arts & architecture

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Saint-Exupery wrote that our 20th-century brand of humanism avoids action only to founder on the rocks of the tentative. It runs aground on rhetoric, whereas true Being is not in the realm of words but of acts. And the essential act, he believed, is sacrifice. Not the involuntary sacrifice of amputation or of penance, but of giving. To be part of whatever domain one aspires to—family, profession, community, region, country, world, humanity—one must give of himself. Only he who has sacrificed a part of himself to it, struggled to save it, striven to improve it can truly comprehend it and from there come to love it. Such domains—from family to humanity—are not, then, the sum of the interests of the members. They are the sum of the giving.

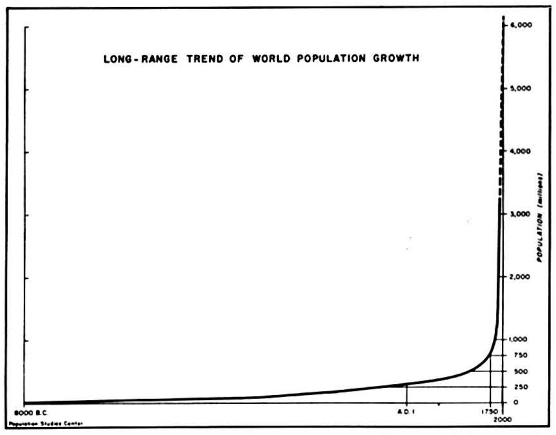
Most of us seem incapable of this kind of sacrifice, leading alienated private lives centered around nothing but themselves in spiritual and moral poverty of Appalachian depth. But there are a few who do give, who struggle to make what ought to be what is, strive to improve reality. In a world which prefers the unreal and those who improve it, this is the kind of giving meant by Saint-Exupery.

In the larger domains, it is the inventor-creator-researcher, who devotes a lifetime to extending the limits of the possible in science, art, building or whatever his field. He challenges the laws protecting the status quo, denounces as fallible yesterday's truths, but it is not through his words that he changes what a moment ago was thought immutable. It is his work, his gift of new possibilities, new patterns of thought and action which illuminates the vulnerable spots in the status quo, the irrational and bromidic.

There is no lack of irrationality. The future is coming at us like a tidal wave and we are concerned about the temperature of the water and what style bathing suit to wear. Stubborn reliance on our instincts, intuition and the increasingly inapplicable, albeit painfully accumulated, experience of the past has proved no defense against the tremendous forces and upheavals of our century. Traditional thinking and instinctive behavior will no longer do. Two-thirds of the world's 3.3 billion people live on a diet below the minimum subsistence level. It is estimated that 17,000 will starve to death this year; the number that will die from other causes directly attributable to poor nutrition—hunger—is beyond speculation.

Yet in the face of this we continue to breed at the rate of more than 200,000 births a day: instinct and traditional thinking—euphemisms for ignorance, as are such turgescences as "private moral issue" and "religious principles" when used to oppose birth control.

New ways of thinking and acting, learning and doing must be discovered. The time lag between our acts and their consequences is approaching instantaneity. A blink of the eye can easily be fatal at 65 m.p.h. Population doubling time, which remained constant at something over a thousand years between 8000 B.C. and 1750 A.D., is now down to thirty years. Each of us will have twice as many neighbors by the turn of the century, and if we are going to assume, in David Reisman's words, "that there exists a basic human nature, potentially benign, which needs only to be liberated," we can no longer wait for it to manifest itself in others. Those bitterly indicted by Russian poet Yevtushenko, the "Hallooers,/ hounders,/from your safe seats/ you squeal/ at us to be fearless," must come out of their safe seats. The insulated private life responsible only to itself is just a memory and a return to it is unthinkable. The sum of Saint-Exupery's giving must be multiplied.



Between 8000 B.C. and 1750 A.D. the world population doubling time remained constant at something more than 1000 years. It had decreased to 150 years by 1900 and 65 years by 1965, and the population will have doubled again by 2000. Chart is from The Annals of the American Academy of Political and Social Science.

There is a direct relationship, a causal parallel between substandard diet and substandard shelter. Food and building are both functions of Population/Natural Resources/Technology. As we know, *Population* is out of control in large parts of the world. The world's *Natural Resources* have been and are being exploited ferally, casually or not at all according to shortsighted and often artificially invoked economic principles rather than according to considerations of real present and future needs. One need not deny the virtues of American industrial efficiency, for example, while aligning himself in opposition to the path of least resistance down which it has trod in the 20th century—spurred, it might be added, by 18th- and 19th-century legislative and judicial policies designed to encourage the development of a continent now long since domesticated. And finally, *Technology* is universally misapplied. (Reyner Banham commented recently that "current U.S. tract housing represents the most technically sophisticated application of industrial methods in building anywhere in the world." The significance of this lies in what he most eloquently left unspoken.)

It is hard to discuss the inventor-creator in the limiting terms of architecture or any other single discipline. The force and scope of their work and thinking repels artificial boundaries, constantly pushing you back into the realm of ideas, the larger context. Konrad Wachsmann, whose work is the subject of this issue, made the point in a talk at the 1965 Aspen Design Conference: "I always feel uncomfortable to talk about architecture. In fact, I do not know precisely what today's architecture is, or what we mean by it." What's more, he shows no signs of concern at not knowing.

In explaining the title of his lecture, "To Build is Everything or Nothing is Built," he stated, "When I said 'to build is everything,' I meant it includes, it embraces everything. The time has passed, even if we do not know it, but I am quite sure it has, the time has passed in which, for instance, design criteria have meanings by themselves and a colorful rendering makes architecture. It is everything that makes it. The collection of facts. The common effort, the common evaluation, the collective work, the use of absolutely everything this time has to offer. This is building. If the basic approach is not comprehensive, then nothing is really built. It is only the image, the make-believe of building. It is true that it is there; I can see it, it is tangible. But I believe it is not really a building at all . . . It may serve some purpose, but it is just plain something else. Maybe it is some sculpture or monument, something from the world of entertainment, but architecture or better building is more . . ."

No matter what his field—science, art, philosophy, literature, building—even the most transcendent inventor-creator owes more to the time and the society in which he lives than he might care to admit. Not just politics but every field of human endeavor is the art of the possible. Much as he would like to believe himself to be working in the domain of the universal and viewing the infinite and eternal, he is looking from atop the shoulders of the present. In Norberg-Schulz' figure, his work is "like a lens [which] collects the causes and spreads the effects into the environment." The point has been made often and well that elevators not architects make highrise buildings.

Whether or not they acknowledge this debt to the present, the inventor-creators repay it many times over—unfortunately in coin that finds little popular currency. They challenge our assumptions, make us question our delusions. They carry the aroma of the future about them and prepare us for change even against our inclinations. Their discoveries cut across societal subdivisions to stimulate others of their kind, and occasionally their ideas reach down to touch here and there a receptive member of the establishment who advances their work rather than exploits, blunts or debases it.

Hannah Arendt calls the present the battleground where the forces of the past and future clash. To resolve her metaphor, it is rarely neutral ground. Konrad Wachsmann is one of the elite line of *baumeisters* who have given a lifetime to the struggle for better building, who have fought to narrow the gap between architecture and industry. He is one of the few who have been able to divest themselves of the 2000 years of cultural excess baggage, which, as Banham has written, bows down and defeats most architects in the Machine Age and prevents them from grasping the essence of industrialization, designers whose "machine-age architecture" can be characterized as such only by virtue of having been built in the machine age.

Some would not be defeated; they have worked to master the tools of industry and to incorporate those of science. The lives of these men is their work—and it is travail. If a common pattern is discernible, it is in their stubborn efforts to extend the limits of possibility, mentioned earlier. This is their costly and often ill-requited gift to the present and the future.

Wachsmann's work shows this pattern: the restless search—not to develop but to find—better building materials ("I am permitted to build in steel," he has said. "Someone else made it possible"), better tools, better methods to achieve ever greater spans, lightness, openness. The "Ultimate Space," as Wachsmann calls it. (The search goes beyond, he maintains, to something he vaguely calls a Philosophy of Building, but which might more accurately be described as a Quintessence or a *Mystique*. Certainly the devotion of the inventor-creator to his work is religious in its intensity, the severity of its demands on himself and others. Wachsmann recently turned down an applicant to his graduate institute at U.S.C. because he had been working for some time in an architectural firm. To Wachsmann, the man could not have a truly deep concern and belief in building if he would support himself designing what passes for architecture today. Better to dig ditches, sell used cars and keep the faith—a hard line, but with the lion's share of temporal rewards going to the taker not the giver, the latter can hardly be blamed for investing his work with a transcendence which promises to return a measure of spiritual profit for a life of self-denial.)

In architecture — building — the "Ultimate Space" or "Universal Space" has been the 20th-century grail. Freyssinet, Maillart, Nervi —like Wachsmann, bridge and hangar builders all—explored in concrete for the span of great spaces combined with economy of means. In the same quest, Wachsmann, van der Rohe and, to a lesser degree, Fuller have been steel carpenters. Mies, after designing his monumental Chicago Convention Hall, has turned from space to structure itself as truth. Fuller, too, apparently is satisfied that his dome—which encloses the greatest space in relation to surface area—is sufficient.

Wachsmann, on the other hand, has intensified his search for the Ultimate Space within which the architect can play with floor plans and the toys from Sweets Catalog. The projects on the following pages reflect one or more aspects of his search—first for basic elements which can be mass produced ("Nothing is worthwhile if it is not worth repeating"), then the means to join the elements into simple building components which can be combined to create the endlessly repeatable and variable building shell, the Ultimate Space. **D.T.**

As early as 1925-1932, Konrad Wachsmann had an architectural practice in Berlin, published a book on wood construction and, among other projects, undertook a house for Albert Einstein.

He won the Prix De Rome, and in the interval preceeding his coming to America in 1941, went through unbelievable ventures of triumph, destruction, incarceration and escape.

In Cambridge, he associated himself with Walter Gropius, and later in a partnership with Gropius developed the General Panel Corporation, the design of one of the most brilliantly conceived projects in modular construction.

In 1949 he was Professor of Design and Director of the Department of Advanced Building Research of the Institute of Design at Illinois Institute of Technology, and there in 1951 in the design of a building systems field of airplane hangars for the United States Air Force.

He has travelled under the aegis of the American State Department, (lecturing and giving seminars in the Orient, Middle East, and Europe) which also sponsored major showings of his work in Vienna, Munich, Zurich, Rome and Amsterdam.

There has been the usual flood of papers and publications, and particularly, in 1961, a remarkable book, "The Turning Point in Building".

In 1961 to 1963, he was commissioned to design the skyscraper headquarters for the Italian Steel Industry in Genoa, and in connection with this, to redesign the harbor area.

From 1964 to the present, he has been Professor at the University of Southern California, Director of the Building Research Division, and Chairman of the Graduate School of the Department of Architecture.

The gentleman I present is one of those identities that is by way of being a kind of monument. He has been, and is now, a vital participant of two kinds of worlds. He is like a man standing on a bridge, one of a classic few that for good or bad probably will never happen again. For those of us who dare call ourselves his friends, it is difficult to realize the dimension and the consequence of his existence.

He is a creature of science as it inadvertently approaches poetry. He is an accumulation of a thousand irritations, who unexpectedly transcends the limits of his own existence to suddenly and wonderfully address himself to the central problems and projects of the living conscience.

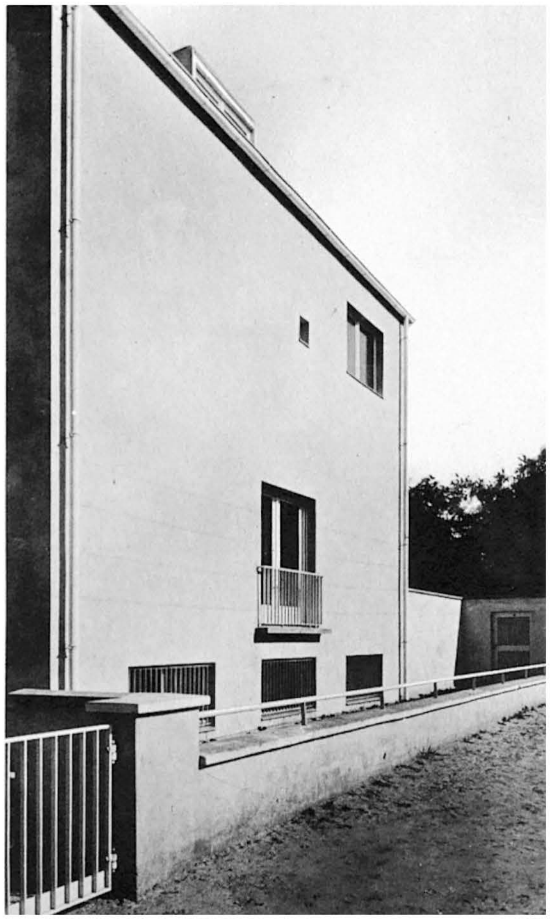
I introduce him in this strange way because I would not attempt to measure him as a human personality. For this kind of true "original"—for this kind of unique creature, there is no prototype —only disciple.

There is some mysterious genetic composition that has ignited this man. There is a recipe for this kind of reasoning human inhabitant that society would be well advised to find again and nurture, and carefully treasure.

And so, I bring to you this old friend, this aging wunderkind, this concoction, this mixture of a Loki and Apollonius of Tyana—this Konrad Wachsmann.

JOHN D. ENTENZA

Introduction to a lecture at the Graham Foundation for Advanced Studies in the Fine Arts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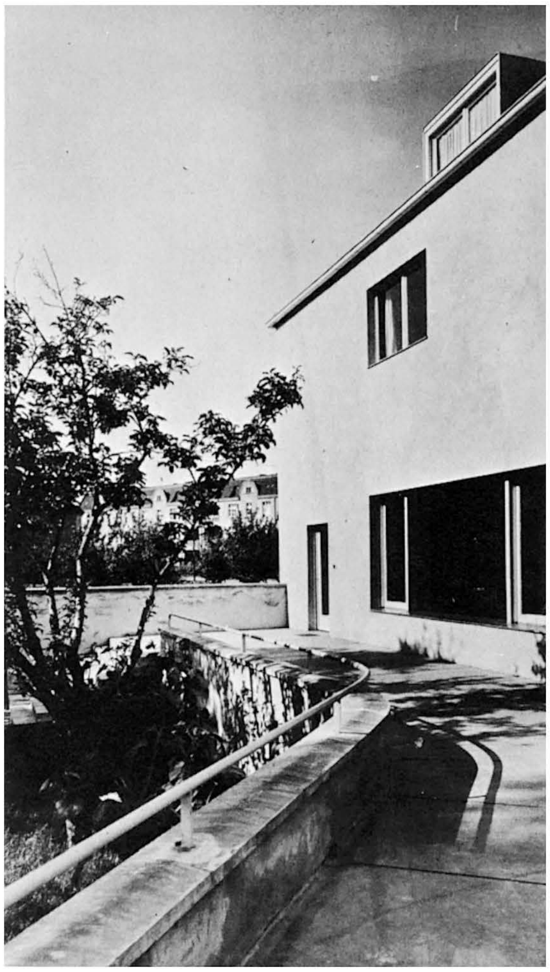
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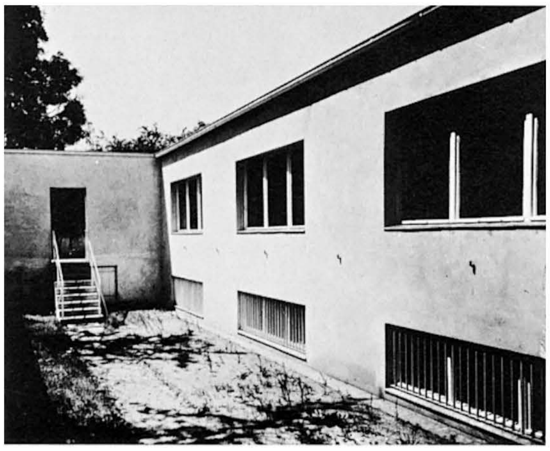
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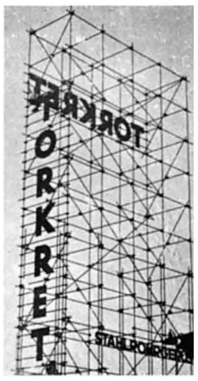
KONRAD WACHSMANN:
Early works, beginning 1925

1-4. Wachsmann's first brick building, a residence for a medical doctor, his family and his professional offices on the second floor, built next to the medieval city wall of a provincial town in Germany.

5-11. A project for a covered market place in Rome, Italy, 1935. The market contains several hundred sales stalls for farmers, large refrigeration chambers, wash and shower facilities for the employees, garages for trucks, surrounding stores on street level and a department store in the basement. The Ethiopian war prevented its execution.

12. First use of steel pipes and standard connections in an advertising tower at the International Building Exhibition in Berlin in 1931.



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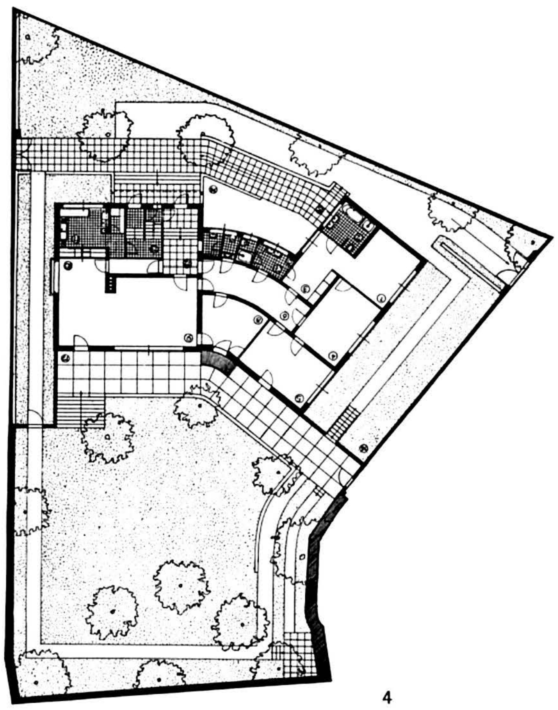
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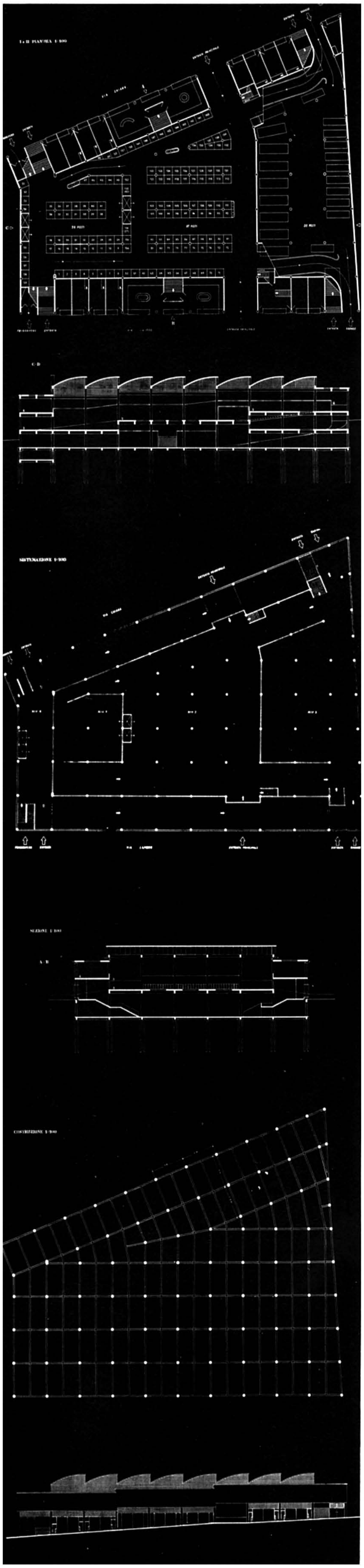
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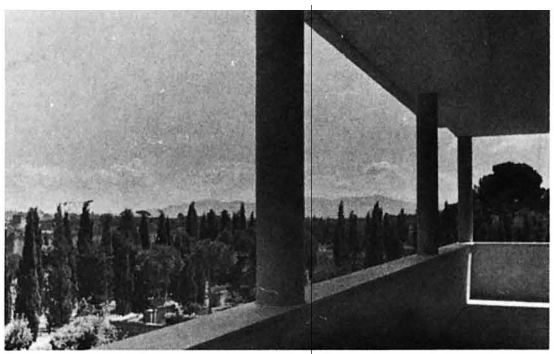

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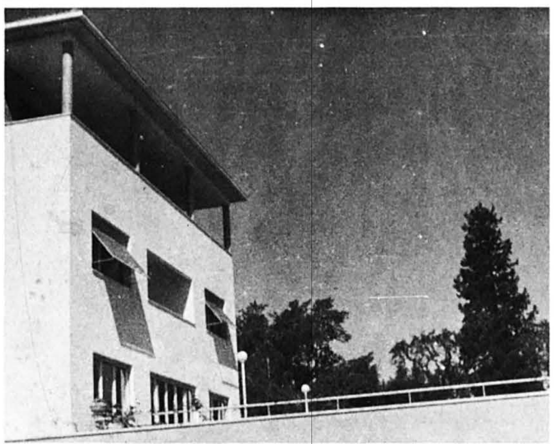

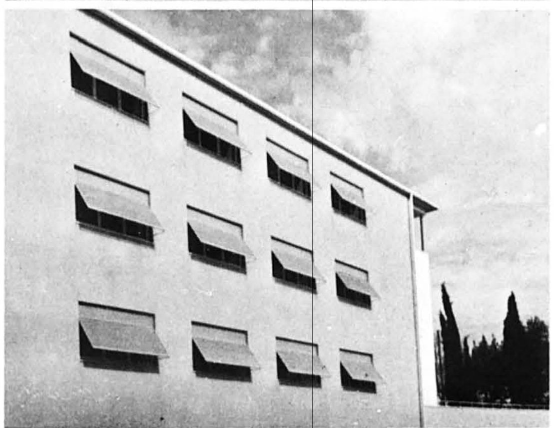

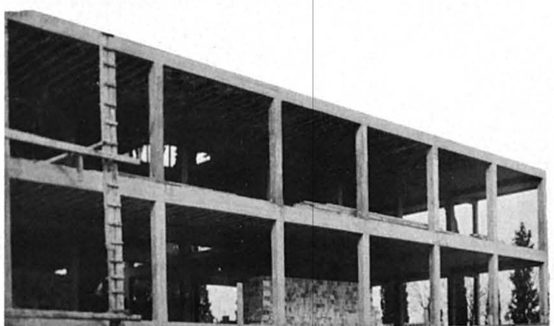

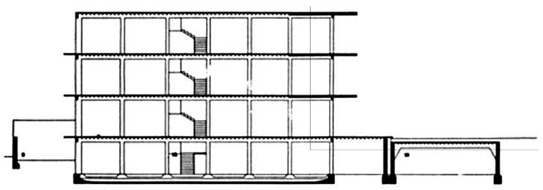

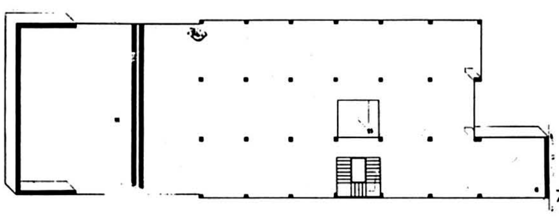

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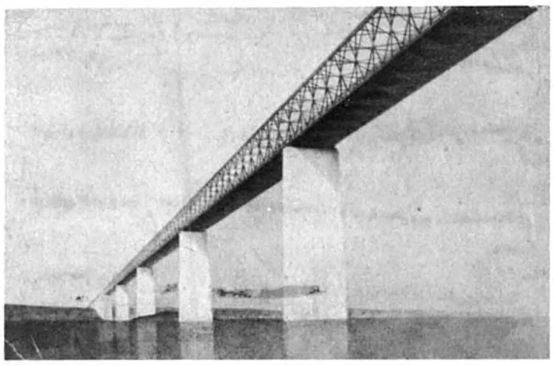
1-8. Wachsmann's first reinforced concrete structure, an apartment building, near the Caracalla thermes in Rome. From the top balcony, one can watch such open air opera performances as Gluck's "Orpheus and Eurydice" with fantastic ballets or "Aida" with elephants, horses, etc., in the Caracalla ruins.

