntoun Chron. i. iii. 171 Pe thryd elde... Contienys nyne hundyr yhere And twa....

The Laws... contain a few passages which are very grand and noble.

b. Of a material body or substance: To have in it (as a constituent element, or in combination).

1391 CHAUCER Borth. I. vii. 255 Pe zere lenes het bydely contyned inne holte pater nostre. c 1400 MAUNDE. (Roxb. t. xiii. 255.)

In is rewme of Surry er many rewmes contende. 1809 FISHER Fun. Ser. C. Class Richmond Wks. 1876 I. 255 The crowne of our lady... after the manere of Rome conteneth lx and thre aues. 1398 BELLENDEN Chron. Scot. Tabula sig. xiIII. 255 Some of them contain besides, carbonic acid. 1880 Tyndall Glac. 1. xx. 141 The rock... evidently contains a good deal of iron.

†3. To include, comprise, extend over, measure (so much space, time, or other magnitude). Obs.

1391 CHAUCER Borth. ii. vii. 56 As myche space as be see and [the] mareys contenien and ouergon. c 1391 — Astral. 1. § 7 The space bytwene contenieneth a Mile-wey. 1398 Trevisa Anth. De P.K. ii. v. 1493 — Of all the figures of the same lengthe the cercle is moost and most contenyth. c 1425 Wyntoun Chron. i. iii. 171 Pe thryd elde... Contienys nyne hundyr yhere And twa....

Then returned they... from mount-olivete, which is nye to Jerusalem, conteyninge a Saboth dayes iorney. [So 1557 GLASGOW. 1551 ROBINSON ii. More's Utop. 1. (Ach.) 72. The Island of Utopia, conteynethe in breadthe... cc miles. 1563 SHUTE Archit. E. i. Tuscana contenineth in height... Diameters. 1697 PORTUL Antiq. Greece i. vii. 1715 42. They were not exact Semicircles, but contained the bigger half of the Circle. 1793 Moxon Arch. Ext. 263 That the first Story contain full 10 Foot in height.

† b. tetr. with of = prec. Obs. rare.

1380 Trevisa Hitden (Rolls) II. 235 (Matz). A cubite of geometric contenineth sixe common cubites. c 1391 CHAUCER
To contain the unruly people from a thousand evil occasions. To contain Anger from Mischiefe. To contain the Spirit of Anger.


To restrain from expressing or yielding to feeling, passion, etc.; to restrain oneself; to refrain from expressing or yielding to feeling, passion, etc.; to restrain oneself; to refrain or keep from (obs.); to be continent, keep oneself in chastity (obs.). (Cf. 11 b.)

To contain the Spirit of Anger. To contain the Spirit of Anger. To contain the Spirit of Anger.

To contain the Spirit of Anger. To contain the Spirit of Anger.

To contain the Spirit of Anger. To contain the Spirit of Anger.

To contain the Spirit of Anger. To contain the Spirit of Anger.

To contain the Spirit of Anger. To contain the Spirit of Anger.

To contain the Spirit of Anger. To contain the Spirit of Anger.

To contain the Spirit of Anger. To contain the Spirit of Anger.

To contain the Spirit of Anger. To contain the Spirit of Anger.

To contain the Spirit of Anger. To contain the Spirit of Anger.

To contain the Spirit of Anger. To contain the Spirit of Anger.

To contain the Spirit of Anger. To contain the Spirit of Anger.
Completion (kəmplə'ʃən). [ad. L. completus, n. of completus, to fill up, complete.] The action of completing or making complete; the condition of being completed or perfected.

1657 CHOWELL Spec. 21 Apr.: They may tend to the completion of the business. a 1744 POPE ii. 170: He makes it the utmost completion of an ill character to bear a malevolence to the best men. 1751 Rambler No. 201: It is necessary to the completion of every good that it be timely obtained. 1841-4 EMERSON Essays, Manvers Wks. (Bohn. 1. 269) A plentiful lateness is reckoned necessary to the completion of this man of the world. 1877 MRS. OLIPHANT Makers of Forum v. 157: The past in its stony completion is always a poor substitute for the present.

b. Accomplishment, fulfilment (of a prophecy, wish, etc.).

