BUILDING AS A SYSTEM OF GROWTH

by

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SUBMITTED IN PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF ARCHITECTURE

at the

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
June, 1966

Signature of Author

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Department of Architecture

Thesis Supervisor

Head, Department of Architecture
Lawrence B. Anderson  
Dean, School of Architecture and Planning  
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Cambridge, Massachusetts  

Dear Dean Anderson:  

In partial fulfillment of the requirements for the degree of Master of Architecture I hereby submit a thesis entitled "Building as a System of Growth."  

Respectfully,  

Konstancija Brazdys  

June, 1966
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Introduction

In our day and time, where there is this rapid pace of technological development, scientific discoveries become available for technological exploitation.

Society, which in the past was reluctant to accept radical changes, is now eager for new feats of design.

Design is a purposeful activity directed toward the goal of fulfilling human needs, particularly those which can be met by the technological factors of our culture.

Philosophy is a love of wisdom, wisdom which has been organized to form an intellectual structure. It is the underlying body of principles which govern a branch of learning, a discipline or a religious system, as well as any other important human activity.

But in a personal scope, there are also philosophies - the consistent and integrated personal attitude toward life, or reality, or certain phases of them - like one's attitude to one's profession, especially if that attitude is expressed in the beliefs or principles of conduct.

The origin of philosophy is empirical, but its test is pragmatic, i.e., testing facts of history with reference to their practical lessons. The solution to which it leads must be good in the sense that it is useful. But good is a relative term that needs a specific definition, especially suited to each particular situation. The evaluative element is a feedback mechanism which serves to indicate how well the principles have been applied in a particular instance, and to reveal shortcomings so that improved application of the principles can be made.
The Process of Design

1) Definition: In the process of design one encounters problems arising from developing, organizing, and evaluating information almost always in the face of uncertainty, from the necessity of taking into account the complicated interactions of components from the need to work always within the contraints of an economic framework and from the constant requirement to make predictions in terms of design criteria.

In design, one must seek out those principles and concepts that are of the greatest generality, consistent with usefulness and that can lead to a discipline of design. A method must be formed to apply the discipline of design (in a very general sense) and then a general critique must be established to measure the validity and value of results in specific applications.

2) Search: The principles and concepts on which we must rely stem from the collective experiences of mankind. They are what by observation we believe to be true. We cannot prove by logic that any particular principle is true. Thus, the choice of principles and their formulation will be based by our personal experiences and idiosyncracies. For this reason there are many philosophies and schools of architecture.

3) Evaluate: When one works with problem situations, one finds that
one does not know enough about the factors that compose it. One focuses on goals, which may change in the light of future evidence and additional knowledge.

A solution is a synthesis of component elements which hurdle the obstructive difficulties and, neither exceeding the available resources nor over-reaching the limits set by the constraints, accomplishes the prescribed goals.

What are and where do the component elements come from? For the most part they are stored in our memory; we add to the stores as our experience widens and as our ability to see and hear the potentially useful sharpens. The elements may be of ideas or of physical things. What enables us to draw upon our experience just at the right set of elements and to put them into just the right combination so that they have a sense of fitting the situation we do not know, since no definite formula exists. The solution favored for development has to be refined.

Only very minor solutions are solely for personal consideration. They could be left in a rough form, for no one else will have to judge their merits.

Final solutions have to be communicated. Communication
is a perilous adventure beset with semantic pitfalls; lack of delineation, control, and expression strewn with sheets of misunderstood proposals and solutions; for there is no other way in a design project, except for occasional alternatives, to implement the solution.

4) Select: Decision is a man's most difficult critical task. It lies at the heart of all human problems. It determines the direction in which human effort will be directed. If good decisions are made, man moves closer to his aspirations; if decisions are poor, his goals recede.

Good decisions are based on the immediate evidence of one's senses, the accumulated experience of one's lifetime, the intuitive feeling for what is proper or fitting, and recorded wisdom of civilization. The evidence must be brought to bear upon the favorable alternatives, which the individual perceives, thereby enabling him to single out from the plurality the one that appears the best means to attain the desired ends.