9-15. Office building with cinema and underground garage with scissor type ramps and penthouse restaurant; 1936, in the center of Rome.

16. First studies of long span structures, a project for a highway bridge over the Rance river in France, 1925. First prize in an international industrial competition. Length 1.2 km., span 250 m., height of bridge pillars 60 m.



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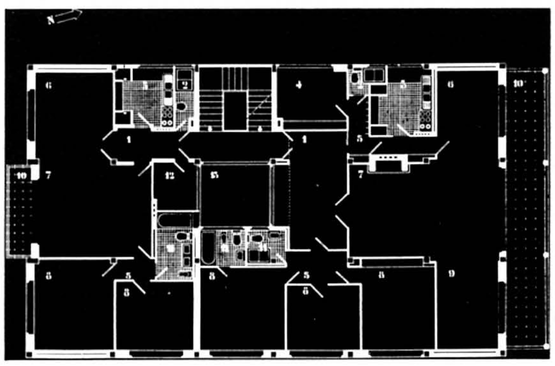

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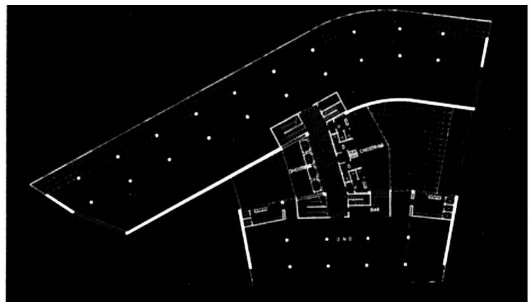

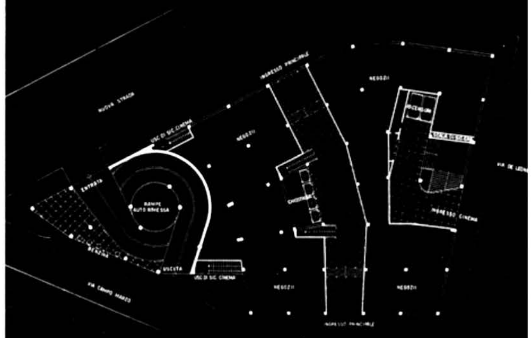

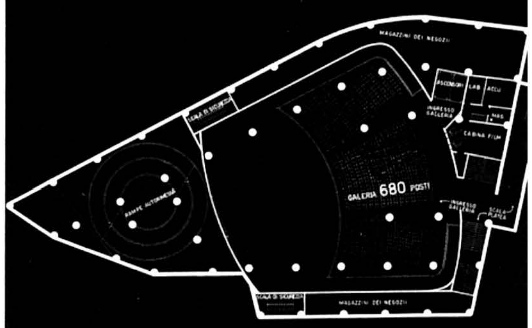

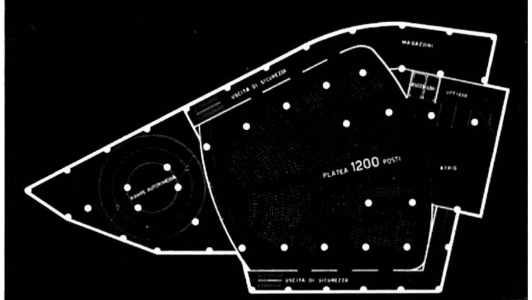

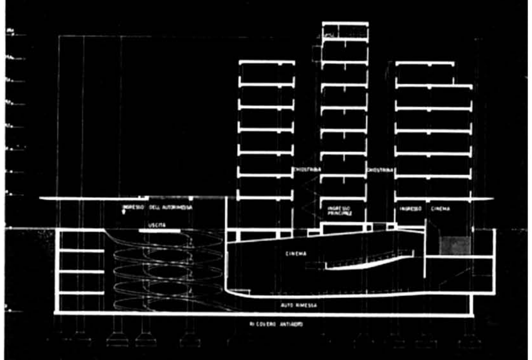

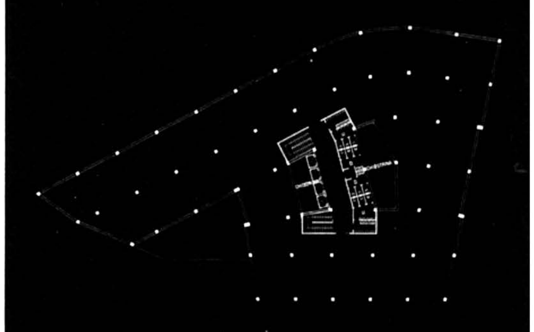

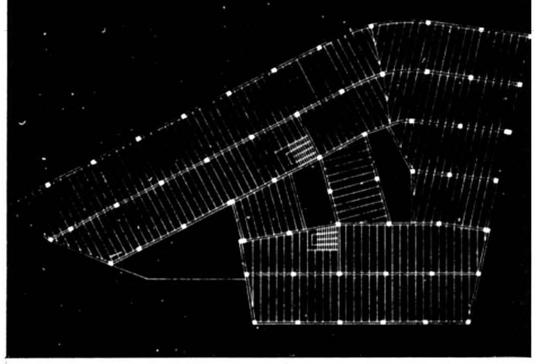

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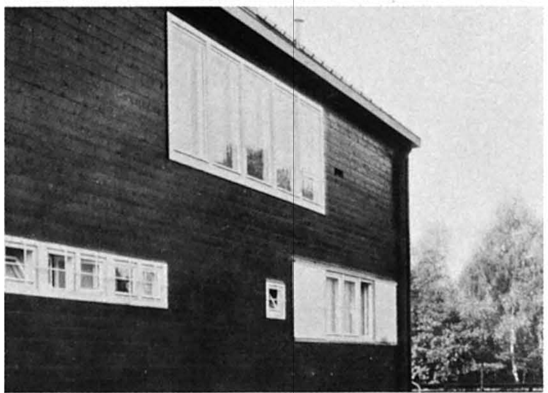

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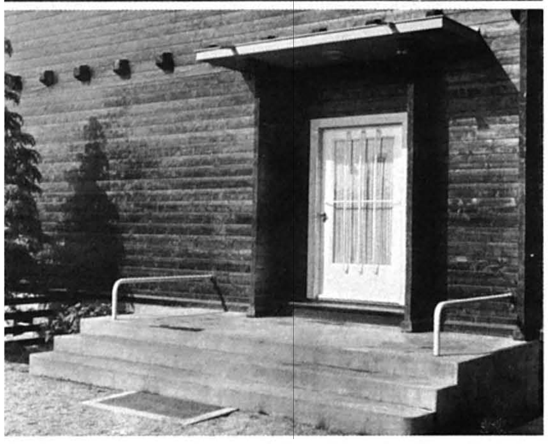

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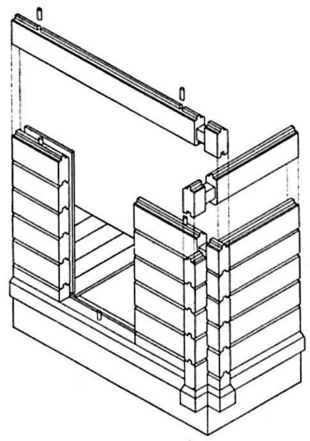

1-4. Private residence, built from solid timber in a provincial town in Germany, 1926, with isometric detail of the structural system.

5-10. Recreation hospital for tuberculous children, built 1927 in a provincial town in Germany in conventional timber construction, covered with horizontal siding; first prize in a national competition.

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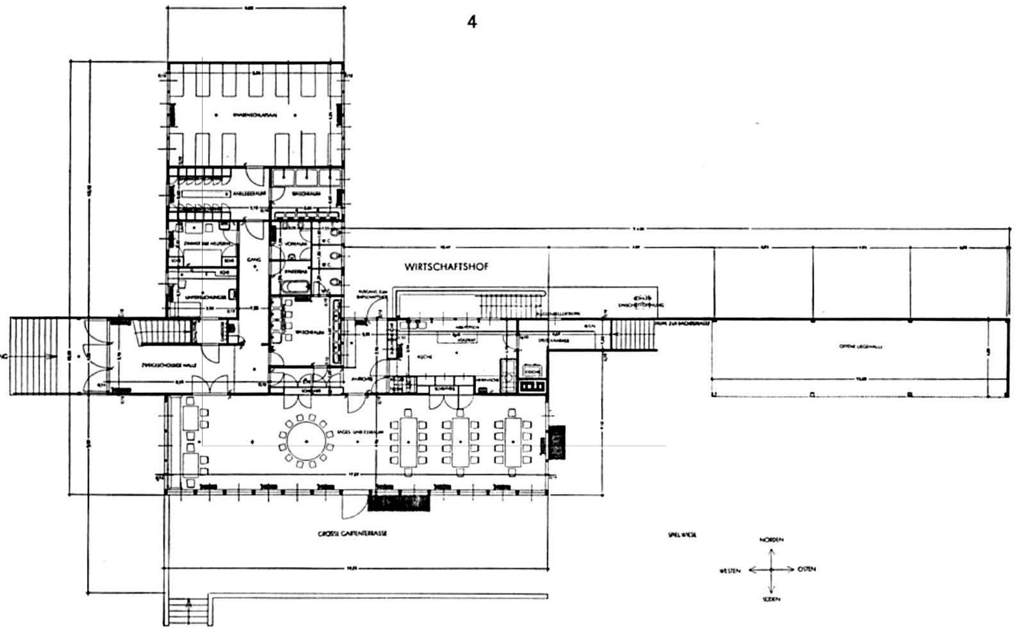

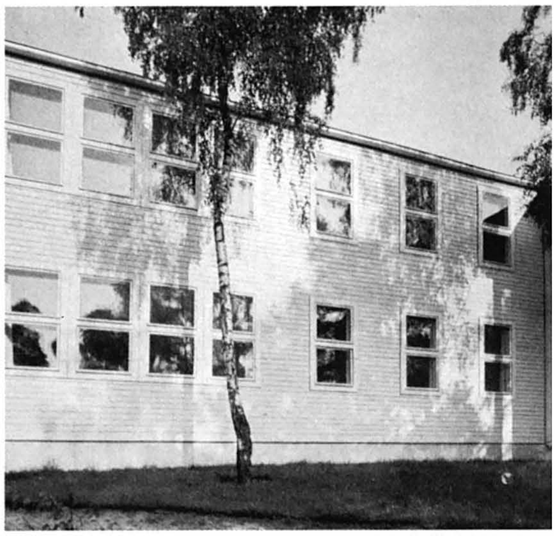

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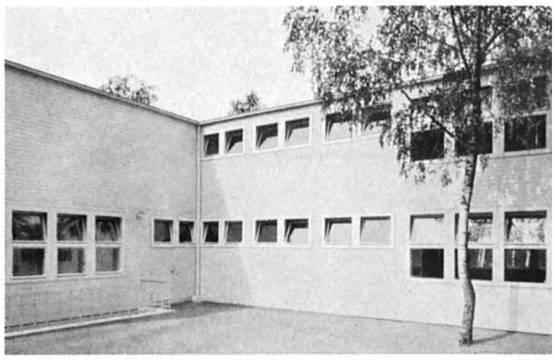

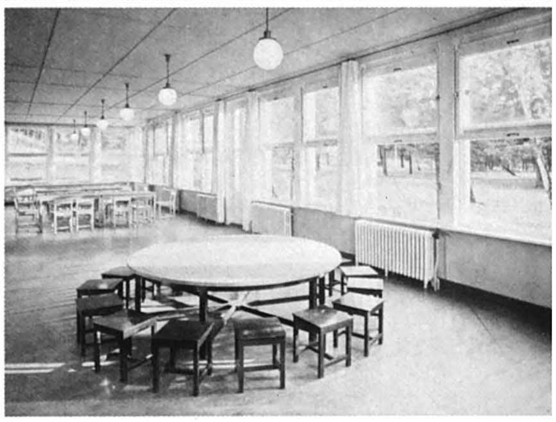

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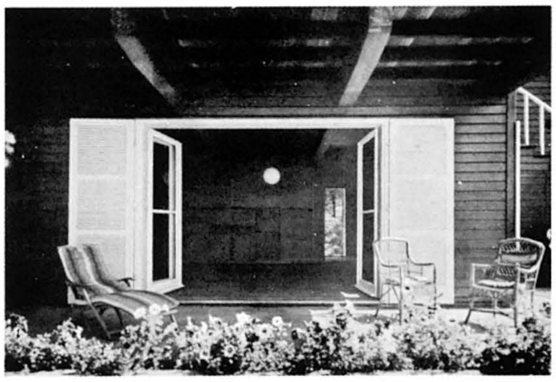

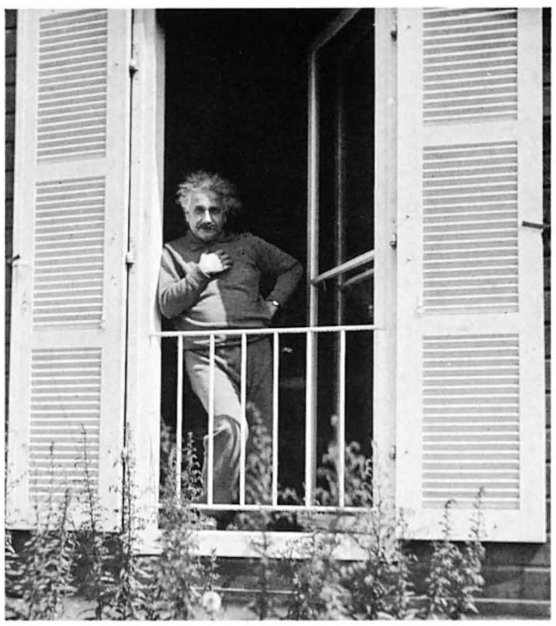

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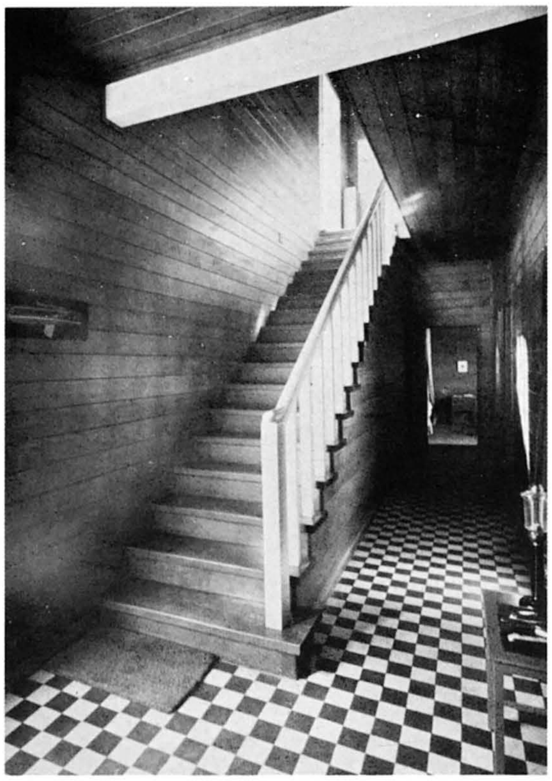

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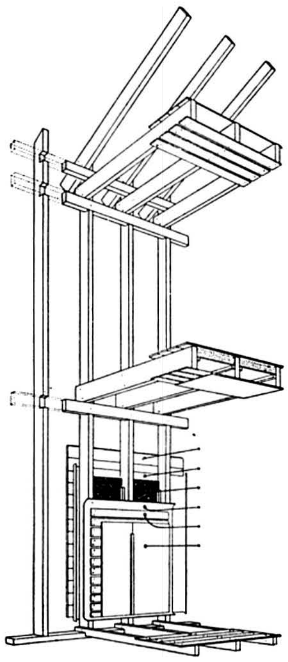

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1-5. The country house for Albert Einstein, in Caputh near Potsdam, 1928. Albert Einstein, looking out of the window of his bedroom and study in which he wrote the first manuscript of the "Unified Field Theory."

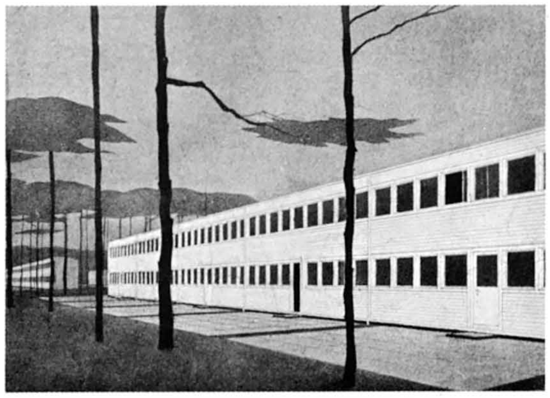
7. Isometric detail of a standardized panel system, developed in 1925, based on early designs and building products, developed before the turn of the century.

8. Second prize of a national building competition for prefabricated row houses in Germany, 1931.

9-11. Prefabricated school and hospital pavilions. Specifications, modular dimensions, and the application of a standardized panel system became the officially accepted modular standard in Germany, 1928.

12. A tennis court pavilion, with 28′ column distance, entirely prefabricated; built 1927, in Berlin.

13-14. A prefabricated large hotel building of which all standardized building elements have been manufactured in Germany, erected for a Dutch oil company in Curacao, Netherland Antilles, 1926.



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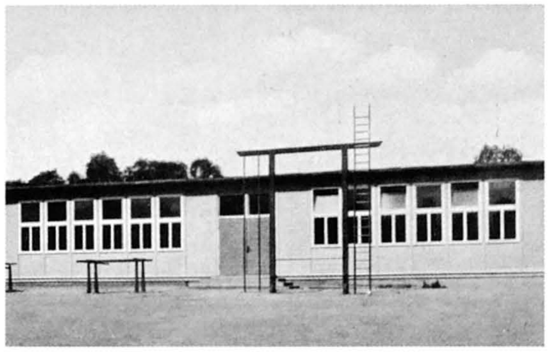

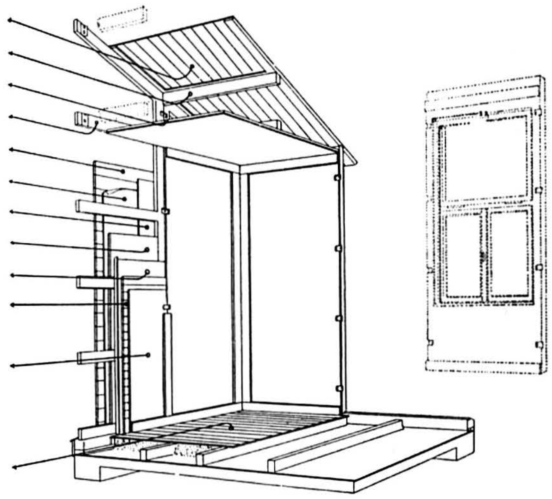

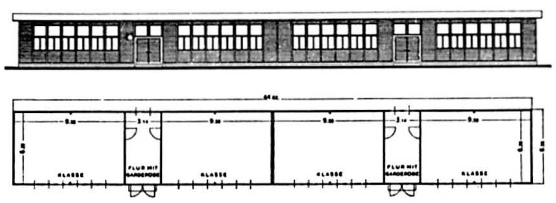

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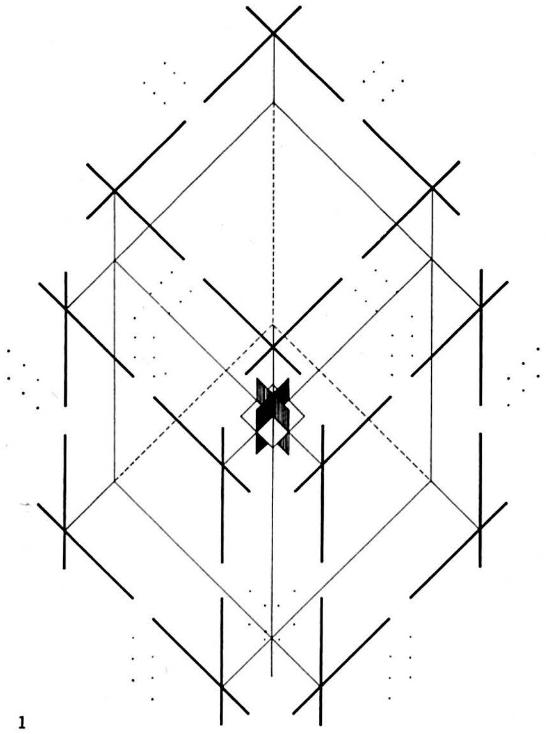

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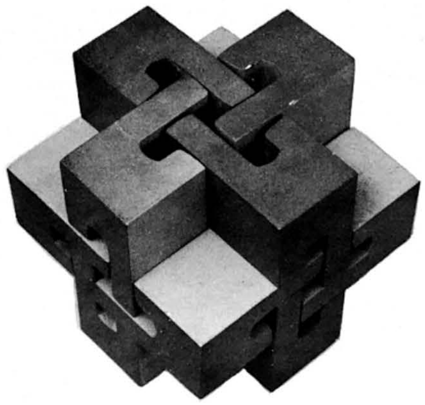

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After immigration in 1941 to the United States, Wachsmann's professional architectural practice was abandoned in order to concentrate on analytical studies of research and development in industrialization, including standardization, modular coordination, mechanical integration, economics, production technology, development of processes, tools, machines and methods of assembly. In the course of the last 20 years, more than 100 individual patent claims have been granted.