1659 HAMMOND On Ps. Pref. 16. 1678 CULPINGTON Intell. Syst. i. iv. 253: Virgil's forementioned Eclogue, wherein there is ... another completion of them [the Sibyl's books] expected. a 1716 SOUTH ii. 1. All the divine predictions, receiving their completion in Christ. 1736 BUTLER Anal. iii. 153: The apparent completions of prophecy. 1842 TENNYSON Gardner's D. 234: That my desire ... By its own energy fulfilled itself, Merit'd in complection.

† c. (with pl.) A perfection, an accomplishment. 1858 Bl. GARDEN, in Chr. Wordsworth Documentary Suppl. i. 182: 24 Your Lordship, in whom are all those completions which advance men to ... love and high esteem. 5 8

Complete (kəmplı't), a. Forms: 4-5 complet, -plete, 6-7 -pleate, 6-9 -pleat, 4- complete. [ad. L. completus, pa. pp. of completere to fill up, finish, fulfil, f. com- intensive prefix + père to fill (cf. plenus full). Cf. F. complet, complète (in L'apres, 1530); the earlier OF. word was complice, complie from the Romance form of the vb. completer. About 1600 often accentuated complete, e.g. by MARLOWE, CHAPMAN, and SHAKESPEARE.]

1. Having all its parts or members; comprising the full number or amount; embracing all the requisite items, details, topics, etc.; entire, full.

Partial "completion" of wall forms at Forderer's St. John's Catholic Church Center in Lucerne-Wurzenbach allows formal interaction between space and built form.
2. Of a period or space of time: That has run its full course, whole.

3. Of an action, state, or quality: Realized in its full extent; entire, thorough.
**Collage**

The key word in this definition is incongruous. Through the addition of incongruous, self-stable bits, a larger whole or continuity may be achieved. Field organizations are usually assembled from a series of collages. Once a continuity is established from an aggregation of smaller parts, that aggregation may become part of a larger definition by interrelating with other same-sized definitions, similar or dissimilar. The same reciprocal and dimensional principles accounting for the initial aggregation apply to larger moves as well. Collage principles are those which embody and organize the continuities, completions, and containments, resulting in formally intelligible aggregations. If there is to be reciprocal interaction between the collage and its environment, then, by definition, the collage itself may never be complete.
Leverkusen-Fettehenne, R.C. parish church, St. Matthias, exterior detail of concrete-glass relief window.

2. [P. réf. à certaines propriétés des colles]
   a) GÉNOL. Clarification des vins et des boissons alcooliques à l'aide de diverses matières collantes qui retiennent les particules (blanc d'œuf, gélatine, colle de poisson, etc.). Des collages déficients (E. BOULLANGER, Malterie, brasserie, 1934, p. 291).


B. — P. ext.


— Rare et p. méton. Persone avec laquelle on vit en situation de concubinage. — Et ton collage à propos, tu l'as donc épousé? (ZOLA, L'Oeuvre, 1886, p. 274).

Each of the form families may be given formal self-stability by the manipulation of their behavioral attributes. Form behavior embodies two polar operational principles: intensification and transformation.

Intensification

Strengthening continuity, or intensification, of any of the generative form groups may be accomplished by the utilization of one or more principles of self-stability. A continuity may be intensified by the repetition and/or registration of similar forms (shape and direction) in the immediate vicinity of that continuity. The form and direction of the continuity must be spatially reinforced by the intensifying elements, creating reciprocity between continuity and adjacent space.
Shrine in front of Yakushi-ji Temple, near Nara.
The operative opposite of intensification is transformation. Transformation occurs when existing environmental conditions need to be countered. In a directional field organization, transformation may occur by a reversal or other major alteration in the initial direction. Manipulation of the self-stability principles allow intensifications to be build independently from the environment. In this sense, transformations are only possible if the transformed definitions are self-stable. The relationship between non-transformed and transformed bits is governed by the same self-stability principles outlined in the section on intensification.