Aim of the Project

To design a footprint of structural, vertical circulation and mechanical components from which different sizes of buildings, with different spatial qualities and character can be defined.
The system to be created can be approached as an orderly organization of components to achieve "a finished product" for each case, or as a system of growth, for which it is required to establish the geometrical, structural and mechanical self-sufficiency of each unit. It is advisable to design a structural and mechanical system where the vital components become permanent elements of the systems (columns, girders, main mechanical service branches) while the secondary components can change or be removed to achieve flexibility in use or spatial changes, (beams, joists, secondary mechanical service branches), thus becoming temporary elements of the system.

An initial step of work was the simultaneous study of a typical structural and mechanical bay, with such behavior and geometry as to allow several organization patterns to form a system of growth.

Building as a System of Growth

For a multi-directional growth a multi-directional geometry as well as structure is required, thus the two way system and pin-wheel unit.

This self sufficient unit consists of a centrally located core with four pinwheeling bays of 10,000 sq. ft. in area around it.

Patterns of Growth

The different patterns of growth and shapes of buildings possible to obtain with such units are shown in the drawings (plates #1 to #15). These drawings illustrate only two dimensional possibilities and the photographs (plates #16 to #24) indicate just a small number of the almost infinite possibilities in the third dimension. The variation of floor to floor heights and elimination or addition of bays increase spatial variation within the desired chosen buildings.
Size of Unit

The code dictates the furthest distance from the exits to the edge of the unit. Such distance is 125 feet. In order to have a most flexible space, one has to have the least number of columns. The 10,000 sq. ft. area is supported by four columns 65 ft. on center with 20 ft. overhangs on all four sides. This is the size of one of the bays of the four of the self-sufficient unit. The 65 ft. column module lends very well to the parking considerations at the subterranean level. The height of the units is four stories, and the floor to floor height is 14 feet.

Since the concrete structure has to be integrated with the mechanical system, the depth between the upper and the lower chords of such structure has to be ample; therefore, the spans of 65 feet are justifiable.

Cores

The central core is 65 ft. by 65 ft. square and serves as a point of vertical circulation for people and vertical distribution for mechanical. The toilet facilities, janitorial and electrical closets, together with storage areas, are also located in the core. The core proper has a fifteen foot corridor surrounding it for the major circulation on each floor, thus eliminating major corridor penetration into the bay areas.

Structural Components

The horizontal components of the system consist primarily of prestressed, precast channels 105 ft. long; 10" x 6" prestressed precast members the same length as the channels and the reinforced
precast floor slabs 5 ft. wide and 10 ft. long.

**Structural Behavior**

The system works as a two way system with the walls of the channels acting as the transmitters of both compression and tension forces. The sides contain reinforcing to take care of the actions. The prestressed member provides the continuity in the perpendicular direction to the lower channels, and the slabs together with the topping provide the continuity at the upper chord. The forces from the lower chord through the point of contact of both the upper and lower channels to the upper chord. This type of action occurs throughout the horizontal structure creating a truss action directing and distributing the forces directly to the four columns. (See photograph of model, plate #31).

**Description of Components**

The prestressed precast members 10" x 6" x 105' are prepared to receive the lower channels. The stirrups stick out to insure a better connection between the member and the lower channel in the pouring of the joints at the intervals of 5 ft. on center. The lower channel has cut-ins to straddle the members. The base of the channel is perforated for later accessibility to the two direction negative space between the upper and the lower channels. This perforation lightens the channels and provides location for insertion of acoustical panels. At intervals of 5 ft. centers the channels are prepared to receive the upper channels and complete the joint for pouring the connection. The upper channels which are the same size and shape as the lower ones (the same forms were used) only
they have small round perforations for the insertion of flexible ducts which lead to the diffusers between the lower channels. The precast reinforced floor slabs have tongue and groove edges to insure continuity after the topping is poured.

Erection Procedure

1. The footings are prepared and columns poured to the underside of column capitals.

2. The prestressed precast members are placed 5 ft. on center on scaffolding at the edges and third points.

3. The lower channels are placed perpendicular to the members.

4. The joints together with column capitals are poured.

5. The upper channels are placed perpendicular to the lower channels.

6. The joints are poured and the columns to the underside of next capitals.

7. The floor slabs are placed.

8. The topping is poured.

All the joints are poured and the members are full length of the area spanned, therefore there is no need to use any additional method to insure continuity.