1. Diagram represents the frame of reference for any three-dimensional approach to structural design analysis, developed as part of a research project sponsored by the Federal Housing Agency, 1950, at the Institute of Design.

2-8. Evolution of penetration and integration of 12 surfaces in one center point, creating a basic modular cube, using one standard profile, 1942.

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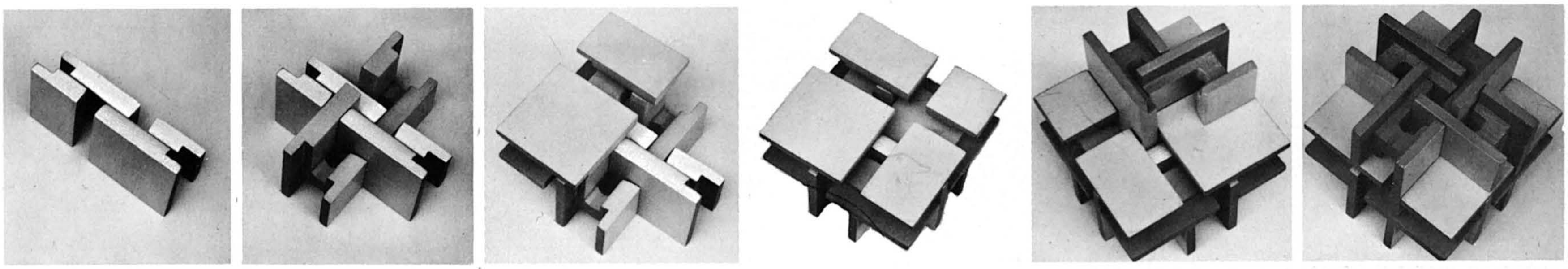

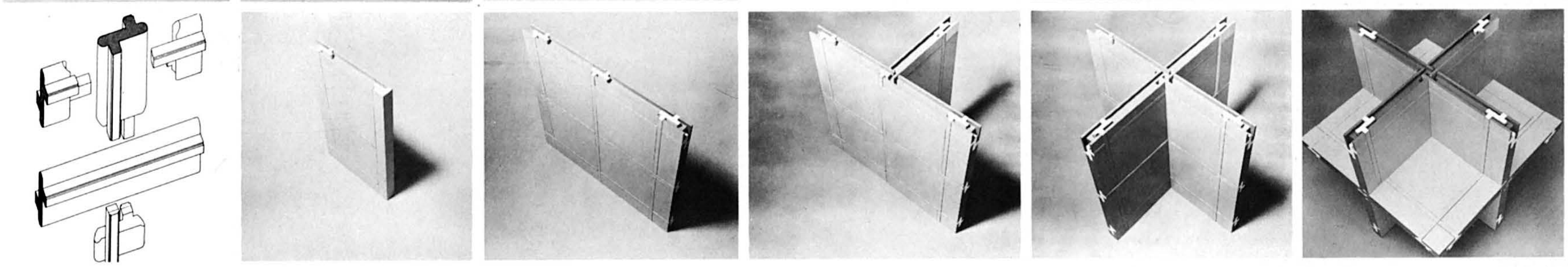

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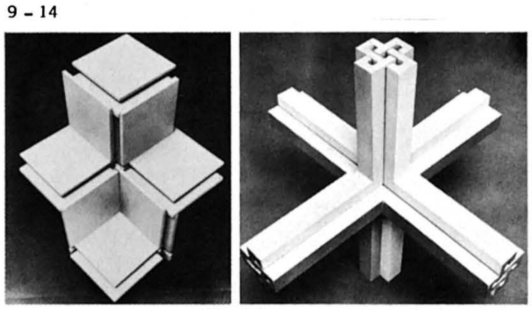
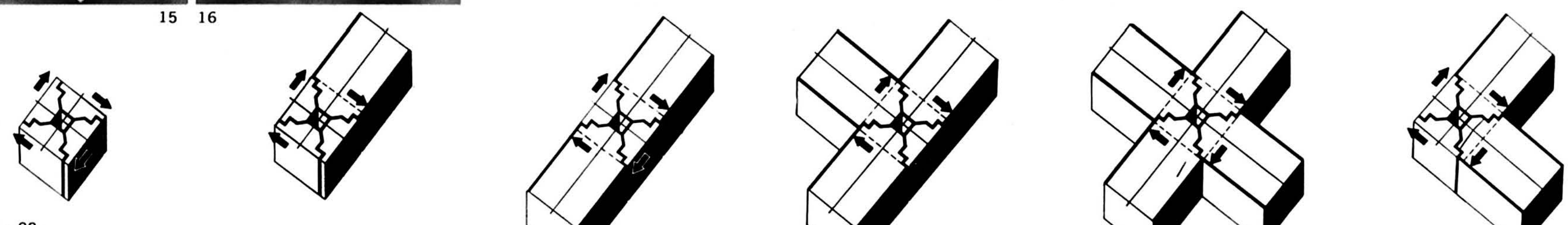


15 16

9-16. Application of this profile, joining planes in three directions.

17-22. Development of a basic profile which permits the universal joining of building elements in any combination and any direction, 1941.

23-27. Development of a connecting device which, regardless of which position or combination, joins standard elements and transfers all resulting stresses, 1943.



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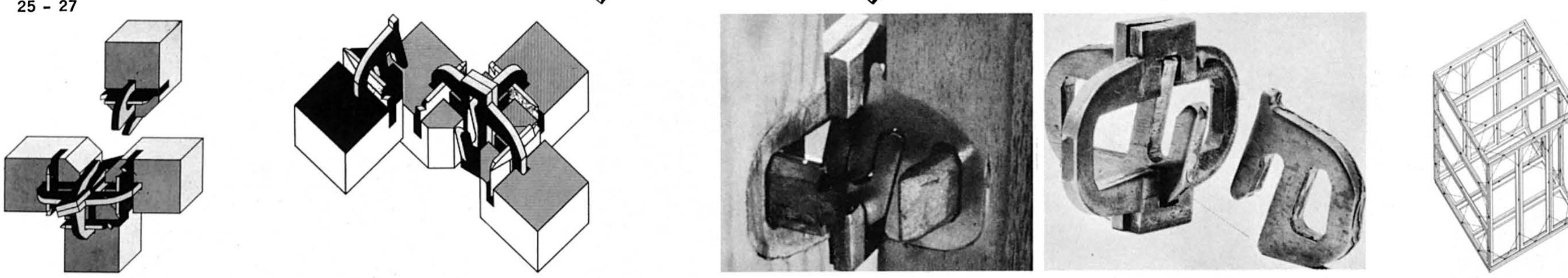

1

1945-1947. The building of a large factory in Burbank, California, to produce building elements almost fully automatically, using high precision techniques based on the principles mentioned before which were developed in collaboration with Walter Gropius. The factory was designed to produce about 10,000 low-cost housing units per annum. Included was the development of all machines, tools, production line layout, quality control methods, market research, shipping and erection techniques.

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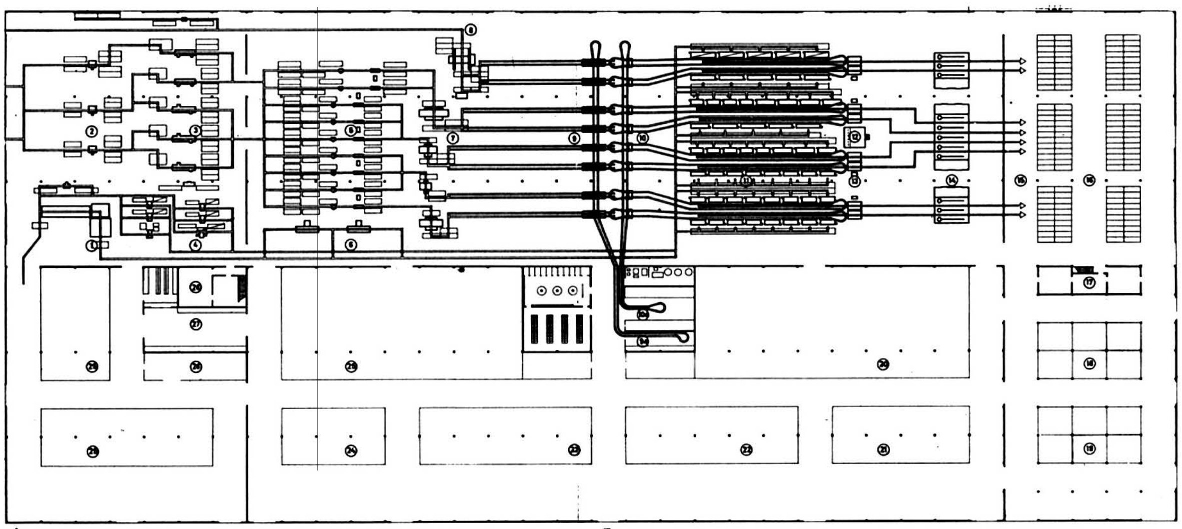

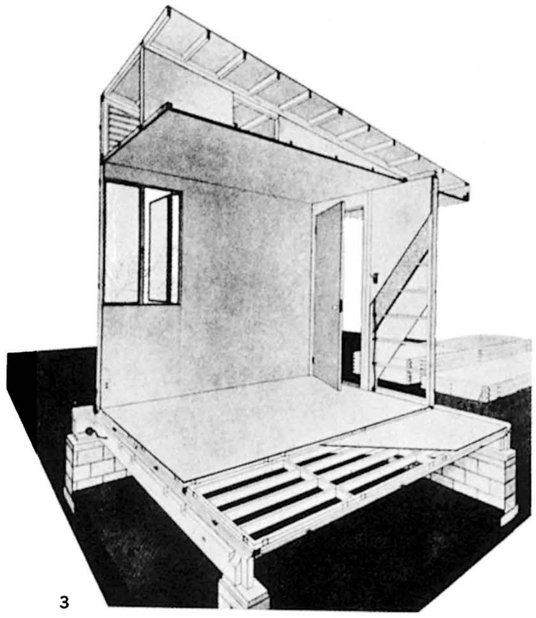

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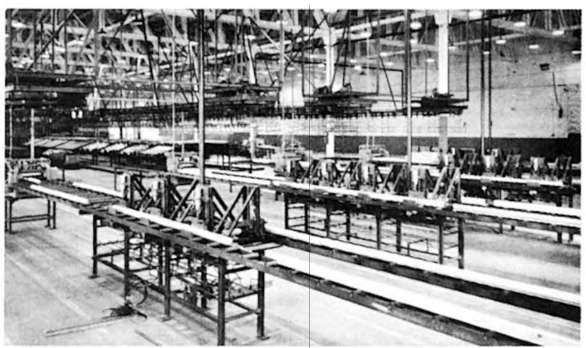

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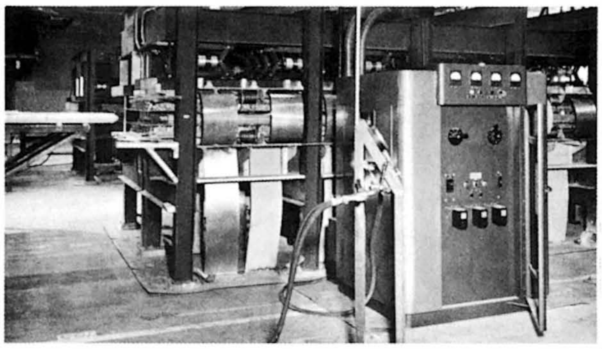

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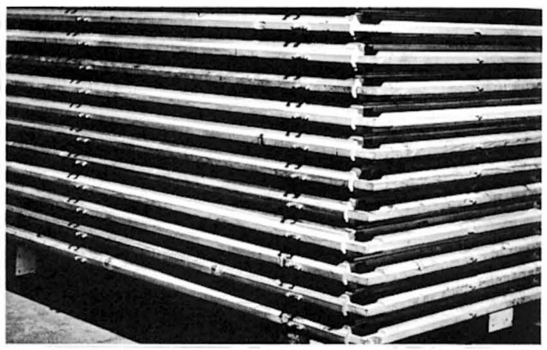

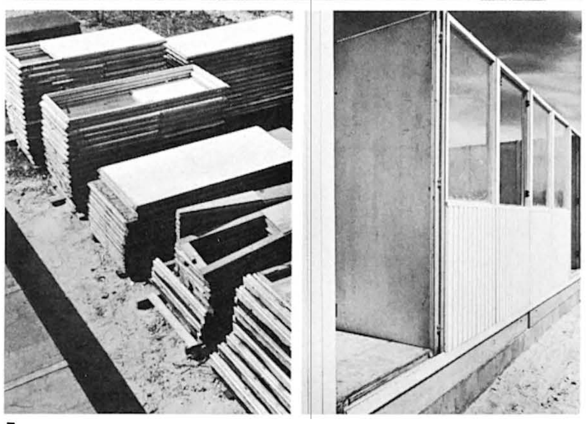

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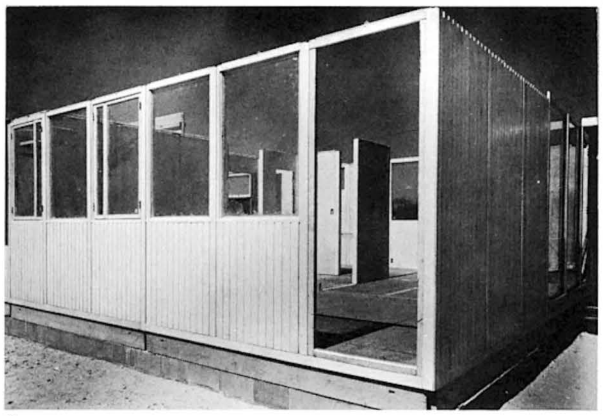

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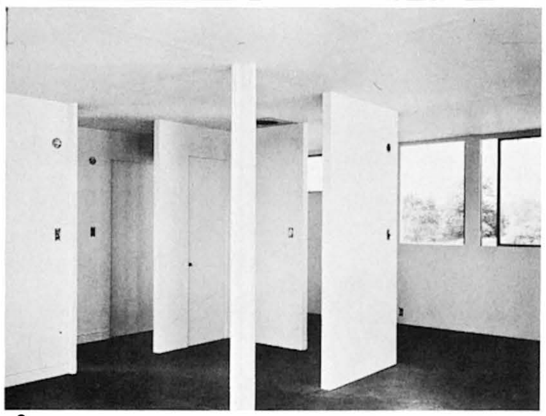


9

1. Uniform sized raw material

2. Plant layout in which all materials move in one direction

3. Diagram of the basic building elements, floor, wall, window, door, ceiling and roof panels, and beams, trusses and components

4. The production line

5. The introduction of high frequency, fast curing methods for the presses

6. The uniform, high precisioned building element

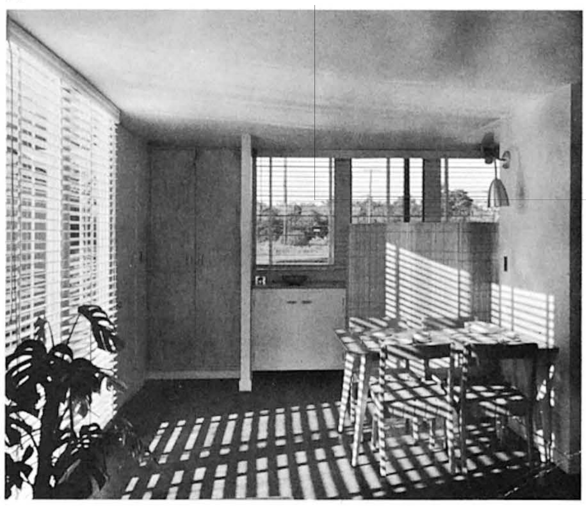
7. The distribution of all parts around the building

8. Various stages of erection

9. Interior of the basic structure before closing with built-in cabinets and mechanical equipment

10-12. The finished building, erected by 5 unskilled laborers in one working day, including hardware, mechanical equipment, all installations

10



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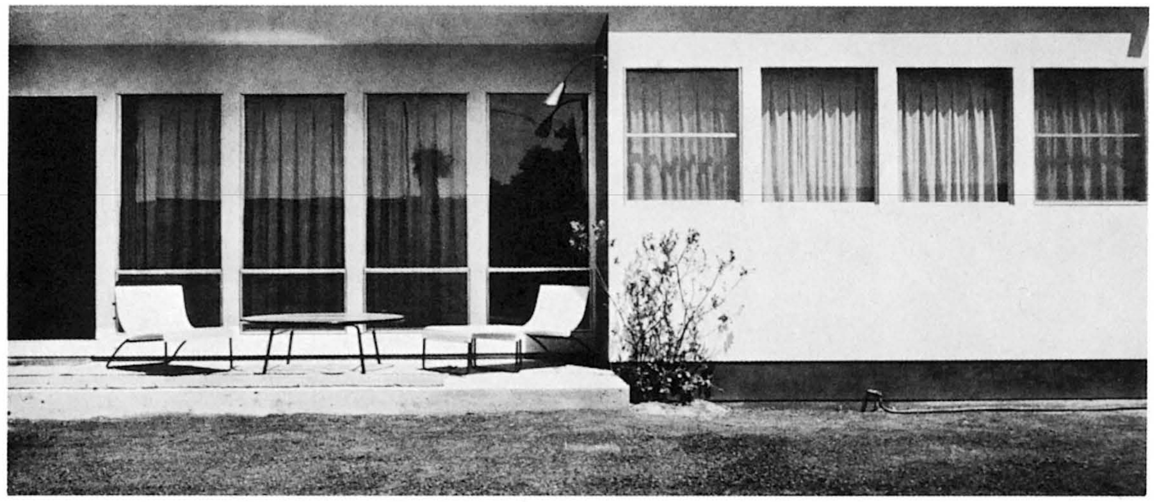
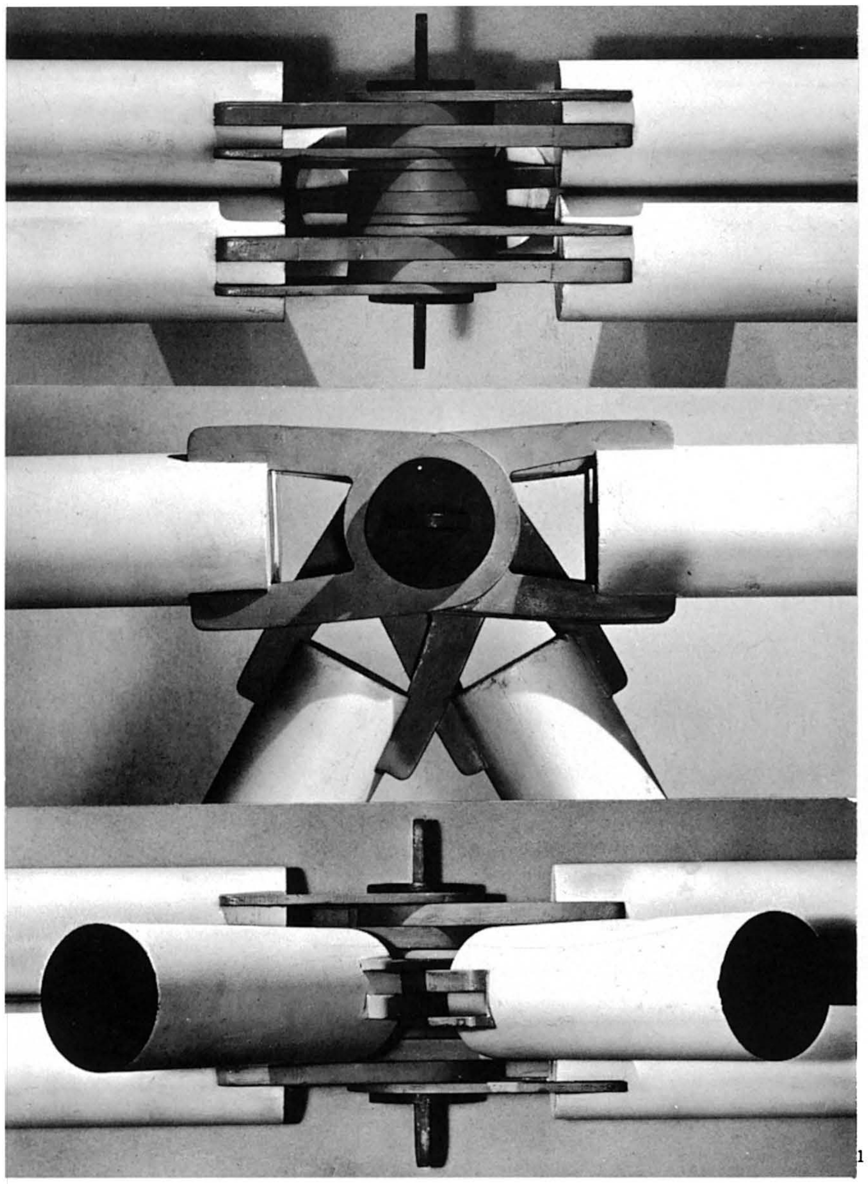




1

MOBILAR

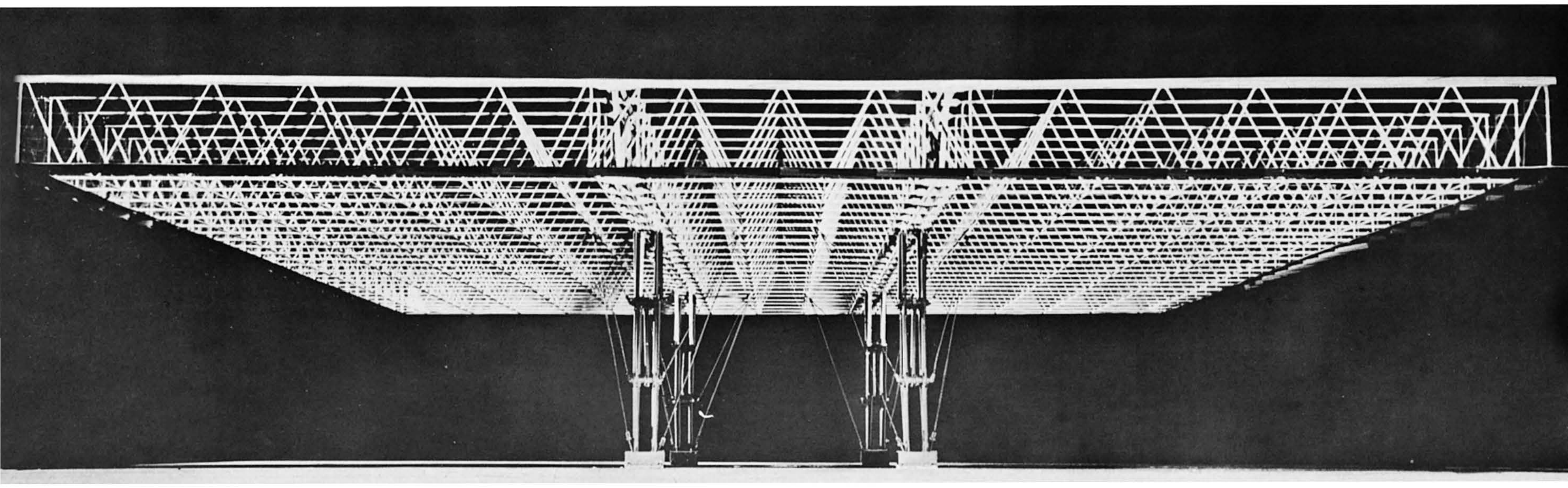
The development of a large span, light weight structural system, based on uniform tubular structural members with variation in wall thickness, joined by a standardized connecting device, led to the "Mobilar Structure," a building system which included movable independant wall sections which permitted any kind of opening of the building, to the ultimate removal of all wall elements. This work, executed in 1942, was exhibited at the Museum of Modern Art, New York, accompanied by the introduction by Le Corbusier reproduced below.