Lucht en Water II, M.C. Escher.
These eight to ten story vertical units at Cuenca add up horizontally to create a larger continuity normal to the initial direction of the vertical units.
The general principles of form may be applied to a broad range of construction technologies. Repetitive industrial construction technologies are agents of practicality in the architectural design process. The era of hand-crafted aesthetics has given way to Twentieth Century notions of functionalism and industrialized processes. The need for speed, standardization, and efficiency is so deeply rooted in our culture that flexibility, plurality, and traditional aesthetic considerations are obsolete. What then is the expression of the Twentieth Century? Is it merely a functionalistic representation of industrialized technology out of control? Is it an attempt to disguise those processes which have created such drastic changes in our culture?
If we recognize a unity in nature and human energy, it follows that science, art, and the humanities are also inseparable. Frank Lloyd Wright addressed this issue in his edict "form is function." These two concepts must exist in a harmonious relationship. As Buckminster Fuller says in Nine Chains to the Moon:

When there is time perspective on [Henry] Ford equivalent to the 400 year interval between ourselves and Leonardo da Vinci, which enables us to appraise da Vinci as the greatest artist of the Middle Ages, Ford will undoubtably be acclaimed by the people of that latter day as certainly the greatest artist of the 20th century.

Given an understanding of the concepts of self-stable form(s) in a field organization, formal and aesthetic issues may be addressed with the use of industrialized building systems. The physical nature of these systems is to be independent of alternate systems. Components are designed with strict operational, structural, and dimensional limitations in mind. These limitations give individual systems character and self-stability. Although some systems tend to work better in particular situations than others, there exists
such a wide range of alternatives and techniques that almost all programmatic and functional requirements may be accommodated.

Republic Steel Mill, Cleveland, OH, by Albert Kahn.
Environmental and site considerations depend not on the choice or design of a specific industrialized system but on the formally literate deployment of the system's components. If reasonable formal principles are used to generate a coherent aggregation, then there is virtually no limit on flexibility for the architect. In most cases, excessive uniformity and other unwanted environmental effects inherent in industrialized construction technologies may be avoided.

The formal inflexibility and failure of many buildings result from both obsessive completion of the industrialized components and an illiterate overall aggregation of components. If definitions have been completed, then there is no possibility of interaction with either the environment or other definitions. The result is merely a honeycomb-like maze of individually isolated components.

Physical aspects of the primary structural system ought to suggest the beginning of a definition or territory. In this respect, the initial system is not restricted to creating only one type of space governed by the formal properties of one system. Without completion there is an allowance made for
subsequent decisions that may either alter or intensify the original move.

The advantage to designing structural systems by this method is that it not only structurally bonds the building together, but also may begin to define partial containments and continuities of space. The formal expression of physical properties in the structural system then lends a unique character to spaces and territories defined by structure. Different structural systems may have different formal implications, and so specific programmatic and functional criteria may be accommodated by the selective placement and aggregation of individual systems. In this sense, form not only is use but use is form.

If each system is designed to be structurally and formally self-stable, then the option to deploy different systems with varying formal implications is left to the designer.
An unfortunate example of industrial building technology.

**Additive Growth Form**

Since it is possible to build partial territorial definitions with the use of industrial building technologies, the overall form and multiplicity of form in an aggregation of building systems is apparent. It has been demonstrated that larger definitions may be built by the addition of smaller, identical forms. The next step is to build the
larger definition or the addition of bits from non-identical systems. The result would be similar to a model built from Legos, Tinker Toys, and an Erector Set, and even though each modeling medium has its own formal* and structural implications, a coherent whole can be achieved through the use of reciprocal forms and dimensional considerations.