Mechanical Systems

For the interior zone the system is single duct low velocity supply and return. The vertical plenums are low velocity 200 c.f.m. located in the cores. The horizontal runs are the plenums created by the upper channels. The channels are treated with a spray sealer to insure no condensation leakage; also this problem is minimized because the channels serve the interior zone only with the
supply, but both interior and exterior zones with the return. The return vertical velocity is 700 c.f.m. The exterior zone is the 20 ft. deep perimeter serviced with high velocity air and hot and cold water through the columns to the under sill induction units. The strip diffusers are located between the lower channels and fed from the upper channels through flexible ducts (the ducts also eliminate noise transmission through the mechanical system). Wherever the location of the partitions, the diffuser is eliminated. Depending upon the air change required, the diffusers can be located at every module 5'0" o.c. or alternating modules 10' o.c.

Pipes

The hollow 65 ft. o.c. columns carry the vertical risers of hot and cold water and waste pipes as well as drainage and the induction system requirements. All pipes in the horizontal direction are located in the negative spaces of the channels and are free to run in both directions of the structure with enough room for slopes. The access panels are the acoustical panels located at the bases of the lower channels.

Lighting

Depending upon the desirability of the light intensity, the 4' x 2' fixture with two 60W lamps/luminaire can be located 5 ft. o.c. emitting 75 foot candles or alternating modules using four 60W lamps/luminaire emitting 75 foot candles; one can use smaller fixtures in each module or alternating modules or even use the members as indirect light coves and lighting the channels.

The Acoustical Treatment is in the access panels and the pop-in
panels between the prestressed member and the lower channel (see plate #26).

**Advantages of System**

1. Standardized parts using the same forms with the only differences between lower and upper channels being the openings attained with blockings.

2. The number of parts - three.

3. No scaffolding required, only at edges and third points.

4. No additional method necessary to insure continuity.

5. All joints wet joints accessible after the members are placed and the operation takes place from above.

6. Standard reinforcing patterns in placement with only changes in size of steel depending on location.

7. The use part of structurally acting member as built in mechanical system.

8. Use of easily accessible two directional negative spaces for secondary systems.


10. Uniform ceiling height throughout the area.

11. Rich exposed primary structure - no feeling of false ceiling.

12. Strip diffusors between lower channels seem to belong to the whole and not feel like an added item.

13. Partition module lends itself to complete ceiling patterns in each enclosed space.

14. Only four 6'6" x 6'6" columns to obstruct 10,000 sq. ft. of area.
Disadvantages of System

1. Working over the same area a second time once with lower channels then with upper channels.

2. The weight of the structure – approximately 11 Kips per channel.

3. Transportation of parts.

4. Expense.

Conclusion

Today one designs afresh following scientific discoveries, new knowledge dictates breaks with past practice. Thus a new design is projected, based upon ideas hitherto untried. The outcome is shrouded with obscurity of the future and blurred by the complexity of technology. The risks are proportional.
Core serves four units
Unobstructed spans - infinity both ways
Filler panels, no spaces
Cores serve four units
Unobstructed spans - nine: both ways
Filler panels, no spaces
Cores serves three units.
Unobstructed spans - one
No filler panels or spaces
Cores serve three units
Unobstructed spans - three and one
Filler panels and spaces
Cores serve four units
Unobstructed spans - three in both directions
Filler panels and voids
Cores serve four units
Unobstructed spans - six in both directions
Filler panels and spaces
Core serves four units
Unobstructed spans – one both ways
No filler panels alternating spaces
Core serves four units
Unobstructed spans - three both ways
Filler panels and open spaces
Core serves four units
Unobstructed spans - three and infinity
Filler panels and spaces
Cores serve four units
Unobstructed spans - five both ways
Filler panels and spaces
Cores serve three units
Unobstructed spans - one
No filler panels alternating spaces
A SELF-SUFFICIENT UNIT

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STRUCTURAL SECTIONS

SECTION A 
COLUMN PLANS 

SECTION B 

SECTION C 

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STAGES OF CONSTRUCTION

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