L'architecture, c'est bâtir des abris.
Pour les hommes de notre civilisation,
ces abris sont faits de planchers éclairés.
La "Mobilar Structure" que j'ai vue
répond étonnamment à ces fonctions:
Portée des planchers éclairés au
maximum.

Le Corbusier

N.Y. janvier 46.

2



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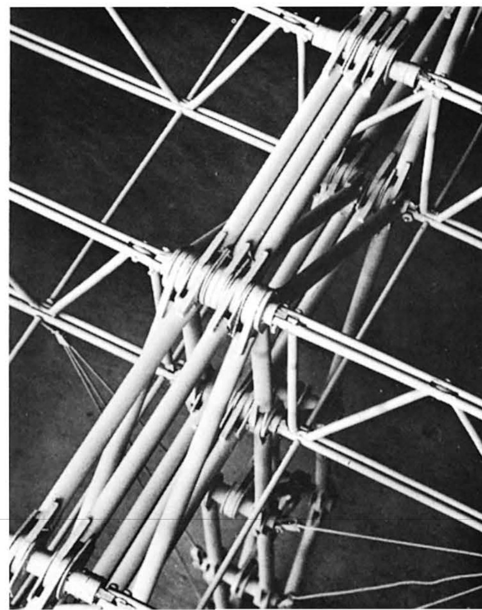
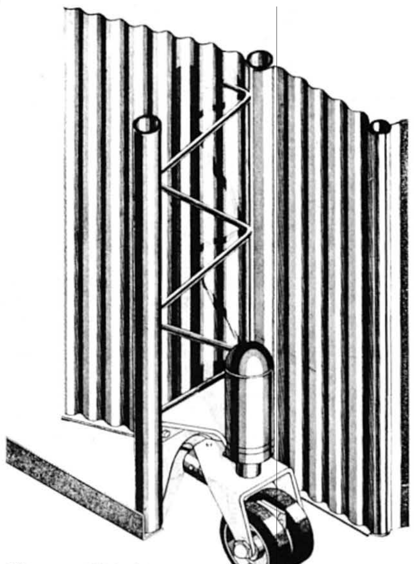
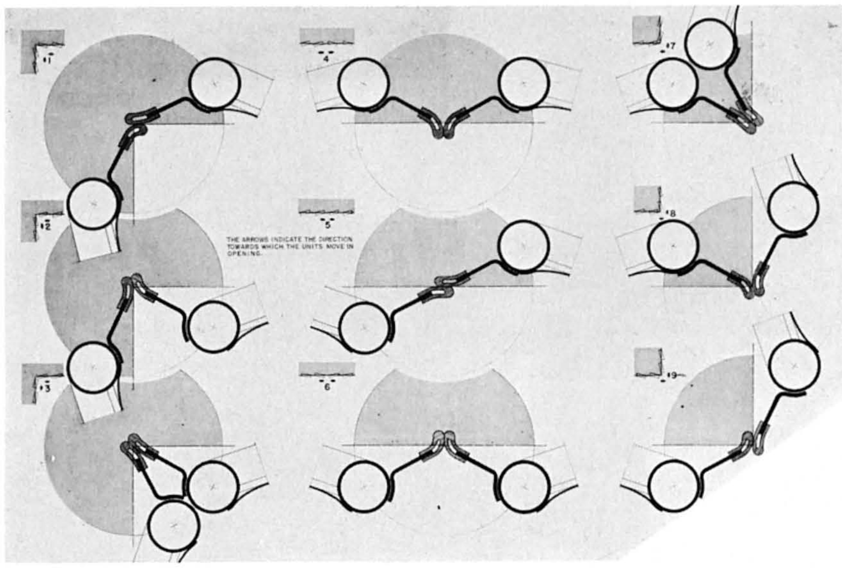


1. The standard pin joint
2. The entirely open structure
3. The independent wall sections, completely removable from the building
4. A sample of the combination possibilities of joining structural members, according to stress requirements
5. The principle of enclosure relationship of movable wall elements in any desired combination of motion and position
6. The structure of a movable wall element



10 ISOMETRIC VIEW



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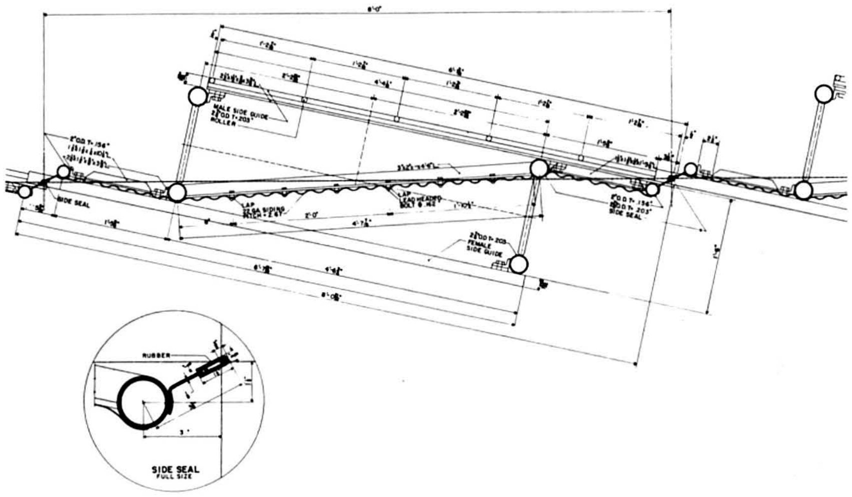
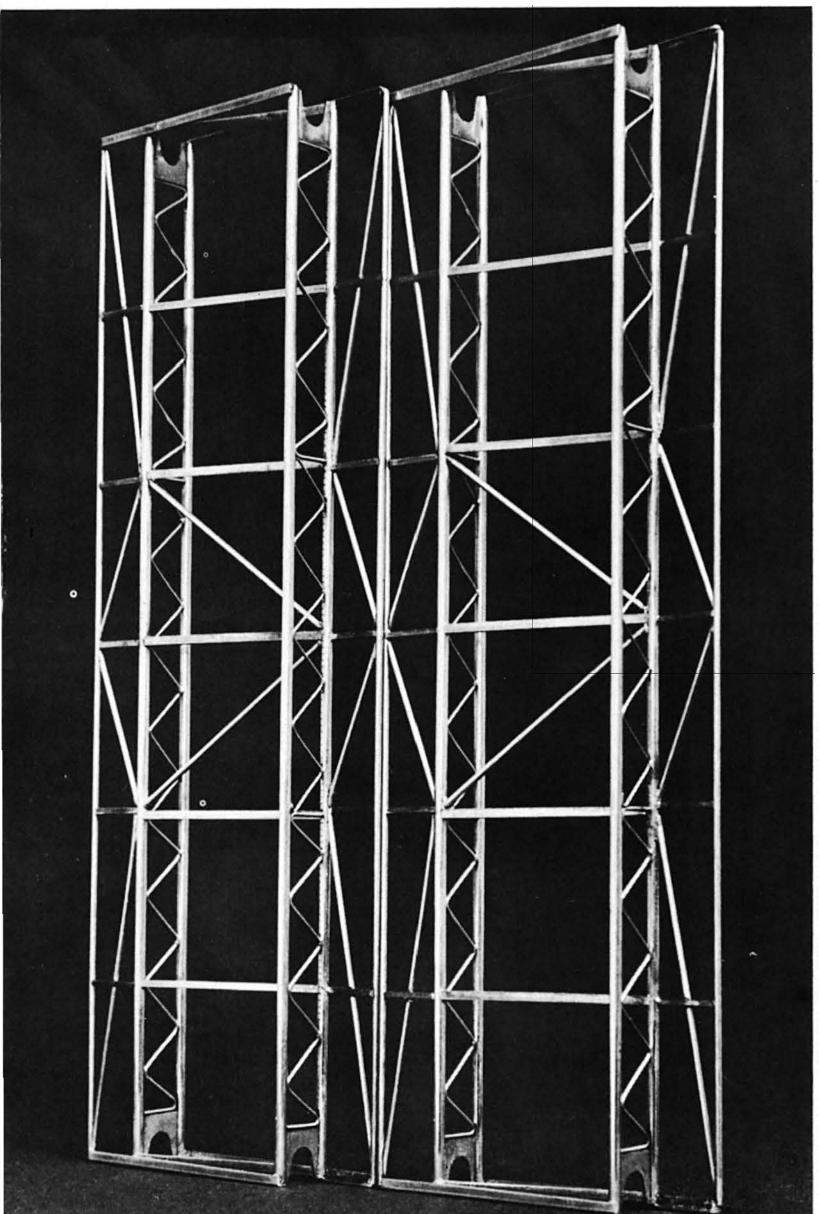
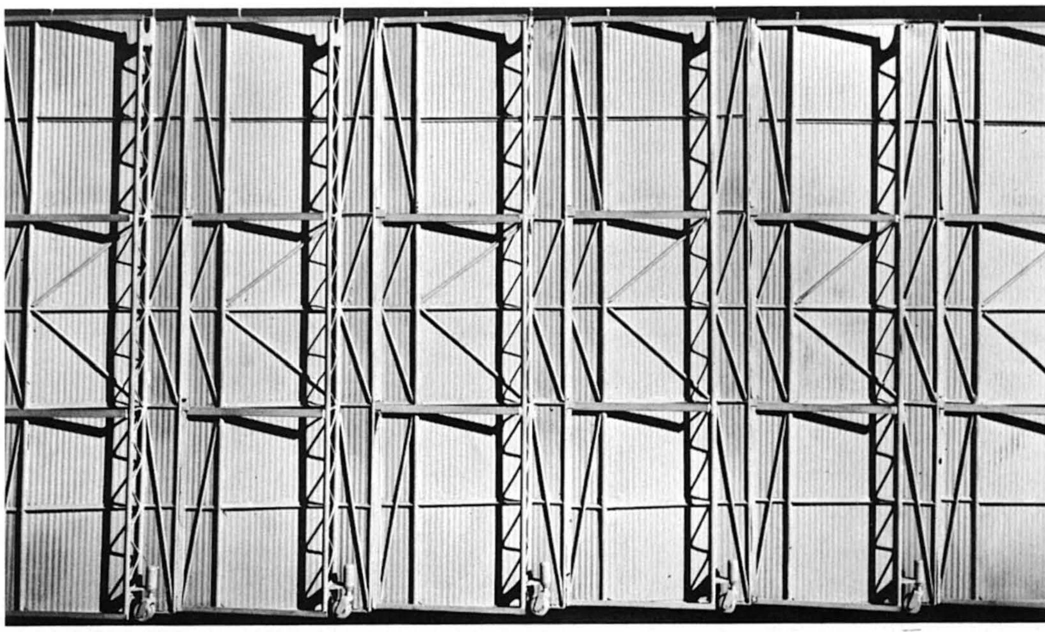
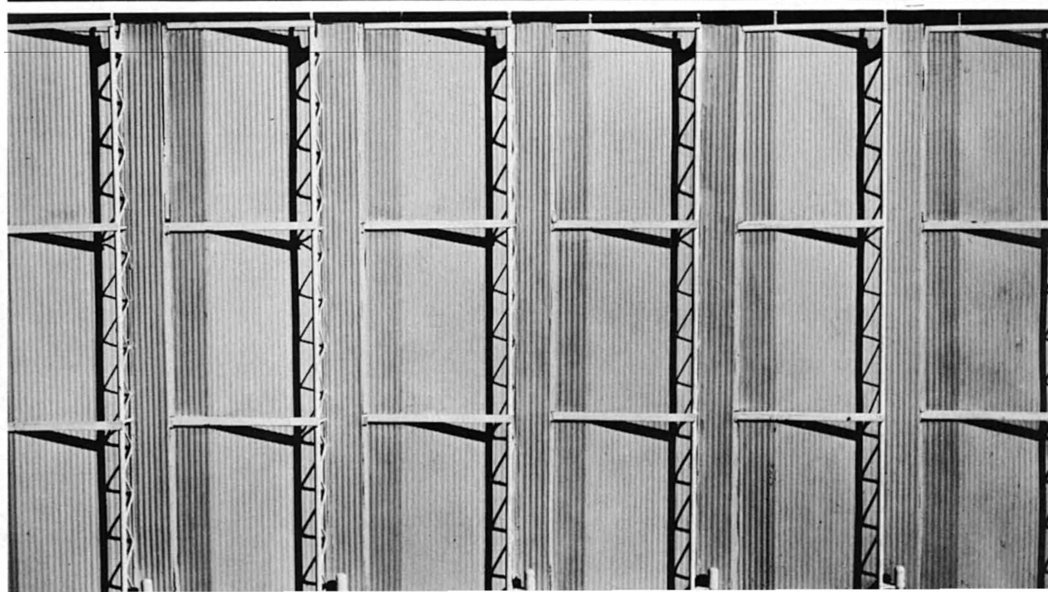


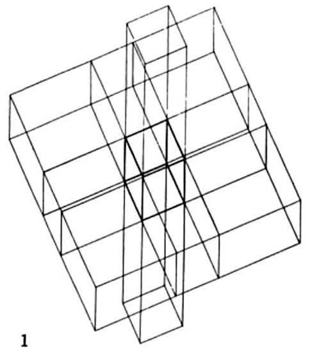
7. The basic truss frame of a wall element
8. The inside structure of the wall element
9. The texture of the elevation of the outside surface
10. The one horse-power airpressure motor of the wall element mounted directly on the swivel wheel and connected with the main tubular section of the vertical wall trusses which act as containers for the necessary air pressure to operate the wheel unit







A theoretical study of relationships between space and structure, conducted at the Institute of Design of Illinois Institute of Technology, 1953, led to the development of a singular three-legged wishbonelike structural member. With its assumed modular and geometrical order the member demonstrated a new principle by which each structural element has a tendency to move away from other members of each grouping by increasing load. They therefore had to be joined by short tension members, cables which basically transform a compression structure into a tension structure.



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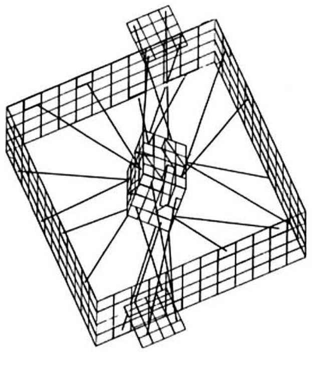
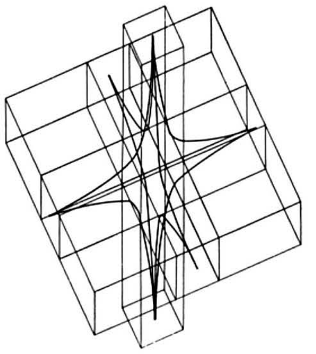
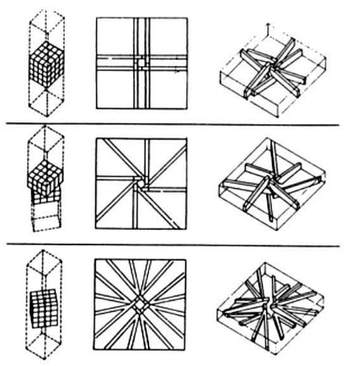
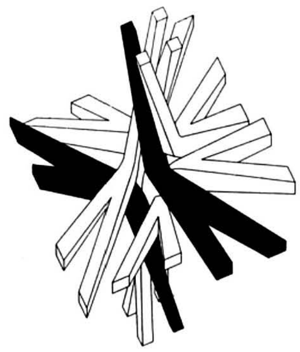
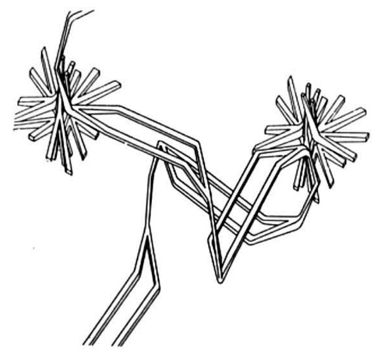
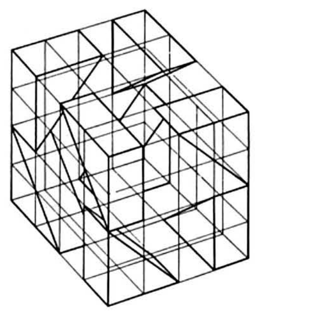


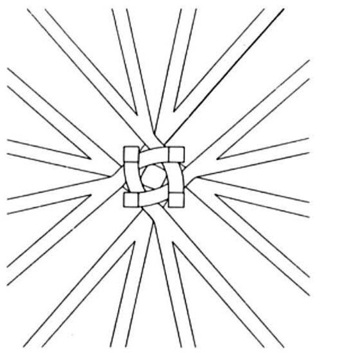


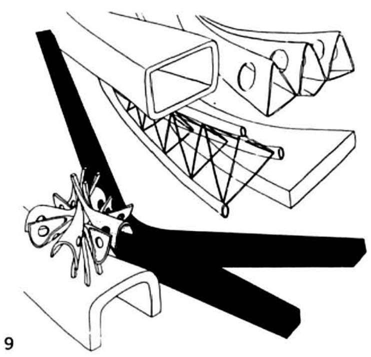










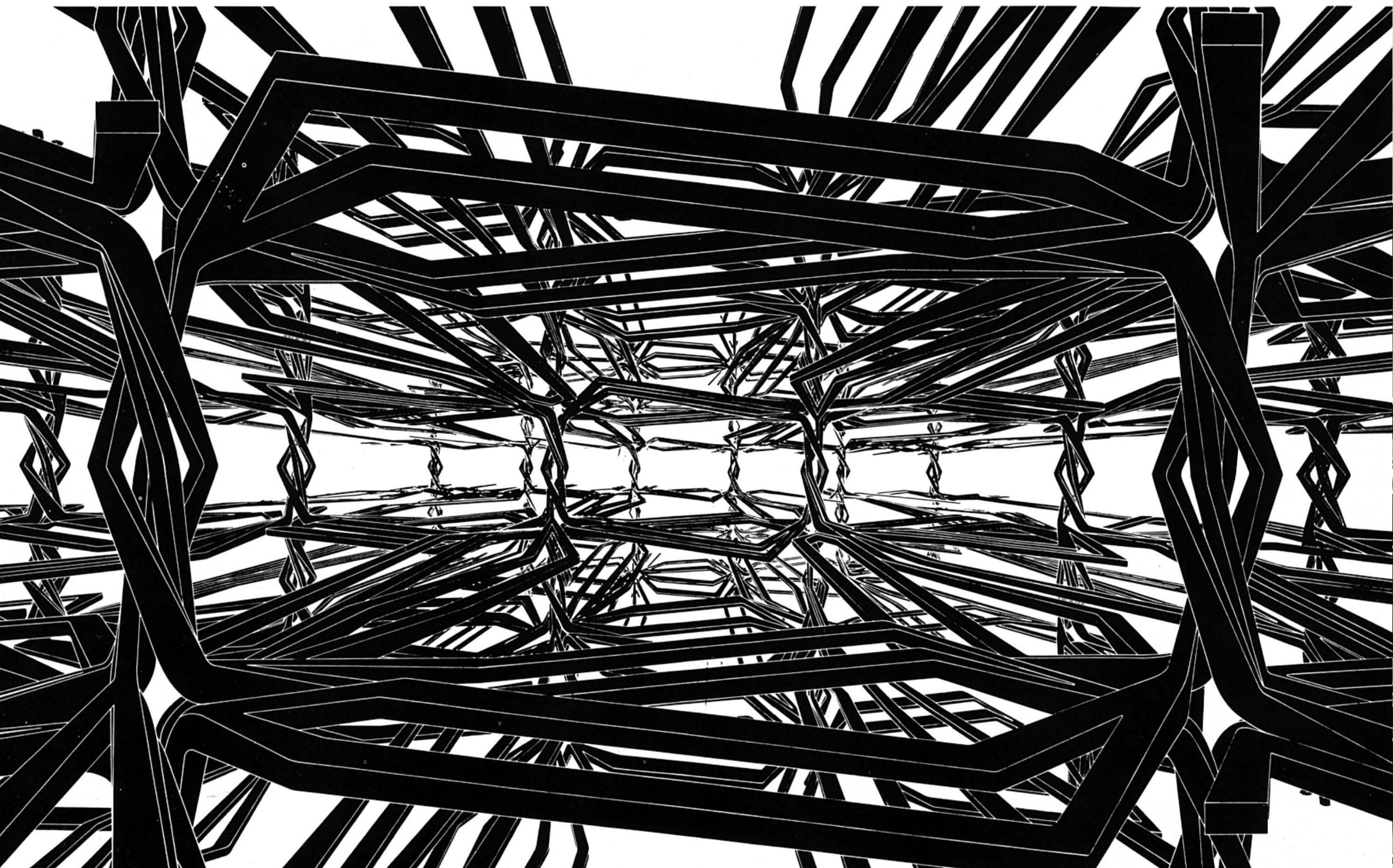


9

1-9. The evolution of the system

10. The perspective drawing shows the distribution of the one element in groupings in a five-story structure

10

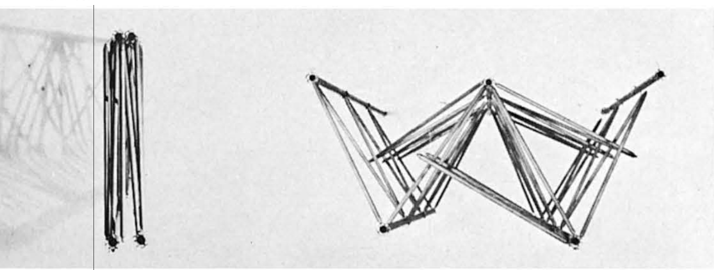


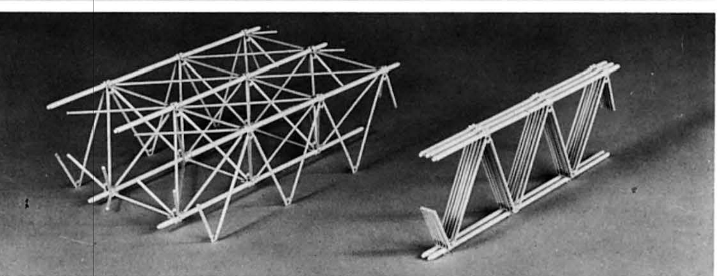
The United States Air Force in 1951 commissioned research and development of a large span airplane hanger. The extraordinary specifications included (1) the development of a minimum of two standard connecting devices, (2) the use of no more than two major structural members, (3) maximum overall dimension of all preassembled parts of 10′ x 30′ x 3′ for reason of shipping, (4) an assembly technique which would permit the use of unskilled labor, (5) unlimited flexibility in design of buildings to any form, shape and size, (6) the maximum span of 150′ cantilever, (7) unobstructed opening at all four sides of any given building, and (8) complete demountability of the whole structure without any loss permitting re-use of all standardized parts for entirely different purposes, designs and dimensions. An additional requirement was greatest possible lightness of the structure which finally resulted in an overall weight of 16.8 lbs/sq.ft. including roof structure and supports. To eliminate maintenance, all steel parts had to be covered with hard plastic coating.