*(The dimensional system need not be only finished parts.)

This Southern Italian town is clearly a more humane and interesting aggregation of components than the preceding example.
While it is possible to create larger definitions by the addition of dissimilar components, the variety attained by employing several systems is essential to the basic concept of plurality of architectural form. As in the Iberian and Italian hilltowns, the addition of individual definitions results in a non-repetitive and hence transformed whole, even though the construction and organization principles may be very constant. Transformation and the use of multiple self-stable components allows us to achieve plurality and variety in form.
When designing with self-stable industrial building forms, it is restrictive to work 2-dimensionally. To begin with, continuities must be treated in a "lineal" manner (as opposed to "linear" which implies 2-dimensionality). Space is by its nature 3-dimensional and the only effective way to understand it is to model it in three dimensions. Further, given the 3-dimensionality of the various building systems involved, it is impossible to arrive at an understanding of the spatial relationship between self-stable components without modeling them in three dimensions.

The modeling process also lends itself to working additively. Individual components can be amassed and then aggregated in a manner appropriate to the basic principles ("facts") of form already discussed.
Several study models assisted in the design of individual industrial building systems. Although many different conventional industrial building systems exist, careful selection and modification of those systems was important in order to arrive at formally workable definitions. In particular, the folding skeletal wall system had to be carefully designed to achieve the desired physical, structural, and formal properties while not obviating its repetitive construction attributes. Once the systems were seen in 3-dimensional space, their unique physical and formal properties could be identified and explored.

Although it is hoped the systems developed in this thesis may be applied to a variety of use situations, the selection of a specific site (Government Center Plaza, Boston) assisted in the aggregation and design process. Site and use considerations must determine the juxtaposition and dimension of individual spaces in any reasonable building design. Choosing a specific site provided clues to the initial round of form decisions at the urban scale as well as the organization of different sized individual habitable territories and zones. Although site and use issues are
crucial to the design of any building, these considerations were given less than the usual attention. It was considered most important for this exploration to deal with industrial construction technologies and generic architectural form principles.
Displaced surface forms are concerned with foundations and site-related issues. In formal terms, the idea is to displace areas of existing ground form by elevating them to allow access continuities to be established between the displaced surfaces and the underlying zones. In plan, displaced edges take on the form of partial containments and establish large scale continuities. Territorial definitions of this nature and scale suggest large public gathering areas such as plazas and ceremonial places.
Because the displaced surface is identified with public use, it is desirable to build vertical access and service cores from its components. If this is possible, then not only does the system allow intensification of ground forms, but it also builds reciprocity between the ground forms and the upper building.
In addition to the vertical displacement of ground forms, displaced surfaces may be "floated" horizontally. Treating surface forms in this manner leads to a directional intensification of the horizontal. It also implies that the region between raised form and the ground may be established as an access continuity. This notion of continuity creates reciprocity between the two regions.

Horizontal surfaces (ground/roofs) are displaced by this village's closure.
1. GENERATIVE SECTION ELEVATION

1" - 40'  79
The formal intent of the megalithic spine is to build large scale continuities. These provide workable definitions large enough to reciprocate with the overall urban fabric of a large city, yet small enough to be recognized as building-sized definitions. By creating urban-sized continuities, the megalithic spine system works in a manner similar to the backbone of an animal. The backbone is the common component to which appendages are registered.
In order for any building system to be considered formally stable, basic dimensional and reciprocal criteria must be met. In this instance, dimensional considerations are resolved through the use of multiple precast components. Territorial and reciprocal considerations lead to the use of a triple column arrangement and the cantilevered spandrel beams. All components are 100% precast with the exception of the two-hundred foot spandrel beams. The lower precast portion of the spandrel beams are hoisted into place and secured, and the upper section and webbing are poured in place. The precast bottom portion is a support for formwork while the upper half is poured. By allowing the webbing and top of the beams to be cast-in-place, homogeneous structural connections to the cip folding...
**PHYSICAL STABILITY** - STRUCTURAL ISSUES

**TRANSVERSE STABILITY**

This will be achieved through a vertical truss arrangement - probably vertical. 2 columns connected at approximately intervals by moment connections (or triangulation) to the floor, will be anchored at the ground having footings. This is the primary moment connection.