1

1. The basic straps enclosing the standard joint
2. The plastic coated joint
3. Joining combination
4. The mass produced precision forgings
5-6. The pre-assembled spaceframe unit, folded in stage of opening and in final assembled position

5 6





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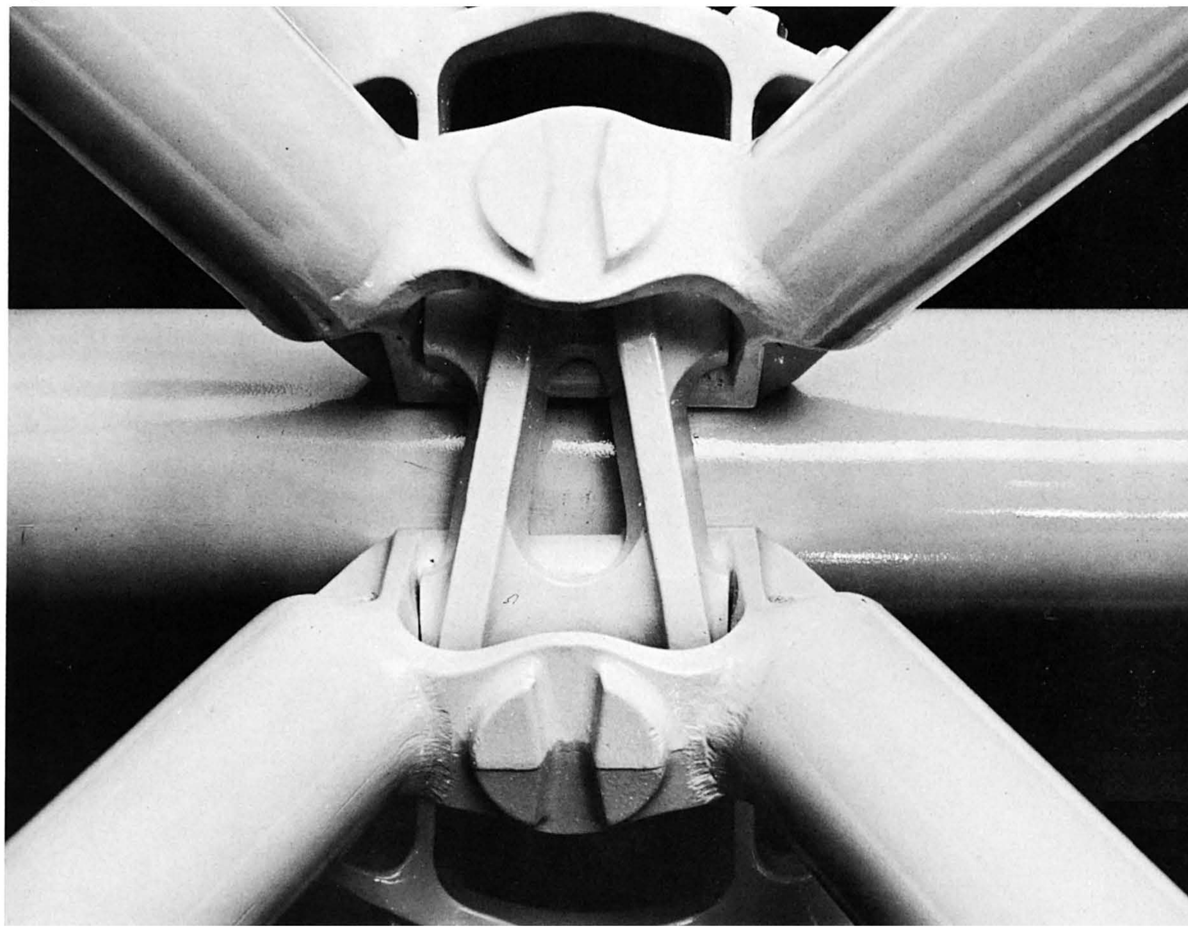

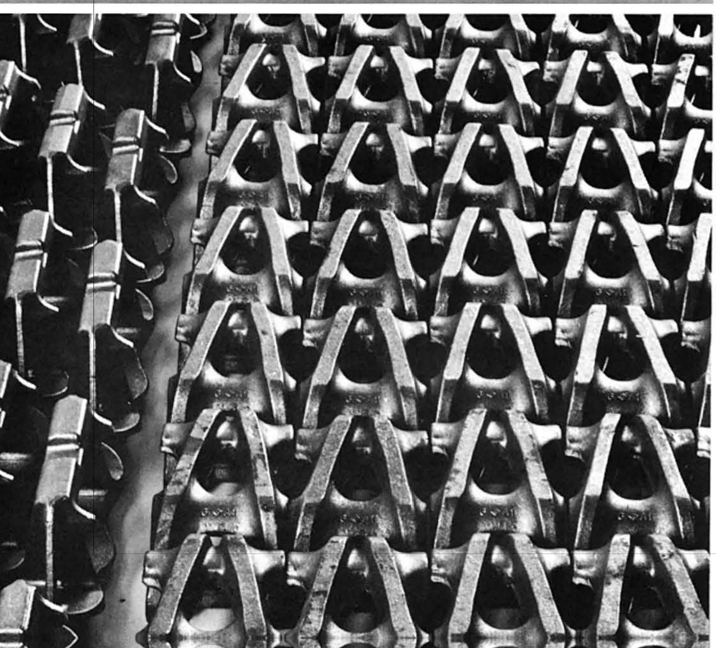

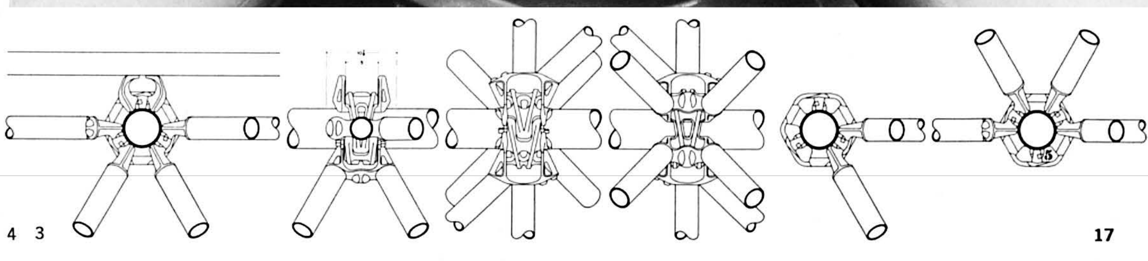

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Research analysis and development of the hangar were conducted at the Department of Advanced Building Research of the Institute of Design. A tetrahedral system with uniform length of 10′ between all vertices resulted in a spaceframe structure composed of two types of tubular sections, 6″ and 3½″ in diameter, and steel forgings for the joints. Pre-welded, individual structural components were pre-assembled in 30′ long units to be shipped folded and to the site. The erection process did not allow the use of any kind of scaffolding and was performed only with a light weight crane which traveled on top of the already assembled members and which after completion of the building became the struts of the attached glass curtain louvre system above the hangar doors.

1. The end elevation of the hangar with supports between which two floors of office space are located

2. Span between supports (130′)

3. Cantilever of the hangar (150′)

4-5. Structural integration of the tetrahedral system applied to the center supports

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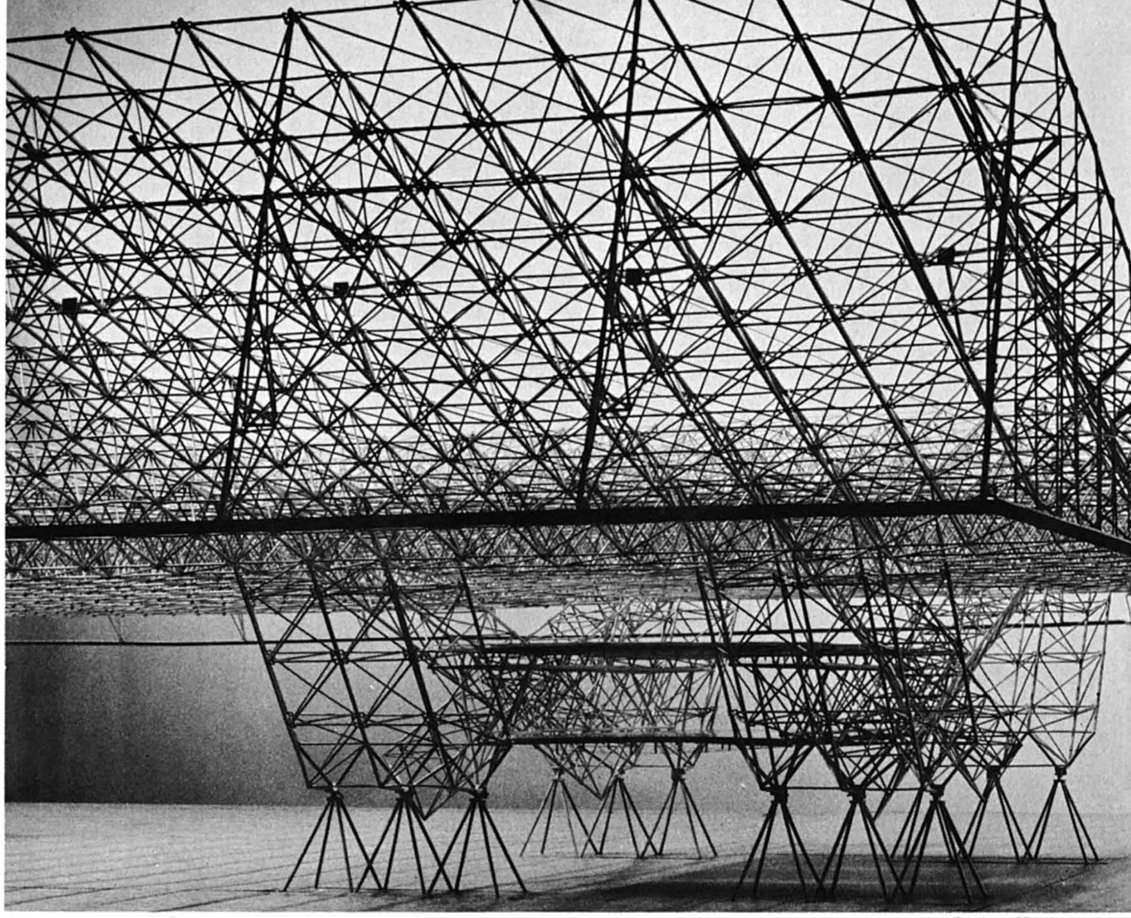

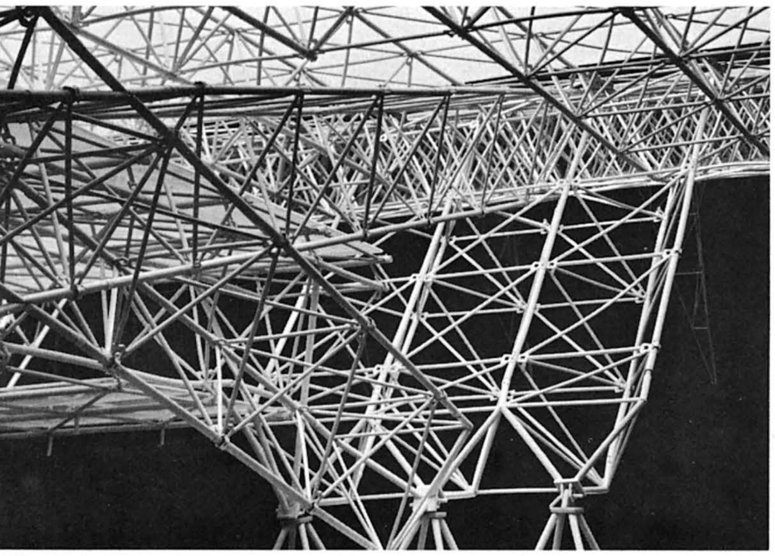

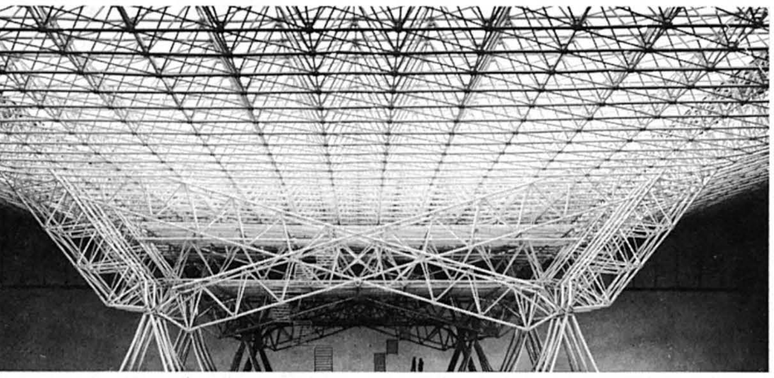

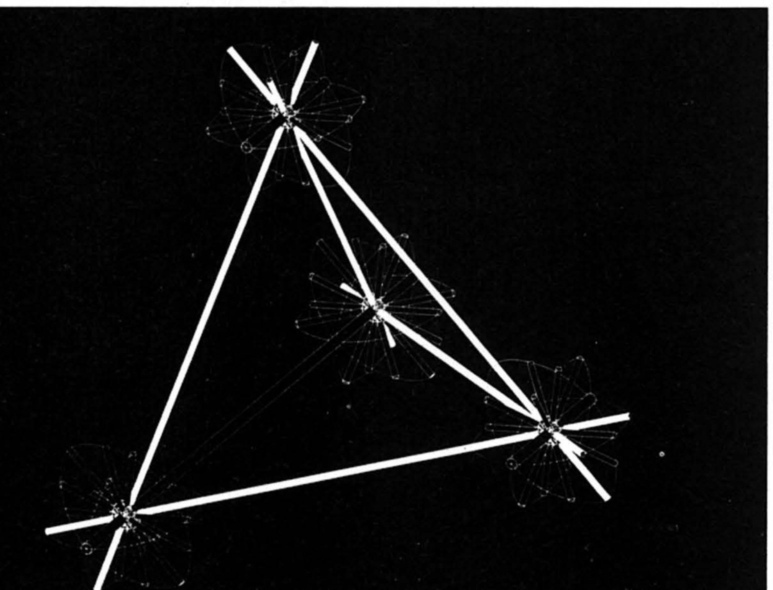

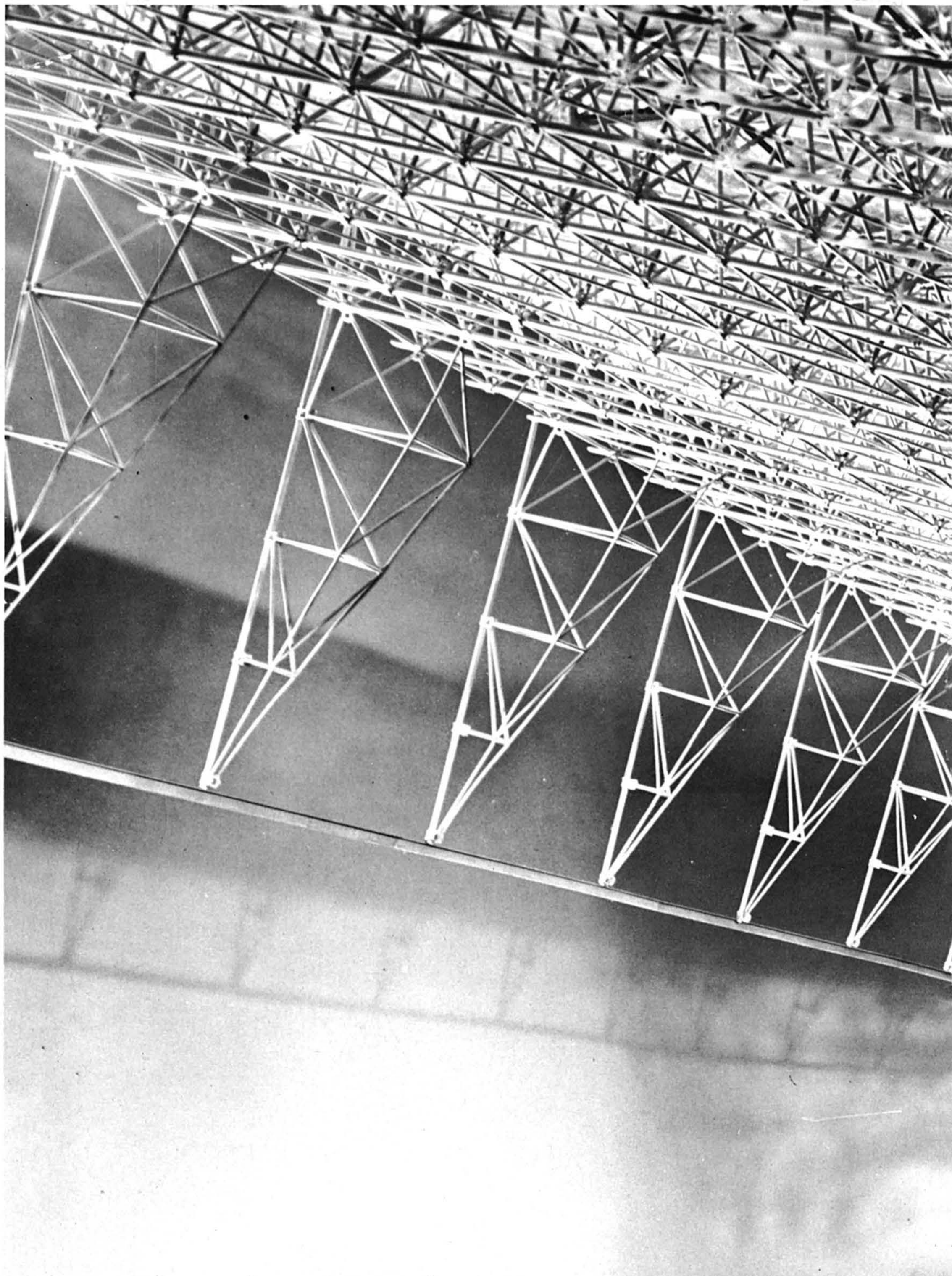

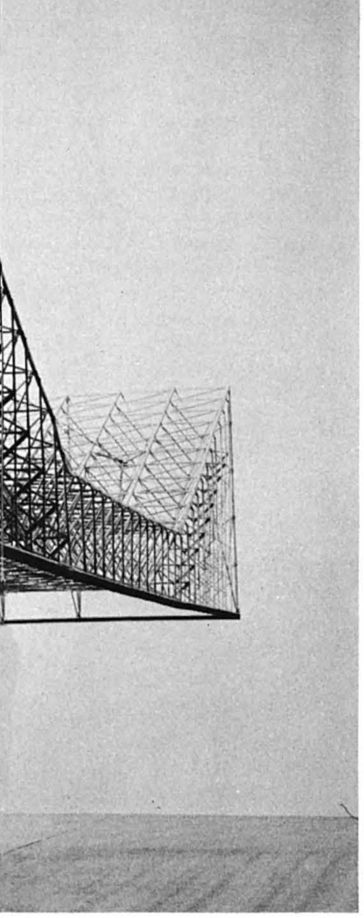

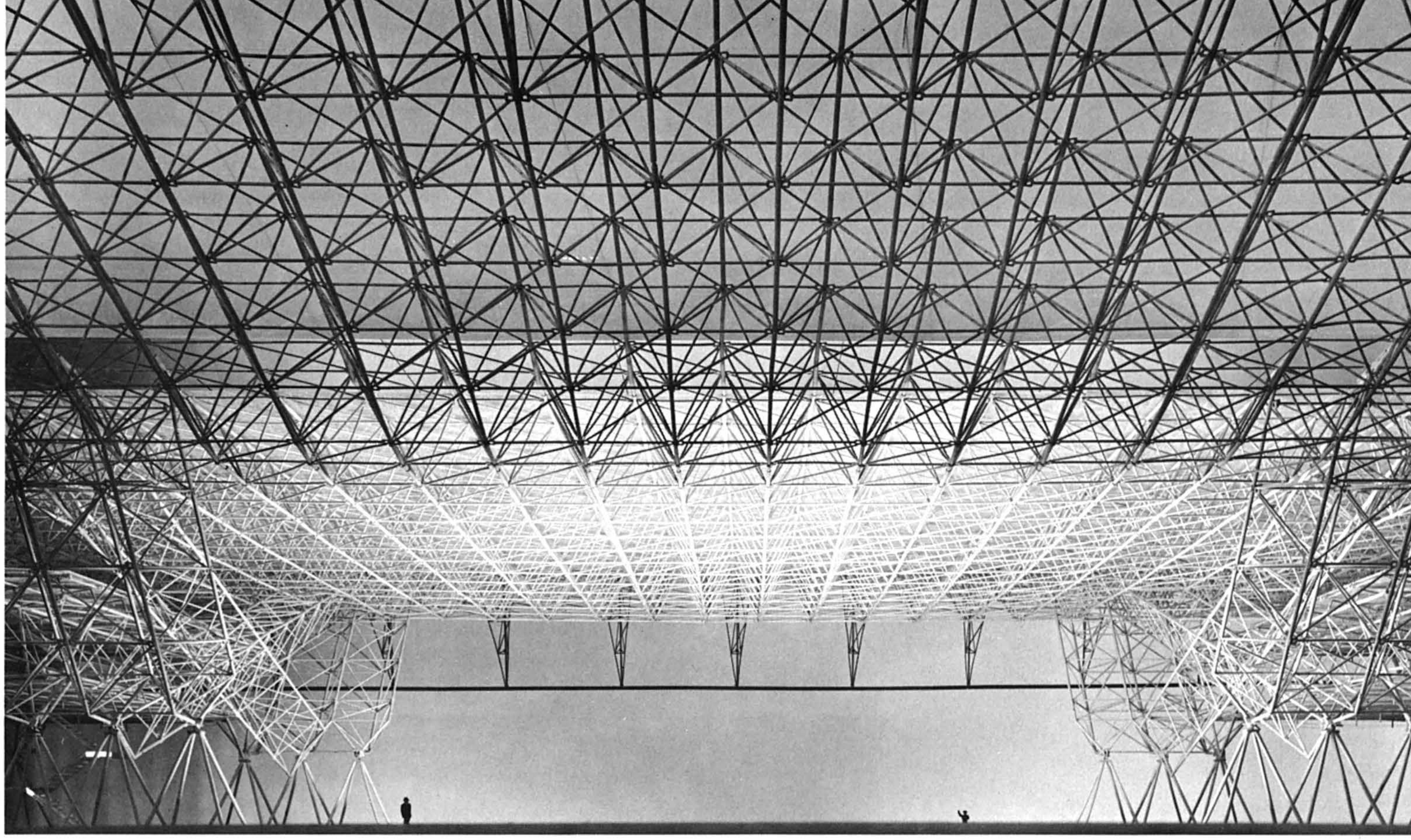

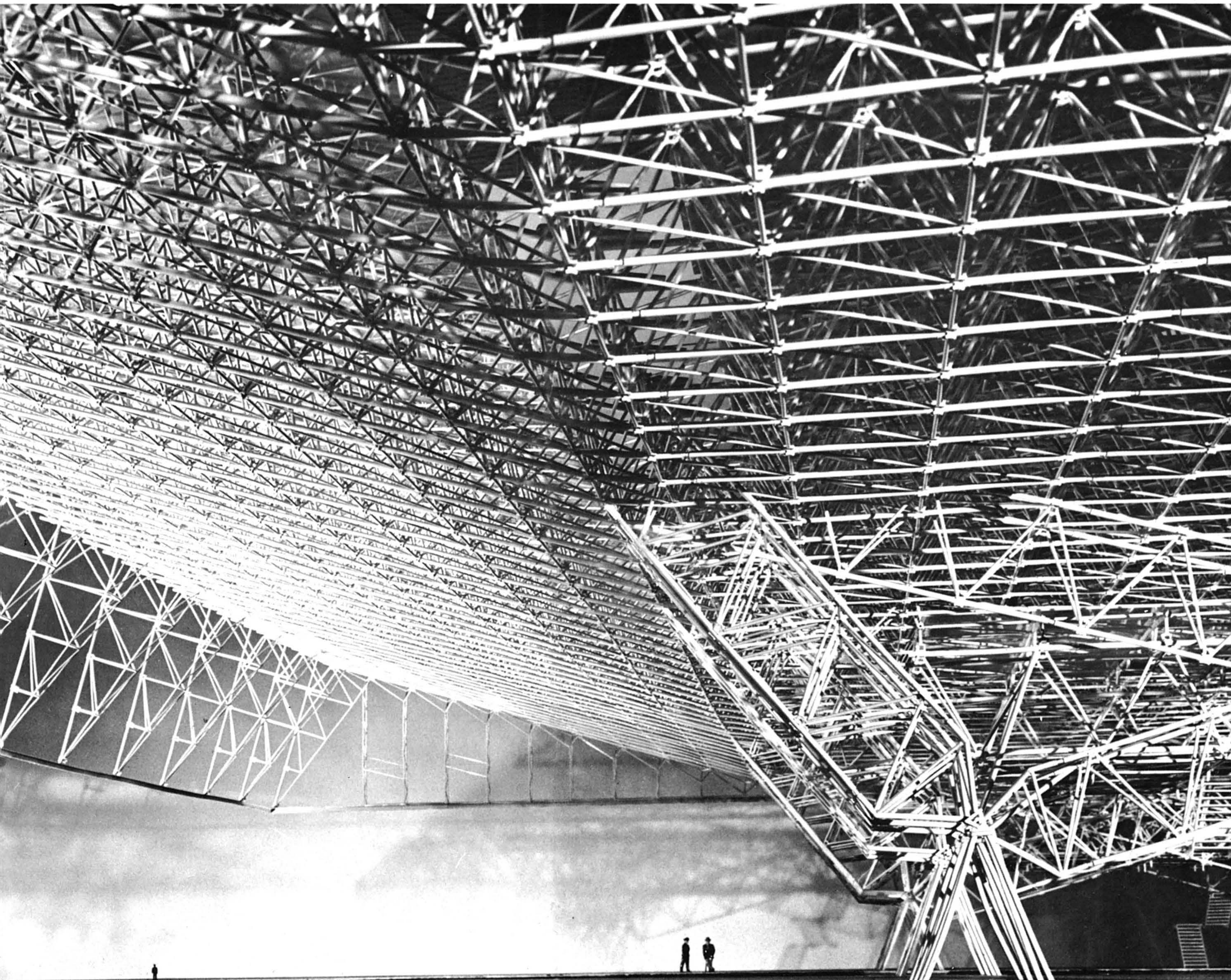

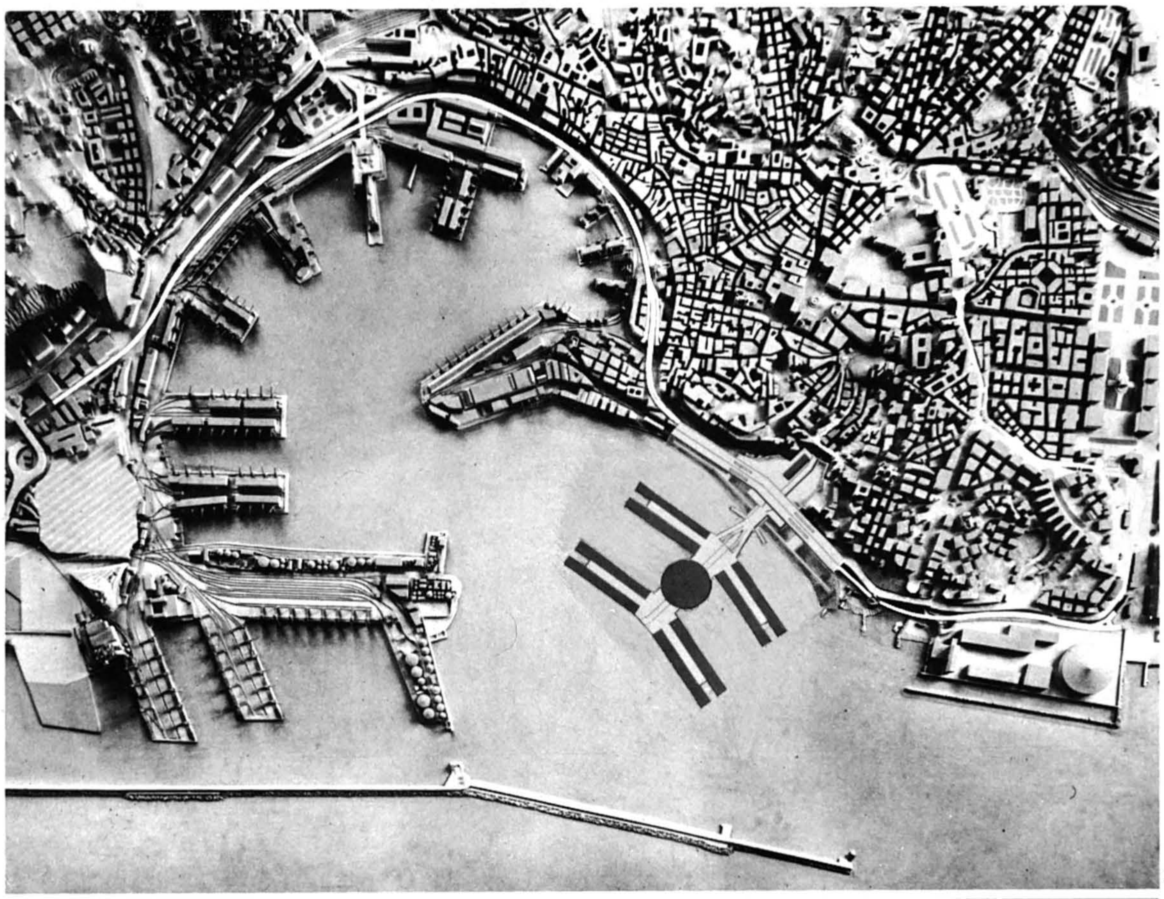

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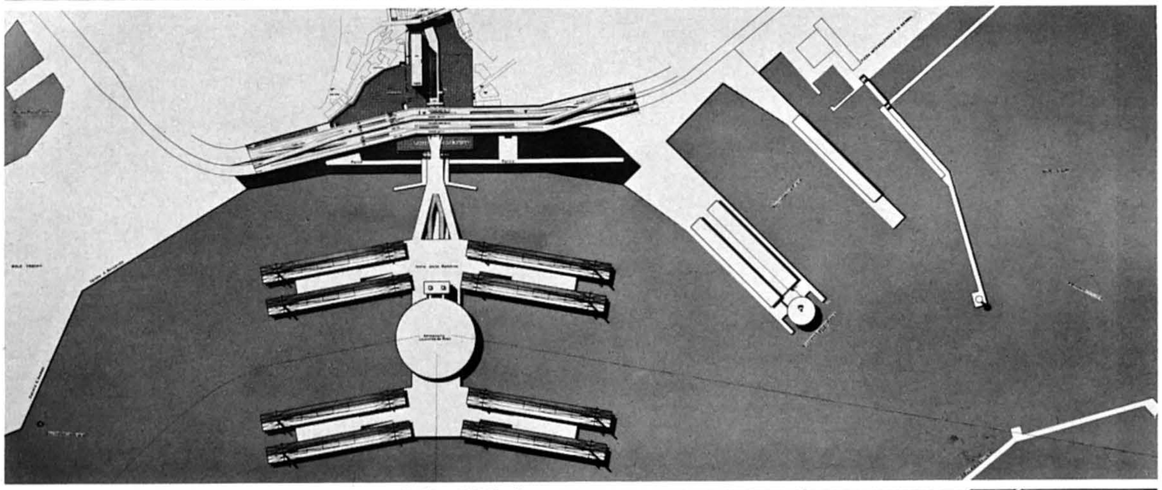

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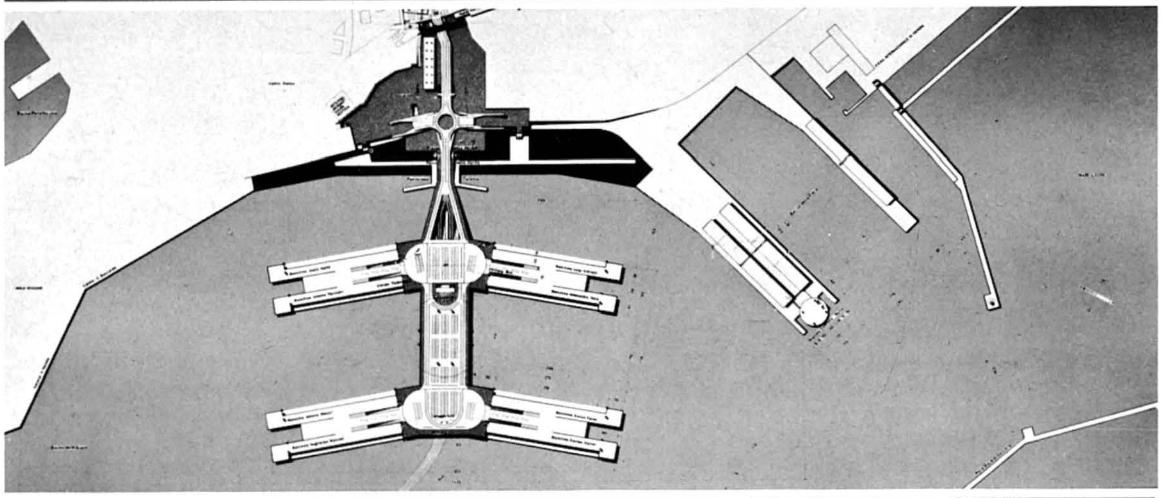

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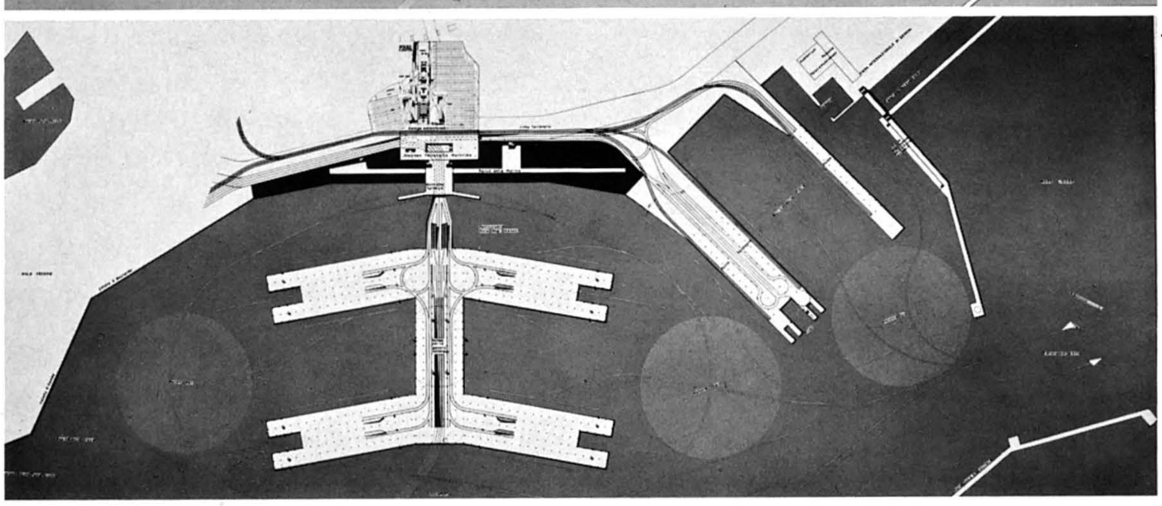

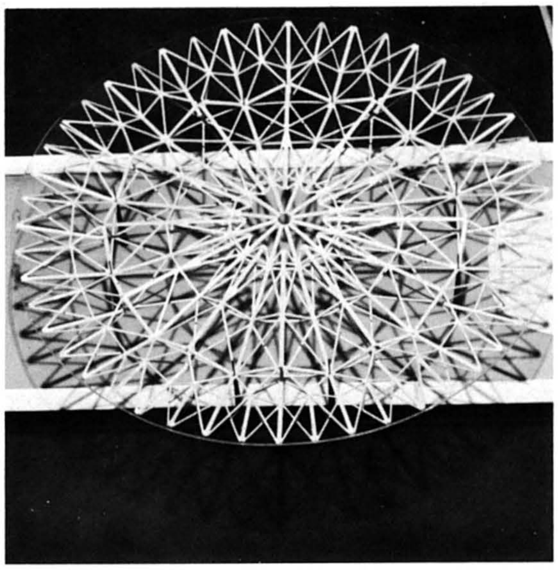

5

GENOA URBAN PLAN AND HARBOR PROJECT

The Italian Steel Industry, **Italsider,** commissioned in 1961 the design of its headquarters in Genoa, Italy: a steel structure of 40-50 stories, with parking space for about 3000 cars. Subsequently, the whole urban plan and the harbor shoreline had to be examined and extended into connection with the regional plan of the Genoa-Milan-Turin triangle.

This project was only designed to initiate long-term 7
research and planning studies, which would include a passenger terminal separated from the industrial harbor; a helicopter terminal to serve the triangle Genoa airport and Nice, Milan and Pisa; a railroad terminal for incoming passengers with direct connections to the main Swiss, Italian and French arteries; a long distance bus terminal; a harbor for private boats; and a direct tunnel connection under the harbor to the outskirts of Genoa. The enormous concentration of multilevel traffic arteries of various kinds still permits pedestrians to walk undisturbed by traffic from the civic center to the very peak of the harbor at city surface level.

All structural parts are proposed to be built in a nearby steelwork and shipyard in Savona and the large multistory, completely prefabricated sections floated directly to the building site. The skyscraper is composed of three identical sections, connected by hinged platforms in the area of the elevator shafts. The section toward the harbor houses all executives and directors, the middle area on the lower floor contains the computer center, and above, the enormous archive of the company. The section toward the city is for employees, preparing the incoming information for computer programming and for book-keeping activities.

1. City plan with the new proposed pier island in front of the skyscraper

2. The heliport platform level

3. The passenger level of the piers

4. The underground service level with the tunnel entrance under the harbor

5. The combination of piers and heliport in island form

6-7. The three-dimensional structure system of the heliport resting on 8 supports, 450′ in diameter

8-9. The structural system of the piers, offering un- 8
obstructed openings of about 700′ 9

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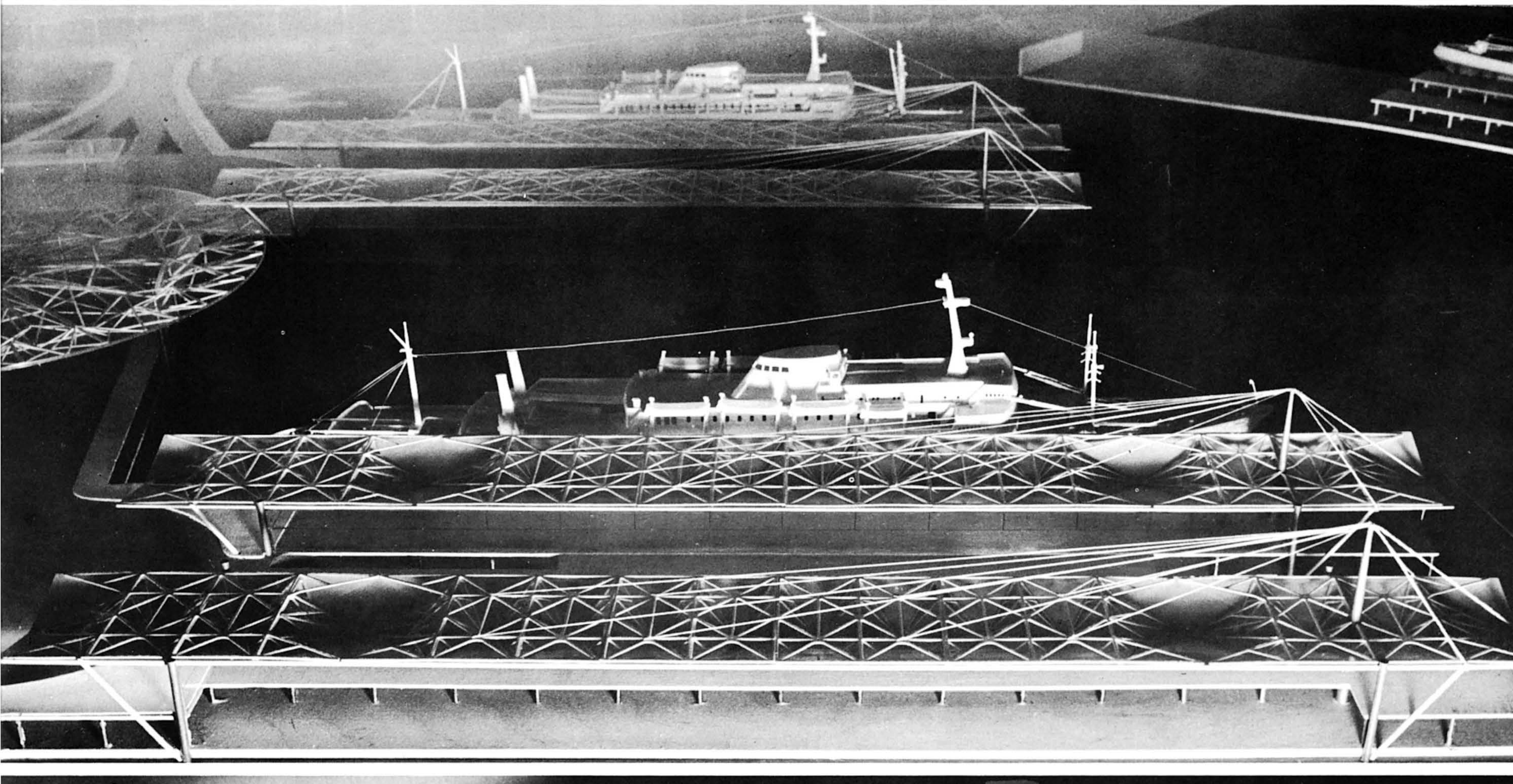