Formally speaking....

This seems to justify the double column arrangement. What will happen is that these double columns will march along with the primary direction (one being on the left). The intermediate zone can become the center of slip. Yet a zone of its own (there is no indication?)

The double column may be the instrument of

The 'slip' here is actually built by the 'primary zone' slopes in contrast to that other zone. The 'slip' here is actually built by the 'primary zone' slopes in contrast to that other zone.
Formally, the clustering of three or more columns is intended to: (1) create the beginnings of territorial definitions at the column base with the possibility of an intensification of that territory through the use of an alternate formal system (probably ground forms); and (2) with the notion of cantilevering spandrel beams, to create major vertical continuities.

Each column is a precast cylindrical form. Column sections are connected to a precast spatial tree. The precast tree enables an inter-column connection to occur, thus providing some lateral stability to the columns by inducing a moment connection. In this sense, the column cluster resolves some horizontal loading situations by working like a vertical cantilevered beam. The interconnections react as shear...
inhibitors in a manner similar to the action of webbing on a horizontal beam.
Spandrel Beams

The basic structural implications of the spandrel beams have already been discussed. They are the components which establish the largest horizontal continuities (200 feet maximum). The spandrels are approximately sixteen feet deep with openings at every thirty feet for lateral access. The spandrel beams are vertically located at a minimum of thirty feet, establishing major access continuities. These access levels function similarly to those in Habitat.

Spandrel beams in the Government Center parking garage, Boston.
Precast Flooring

Primary access continuities are built from precast double "T" sections. The maximum allowable span is sixty feet with the possibility of up to a fifteen foot cantilever. A general rule for cantilevers is that they can be no greater than one-fourth of the initial span.

Flooring is supported directly by the spandrels at one of two points. The first loading condition occurs at the top of the spandrel, allowing the double "T" section to pass over and establish some horizontal intensification. Cantilevering of the double "T" section only occurs at this position. The second support condition occurs at the base of the spandrel.
Here the double "T" rests on the original precast component of the spandrel and is supported in the same manner as is the cip formwork for the upper section of the spandrel.

Connection Details

1. The underlying approach here is basically that when two items come to an intersection, if they are allowed to "feed" each other, that intersection may not only become physically stable, but most important, "spacial."

   At this scale the "spacial" qualities of the intersections need not be habitable (although they may...)

   This lends to some visual interest and formal balance of the connections.

   Per the "spacial" qualities of the intersections generate dimensions which may then be used in a dimensionally stable manner.

2. Assuming that the feeding thing is good lets rephrase the quote: "build it... whatever the set from away ten column..."
STRUCTURAL ISSUES