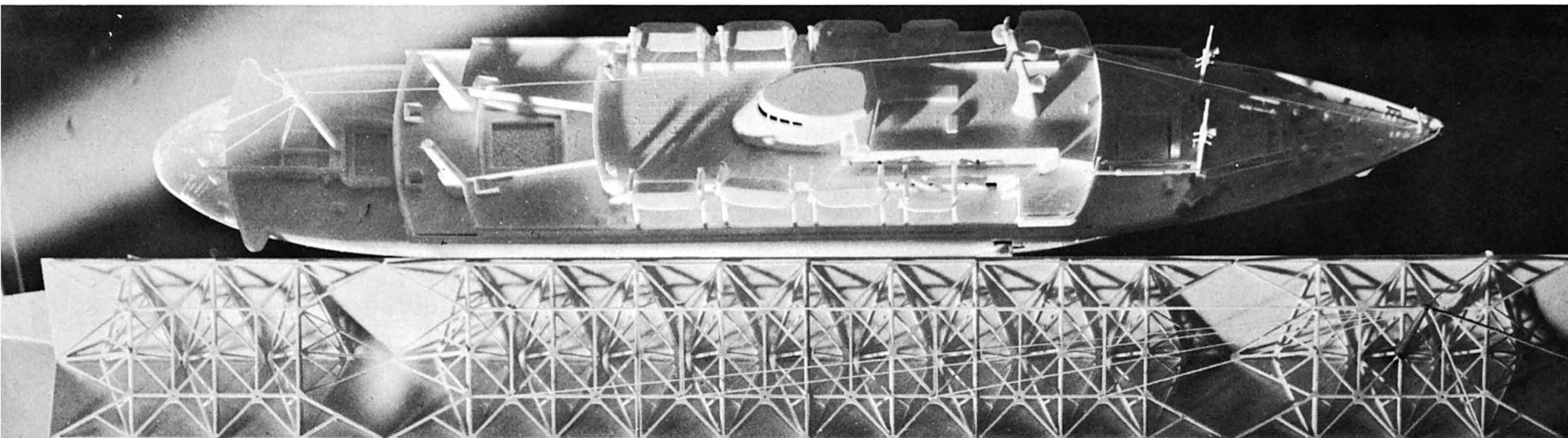

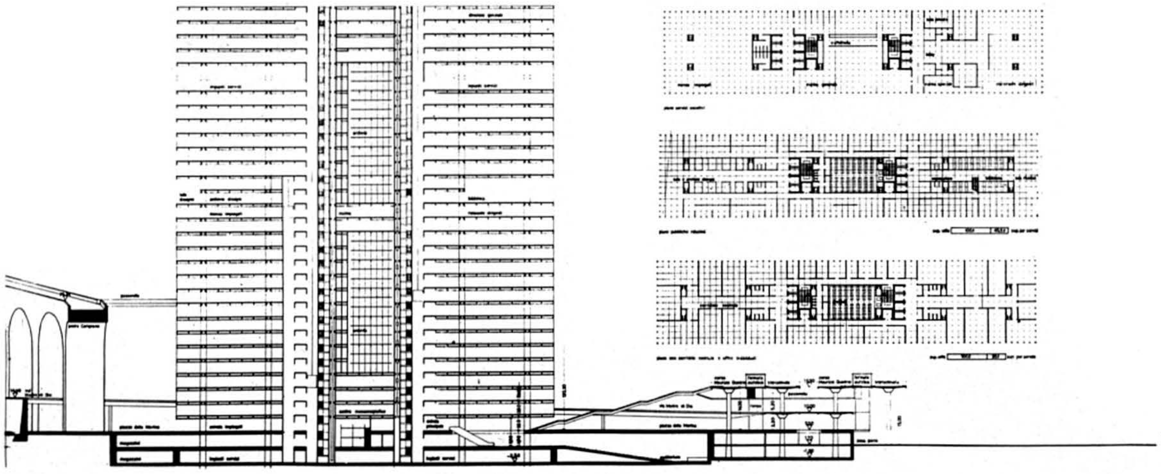

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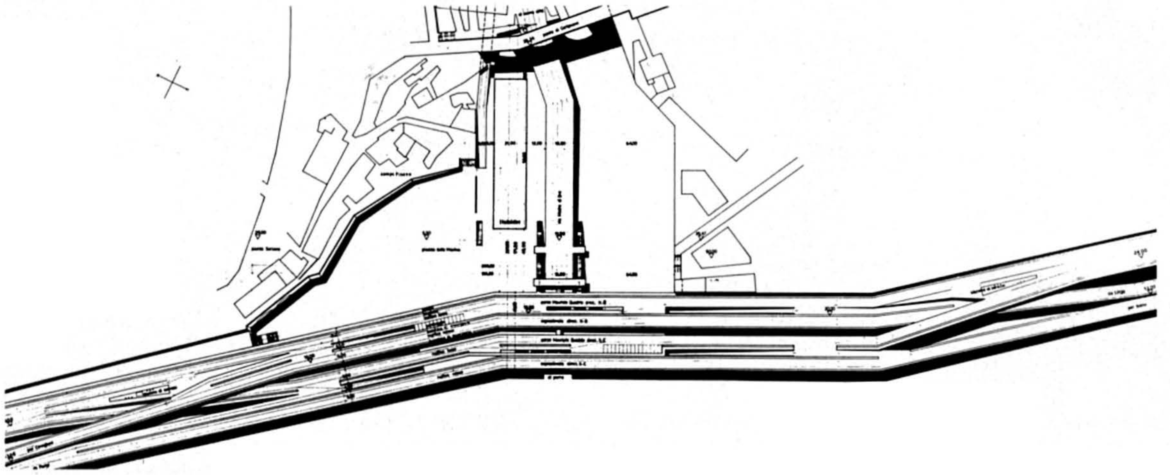

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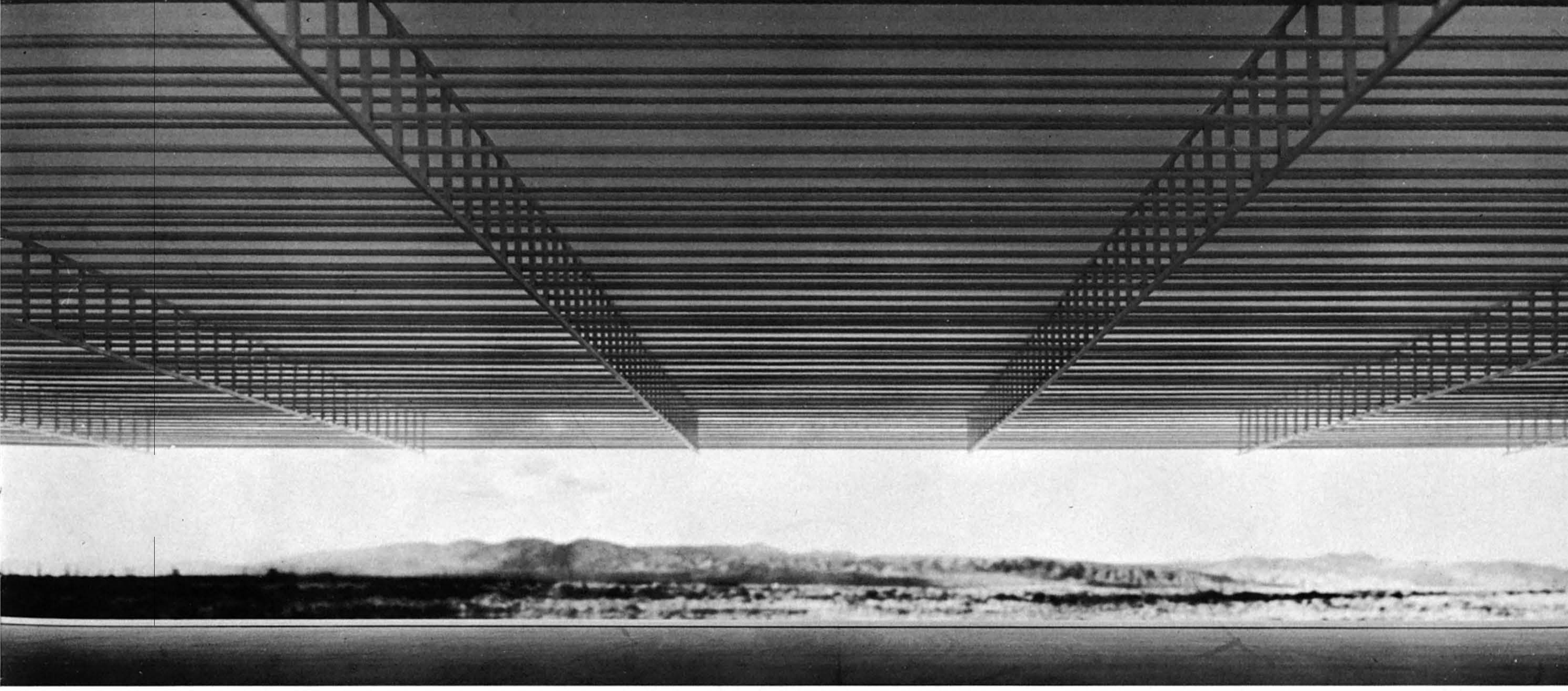
1. Part of the longitudinal section of the building; at left, a 17th-century bridge which connects the Genovese hills; at right, the proposed elevated freeway; entrance and top floor plans indicate inner space distribution

2. Plan of the position of the building in the newly created square between city and harbor, and the multilevel, multilane rapid and local transit connection

3. The relationship between office building and harbor island

4. A newer version of the building in which the lower part will be the City Hall of Genoa.



A NEW AMERICAN CITY HALL

The City Council of California City commissioned in 1966 the design of a city hall, a few months after this new city was incorporated (in area, the tenth biggest city in the United States).

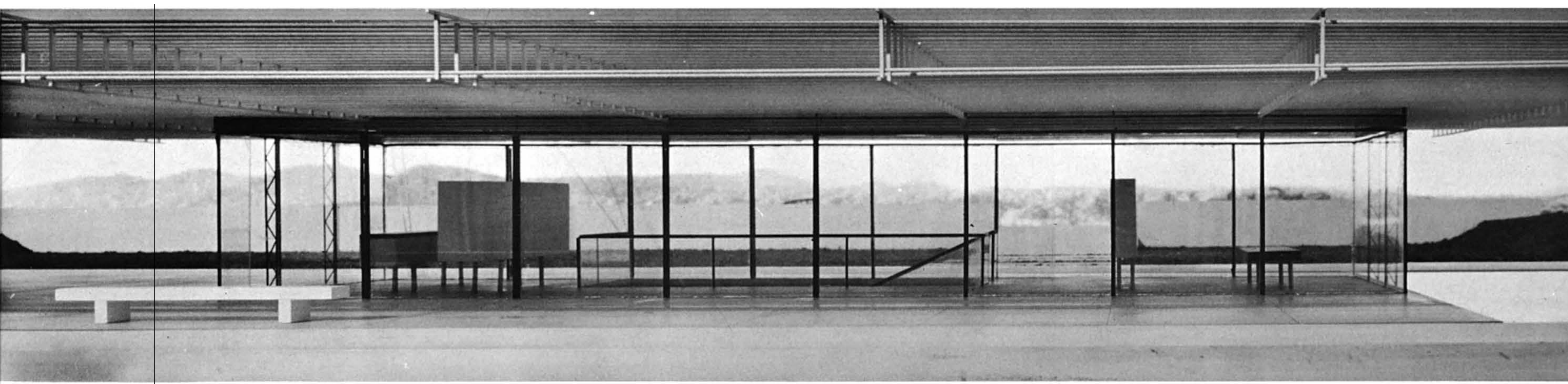
The purpose was to create a complete open space, neither disturbed nor penetrated by any kind of column or support either on the inside or at the perimeter of the building, to create, as it were, an "ultimate" space. Under the floating, tentlike cover spaces can be created as needed, increasing as the city grows.

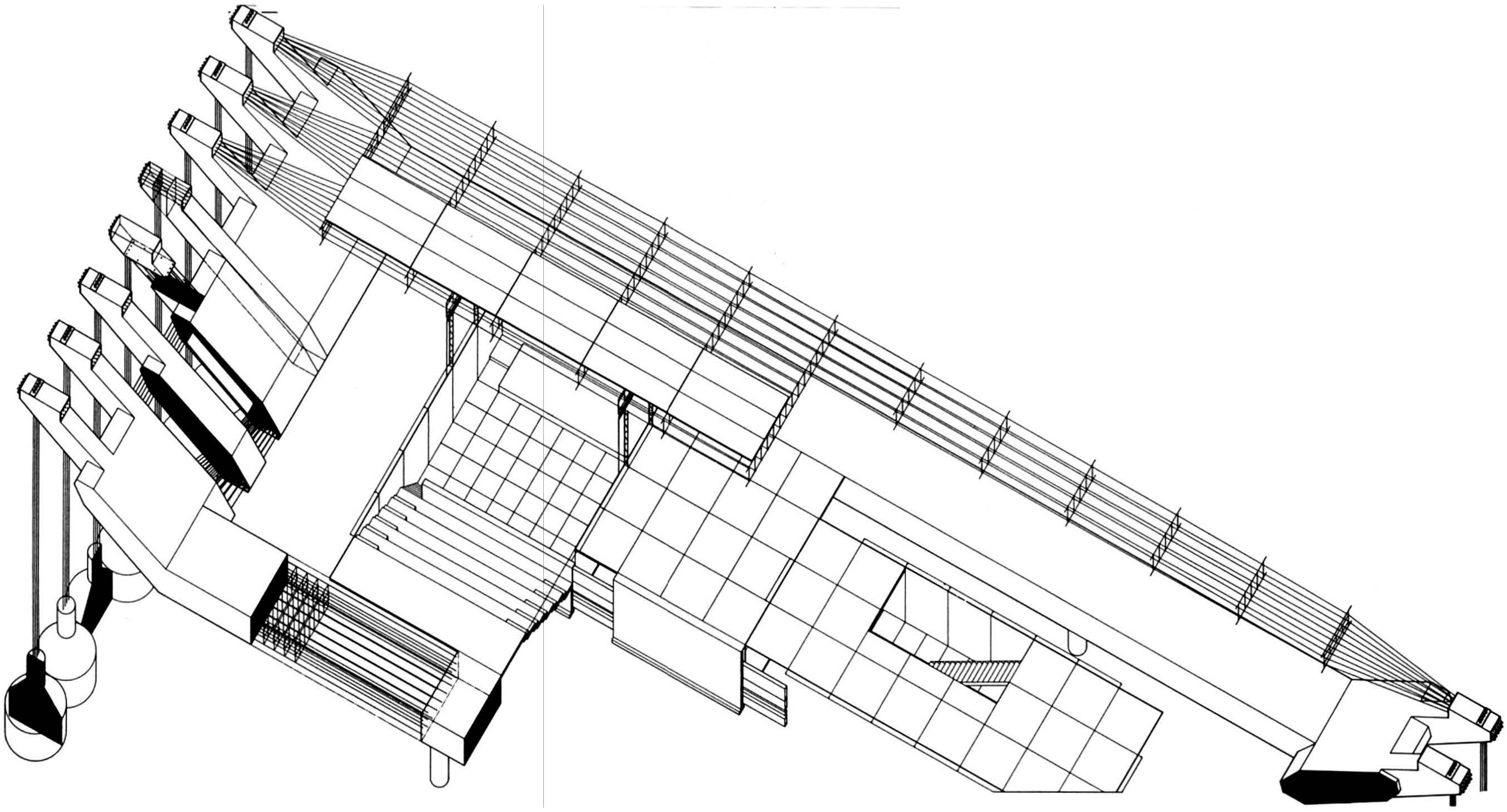
Research and study of many structural possibilities and techniques led to the application of high tensioned cables for the roof structure and a high compression concrete structure for the foundation. The cable struts, the flying "buttresses," are located far outside the roof cover; similarly, the actual major foundation slabs are not under but outside the building, creating an archlike solid structure, that contains all necessary resisting forces to the high tension cables and rests in equilibrium in the desert sand.

1. The completely open space under roof structure

2. Built-in spaces under the open roof canopy, connected to the ground and related to the roof structure only by 12"-high accordion-like deflection areas

3. The mayor's and councilmen's offices at the edge of a reflecting pool





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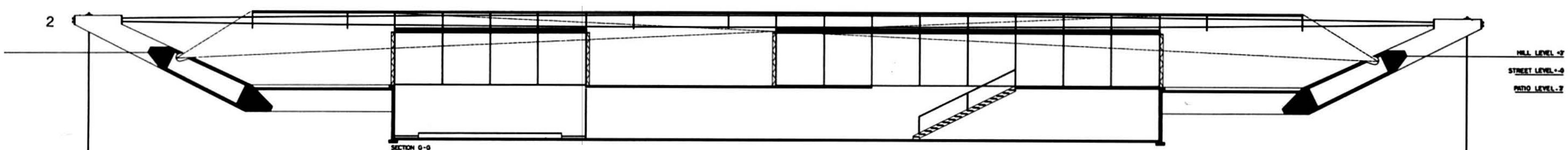

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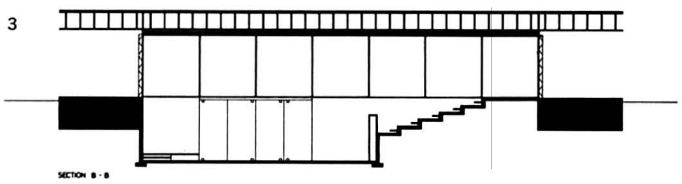

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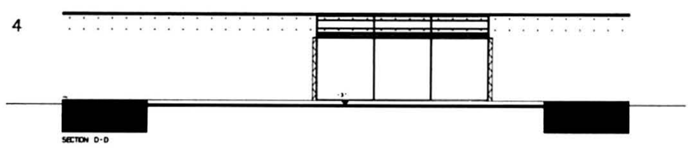

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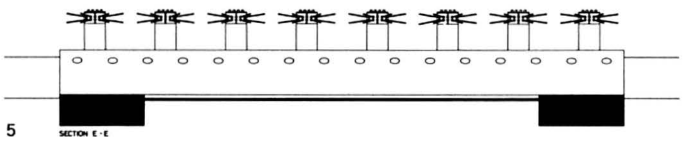

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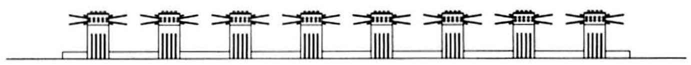

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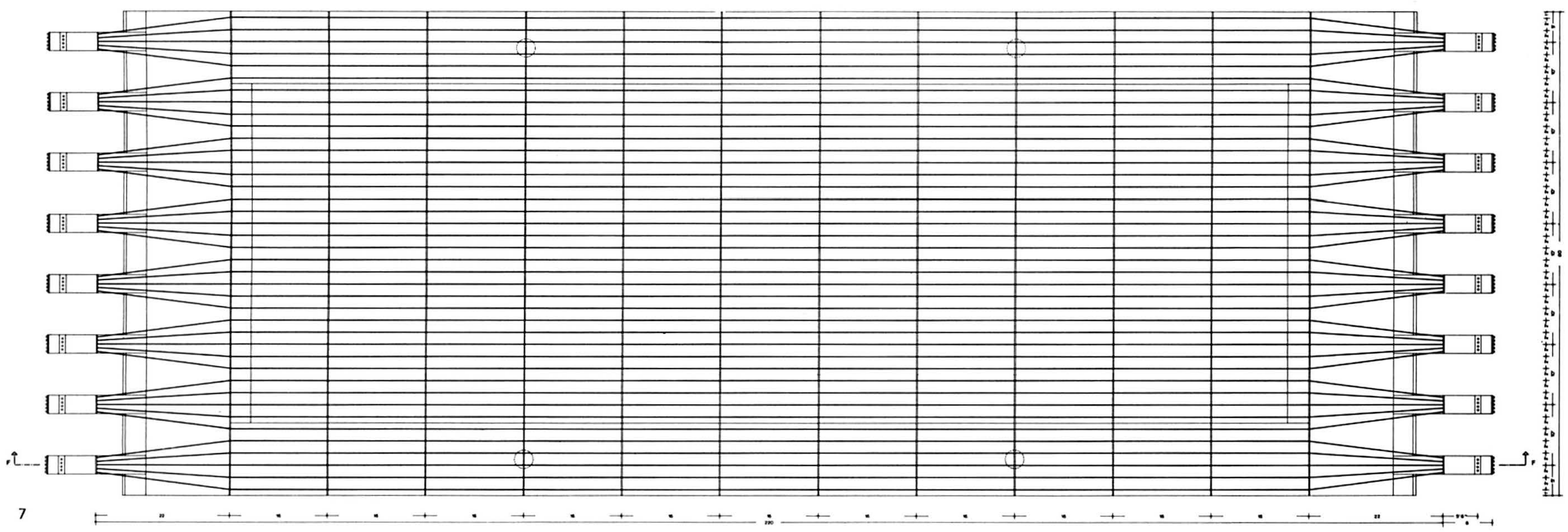
SECTION H-H



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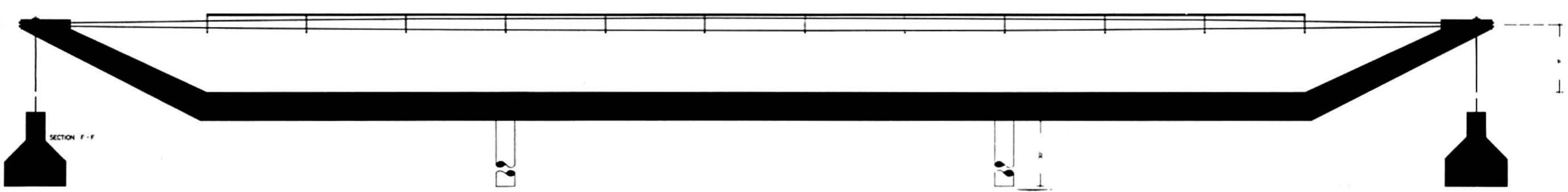