1. 
   a) PRECAST BEAMS - 10' DEEP (6' - 15') TO TRANSPORT IF PRECAST CONCRETE
   b) ONLY CASTING THE BOTTOM SECTION, THE TOP MAY BE CAST LATER - IF NECESSARY.
   c) THIS WOULD ALLOW PRECAST 'T'S TO BE SET ON TOP OF THE BOTTOM ELEMENT (PRECAST) AND THEN CAST
   d) IN PLACE, WHILE THE TOP HALF OF THE BEAM IS TIED - THIS WOULD (? NEED TO RESOLVE A MOMENT
   e) CONNECTION BETWEEN THESE 'T'S AND THE
   f) BEAMS. FOR THE TOP OF THE BEAM A FLOOR COULD BE INTEGRALLY CAST.
   g) WATCH OUT FOR SHEAR PROBLEMS.
   h) AS THE JOINT BETWEEN CAST & PRECAST LIES ALONG THE SPINE AND A SUNK-TOOTH CONNECTION
   i) IS VITAL HERE.
EXPLODED AXONOMETRIC
Although the folding wall system is the most difficult system to design, build, and define, its formal attributes are the most rewarding of all the building systems. To begin with, a continuous surface structural wall system not only serves as a major structural element, but its flexible formal and folded surface qualities are ideal for building partial containments and room-sized definitions.
Formal properties of the folding skeletal wall system imply deployment in a manner intensifying main built continuities (such as spandrel beams), even though large definitions may be created by the selective addition of registered built wall zones. Individual bits of wall or wall zones may be considered habitable because they are spatial. In other words, the folding properties of the wall system allow numerous partial territorial definitions to occur. These definitions may or may not be intensified or transformed by the use of another building system (usually a secondary system). The overall form of the folded wall system resembles that of bone marrow. The homogeneous addition of many different surfaces results in the creation of multiple small spatial definitions; the lineal
addition of numerous spatial bits creates a great deal of flexibility in overall form definition.
One of the greatest difficulties in designing with a system allowing so much formal freedom is that additive continuities (especially horizontal) are a bit problematic. This dilemma became apparent during the first three or four attempts to model the system. Initially, a modified tunnel formwork system was thought to be the best method of building a folding wall system. However, two problems with the smaller territorial scale occurred. First, breaking away from completed cellular definitions proved to be a difficulty and second, the removal of formwork disallowed the casting of surfaces on the face of the structure. Several modifications were made to the tunnel casting process to alleviate this problem, but none was very successful.
Horizontal continuities were the most difficult to build. Initially, it was thought that larger horizontal definitions could be assembled through the lineal addition of cells. Although this technique yielded some success, the approach seemed to be contradictory to the nature of the design of the system. The tunnel casting system works best when the form is cast, the formwork removed, placed on top of the newly cast part and then recast. This sequence implies a greater emphasis on the vertical nature of the overall form. To get the tunnel forms to read horizontally, one must fight the nature of the system. For this reason, the tunnel casting method was abandoned.
CONTINUOUS SURFACE TUNNEL FORM

THE IDEA IS TO CREATE A SERIES OF INITIAL ROOM SIZED DEFINITIONS.

THE KEY TO 3D MODELLING SEEMS TO BE NOT TO COMPLETE ANY OF THE TUNNELS

.... MAY BE COMPLETED BY 3D SYSTEM ?? or not...??

OK...SO THESE INITIAL ROOM SIZED DEFINITIONS MUST WORK IN

V THERE ARE TWO BASIC TYPES

1. HORIZONTAL
2. VERTICAL

HORIZONTAL REGISTRATION (MAY BE CONTROLLED BY THE

BILateral BALANCES) 7

THESE ALSO GIVE 3 DIMENSIONALITY 90, 120, 90

OR DEPTH DIMENSION TO THE 45, 90, 135

CALLED HARMONIC ABSTRACTION OF INITIAL DEFINITIONS

THAT IS ACTUALLY A VIRTUAL WALL.... OK??

BROWN SHOWN POSSIBLY (IN CONCEPT) FROM 90 TO 180
To get sectional depth out of this setup, it may be enough to build the back wall and consider it the finish. The back wall would essentially be a frame for the cold containers to cut into from.

[Do I need the containers anyway?]

On, now we're getting nowhere. The general idea is to design with the back plates and then on and add the use of containers to sharpen the back plates.

So, let's see study after B. 3:05 AM
A systematic method of casting with reusable formwork panels was then developed. While overall formal goals do not vary from initial intentions, the methods used in achieving those goals has been altered. Similar to the SIMIX system developed by Waclaw P. Zalewski, this system provides for the addition of standardized formwork panels culminating in wall forms of variable length and height.

Variable wall forms (circular and angular) are built by constructing two plywood templates which, when placed between the formwork panels, prevent a specific area or geometry from being poured. The two templates are reusable. The circular geometry was intended as a non-structural definition used only when movement or access is hindered by excessive wall material.
The angular (45°) geometry has more extensive ramifications. To begin with, the angle is used when formal criteria indicate that a lateral shift in the vertical flow of forces induced by the structure's weight is necessary. Shifting vertical loads in this manner gives the folding wall system a certain amount of horizontal movement. The 45° shift also allows chunks of built wall zone to define large continuities and territories which are distinctly different in character from the smaller definitions.
Precast Flooring

Floor slabs are the only precast components in the skeletal wall system. They measure twenty five by thirty feet in length, and linear perforations at selected intervals along the length accommodate reinforcing bars from the cast-in-place walls. It is important that a rigid connection be established between the floor slab and walls for structural reasons.
Formwork

The standard formwork panel measures ten feet in width and twelve feet high. Horizontal addition of three panels equals the length of a precast flooring component. The twelve foot height dimension also works as a multiple of three. Reference levels occur at thirty-six foot intervals. The secondary system proposed in Appendix D registers to the wall system only at thirty-six foot intervals, requiring four levels to match the thirty-six foot dimension built with the wall system.
Structural Issues

The relationship between wall and floor components is critical to the overall structural integrity of the additive wall form. By introducing a 45° geometry into the primary structural system, a resolution of the horizontal and vertical components of the 45° thrust is required. Wall sections adequately manage the vertical components, but the precast floor slab is designed to resolve horizontal forces. The overall wall system can be stabilized only in this manner, indicating that floor placement is somewhat more than random. This relationship establishes the formal principle of "continuous surfaceness." For the wall system to be structurally stable, a homogeneous three-dimensional planar aggregation is required.
PLAN DIAGRAM Component Aggregation
3. GENERATIVE SECTION ELEVATION

1" - 40'
The concept of the secondary system is quite simple. The base unit is a propped-up sixteen foot square plate. A square geometry was chosen because it has no dominant directionality. Non-directional form is especially suited to the secondary system because it does not, formally speaking, embody movement. A territory without movement or access may be considered a private, habitable unit. The office and administration buildings designed by Herman Hertzberger in Apeldoorn, Netherlands are the primary reference for this system.
Interior of Hermann Hertzberger's office building in Apeldoorn, Netherlands.
Like the previously mentioned structural and formal systems, the secondary system is formally and structurally self-stable. Structurally, the system is designed to support itself up to four levels high. Beyond that, assistance from one of the primary systems is required. What makes the secondary system different from the primary systems is that, instead of beginning with large continuities and allowing their structural and formal characteristics to define smaller partial containments, the privacies are defined first. The sixteen foot increment is considered a typical private use space dimension. Larger continuities may be reached by adding the individual components in a coherent manner.
The primary purpose of the secondary system is to be used to create some of the partial definitions bound by the T1 systems. For the most part, this is a 3-D screen system that serves as a support for flooring (horizontal planes) and closure (vertical planes).

**Screen System (Self Stable)**

- Continuity Intersection: Must first be recognized or built.
- In the case of the access system (stairs), then discontinuities need to be "built".
- In the case of the addition of a partially defined system (concrete), built and roof line.

**Primary Connective Details**

| Library Stuff is like furniture... it may be placed in any fashion. |
| **Not** regulated to the primary. |

Look at horizontal... addition of square.

Squared because they are own directional.
Closure

Closure consists simply of building a flat weather screen that registers to the exterior of the secondary system. Building large continuities in the secondary is accomplished by first designing the larger form of the closure and then registering the three-dimensional secondary system to the enclosure. Larger continuities of form may then be build from a system of self-contained privacies. It is expected that forms and subdivisions of the closure will meet the basic formal and dimensional principles outlined in the preceding sections.
EXPLODED AXONOMETRIC

PRE-CAST
4. GENERATIVE SECTION ELEVATION

1" - 40'
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