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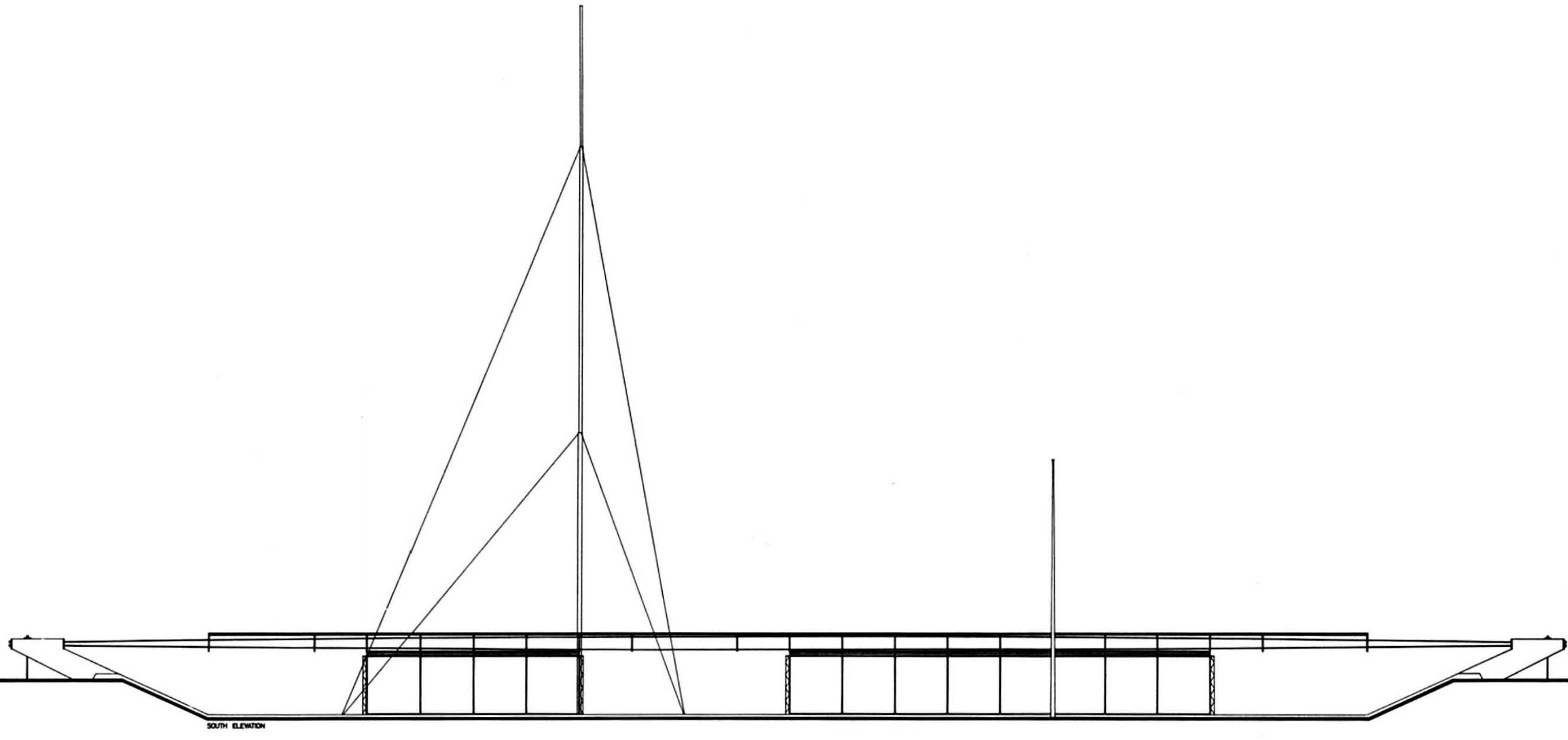

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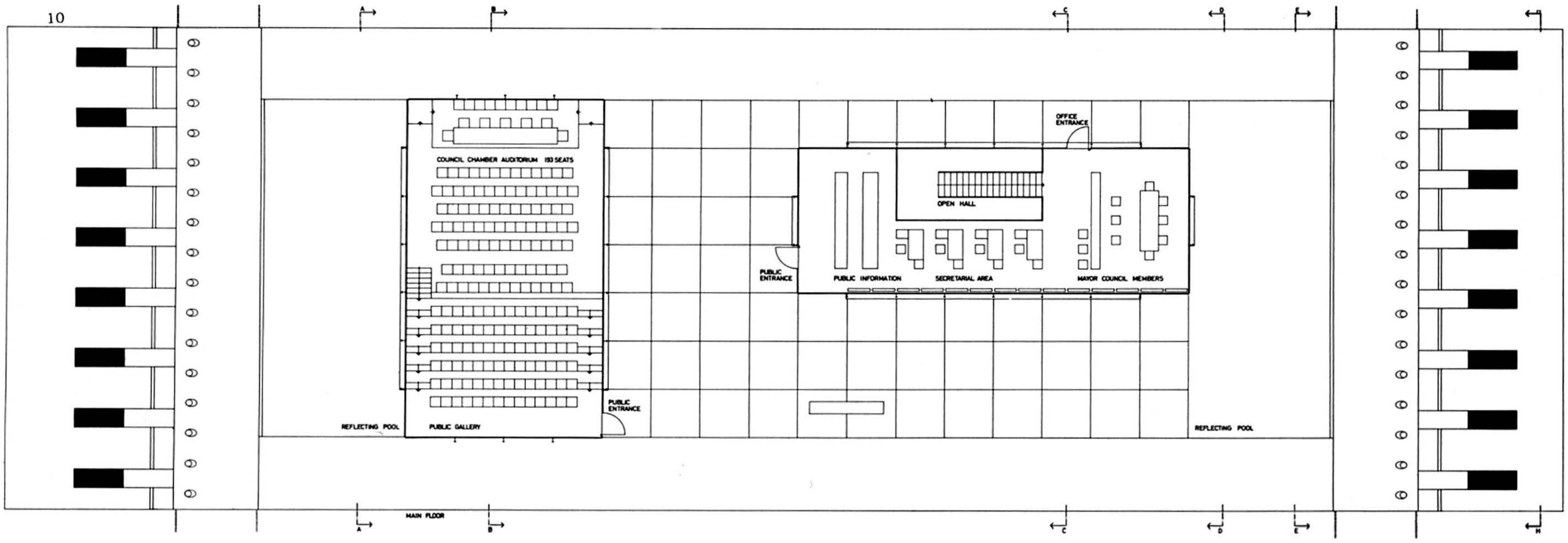


1. Isometric section shows roof cable distribution in relation to vertical ground cables which would relieve bending moments in foundation and the poststressing of the two foundation slabs and the steel reinforcement of the two compression beams between the foundation slabs.

2. Longitudinal section shows the parabolic relationship of the two cable layers and the bow-like shape of the concrete foundation.

3. View of the emerging cables.

4. The backside of the cable struts.

5. Cross-section shows the overall cable distribution.

6. Section through the council chamber with spectator's gallery.

7. Plan view of the cable distribution into 8 groups and their relation to foundation.

8. Elevation

9. South elevation with the television tower which will operate on a low power local channel and transmit all happenings in the council chamber directly to the television sets of all citizens.

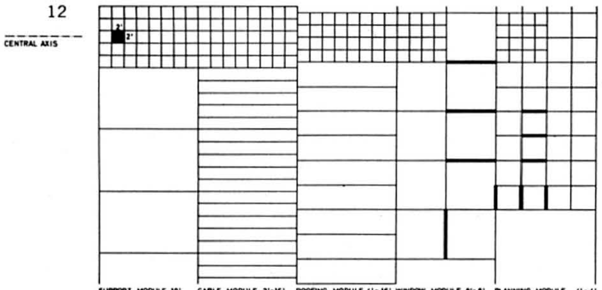
10. Floor plan of the first building stage. At the left side, the council chamber. Council members reach their places from the lower level, spectators from the main surface level.

12. The modular order of all structural and building components based on the 2′ increments in their relationship to each other.

13. Basic position of the council member desk in the mayor's and council member's room and the mayor's and council member's bench in the council chamber.

14. The distribution of functions inside the City Hall complex in the first stage of development.

12



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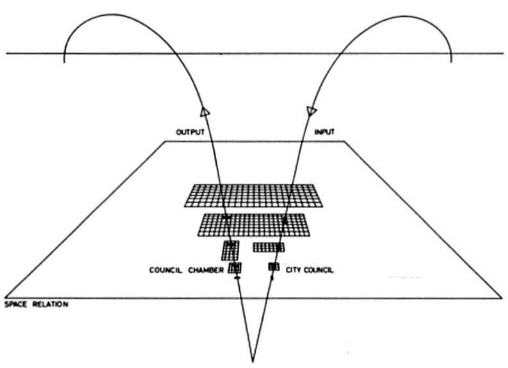

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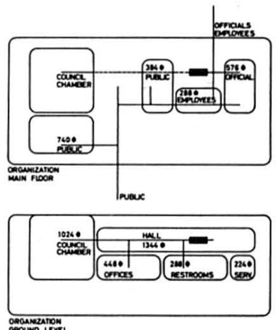

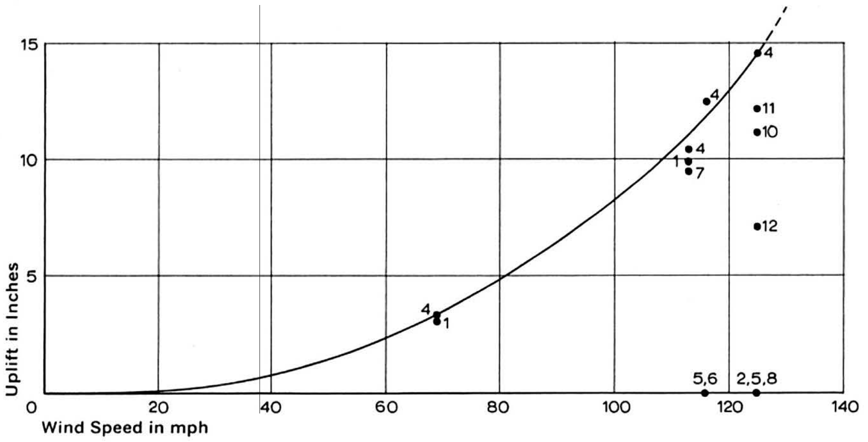

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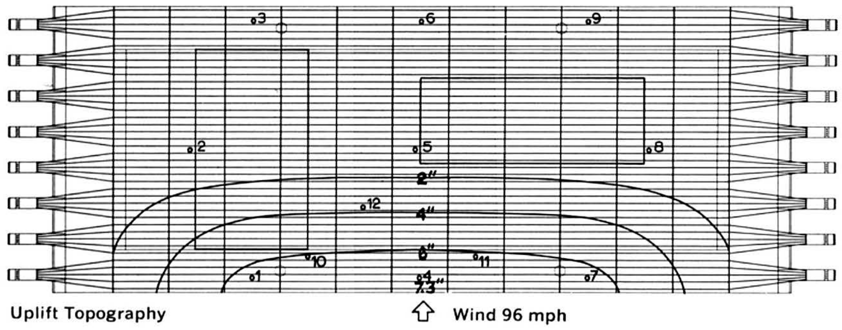

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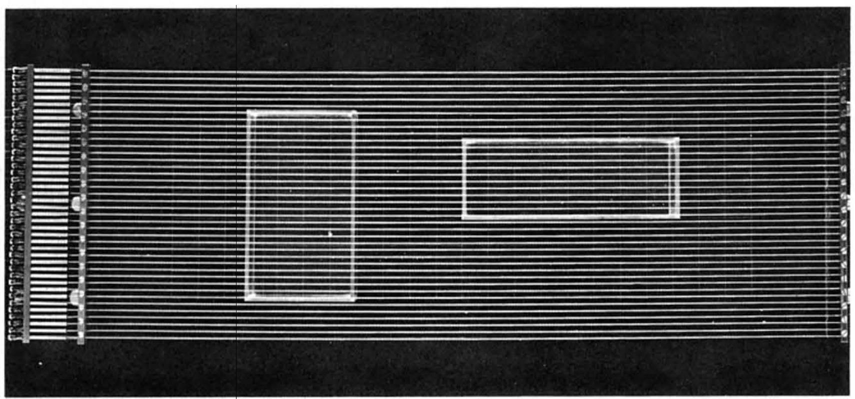
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Very high pre-tension forces are applied to low-sag, high-strength cable systems so that they are stiffened to resist not only wind load deflections but also dead-load and live-load deflections. The structure is 80′ wide and has a clear span of 220′; it requires 18.2 million pounds of pre-tension, which is resisted by 80 1 11/16″ cables located in pairs 2′ on centers.

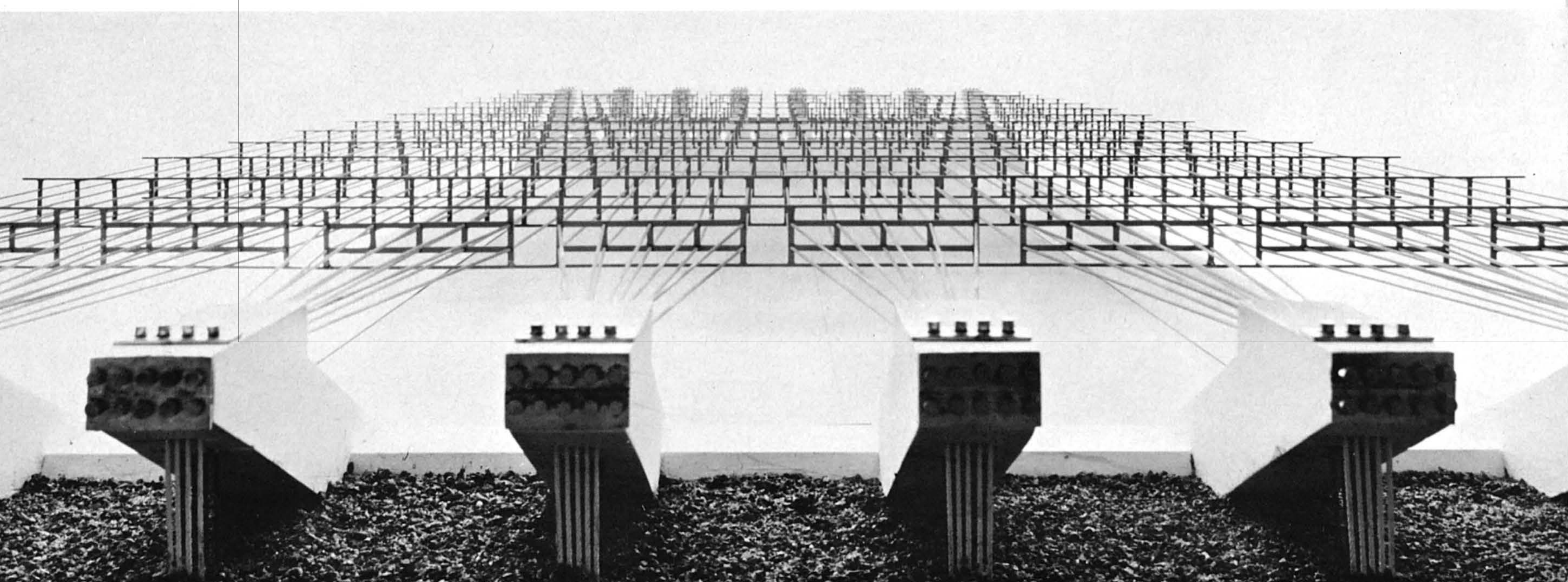
Separate secondary vertical cables are placed to eliminate large flexure loading and critical bending moments of the concrete foundation. The compression loading is concentrated on the foundation and the roof is composed of pure high-tension elements, and truss-like cable spacers. The tension (T) in the cable remains almost constant as dead-load or live-load (Q) is applied and the deflection at center span (F) can be computed from the following simple equation: $F = QL^2/8T$ rather than by the use of cubic or higher order equations. The sag under dead-load is 4.98″ at center span and the sag increases by 6.22″ at 20 lbs/sq.ft. live-load.

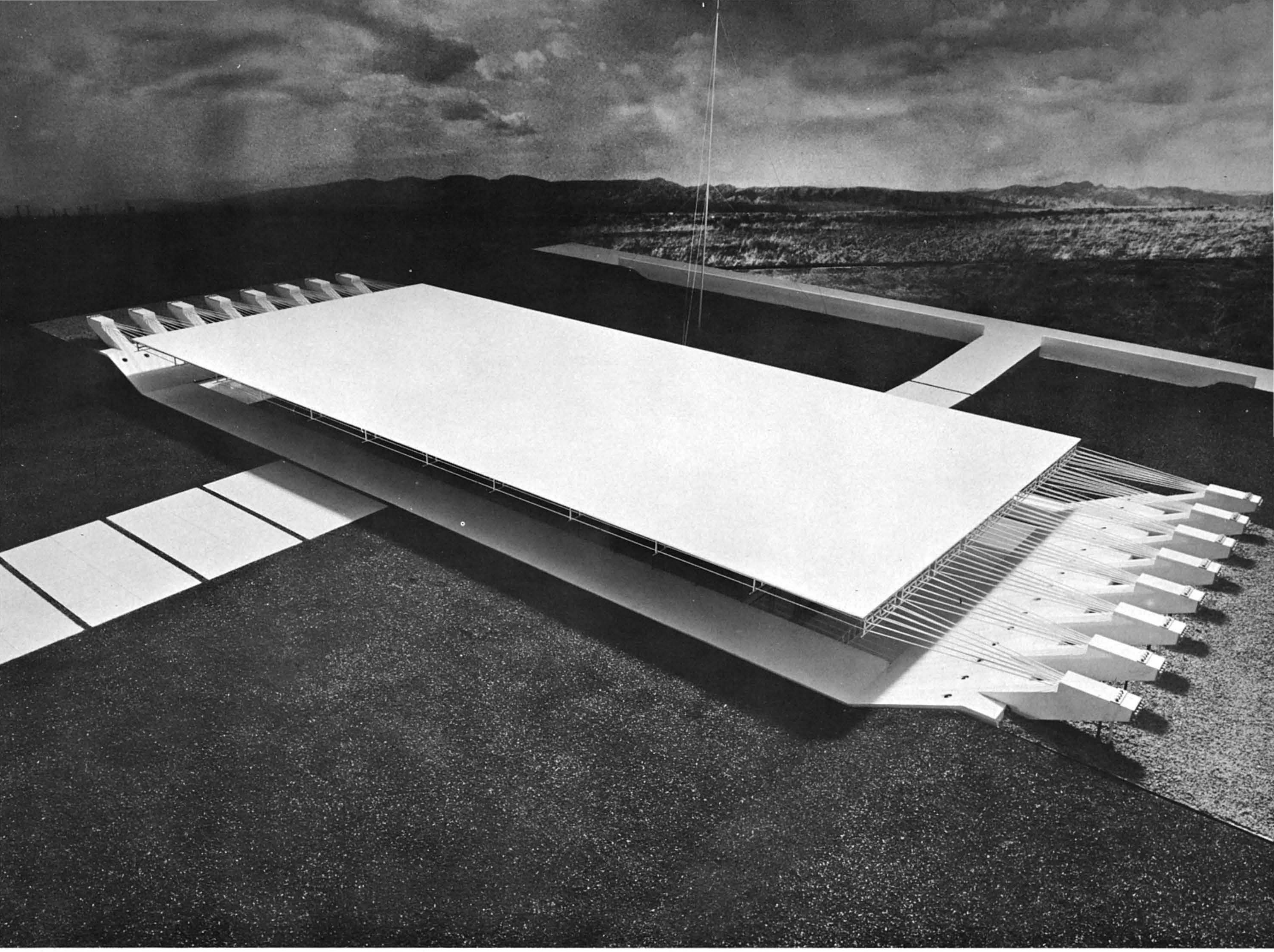
Windtunnel tests have been conducted up to 125 miles per hour. No flutter of the structure was observed. The effect was simply a steady-state uplift. The figures in the lower chart illustrate the uplift topography and its relationship to wind speed. As can be seen, the uplift was concentrated near the leading edge of the structure. Wind tunnel tests also revealed that the stiffness of the individual roof cross frames may be kept quite small ($EI = 100 \times 10^6$ lbs/in^2) without imparing the structural stability under windloads.

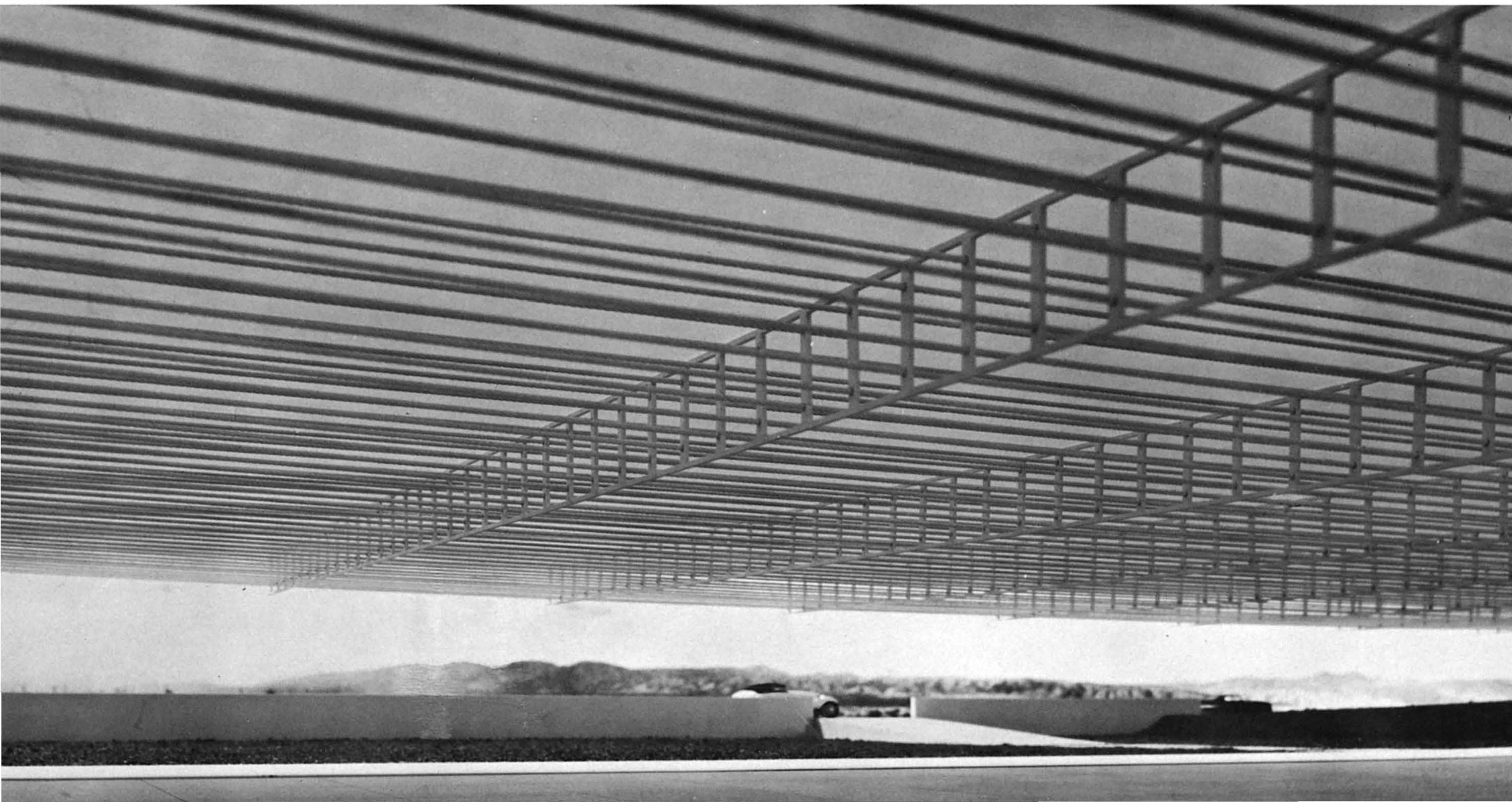
All tests and calculations show that this structural system has no wind flutter or gust or structural fatigue problems.

1. Uplift as a function of wind speed
2. Uplift topography
3. Actual wind tunnel model
4. The pattern of the roof cable structure with the vertical spacers between the cable pairs creating hanging cross fames
5. The City Hall of California City
6. The "ultimate" open space

4



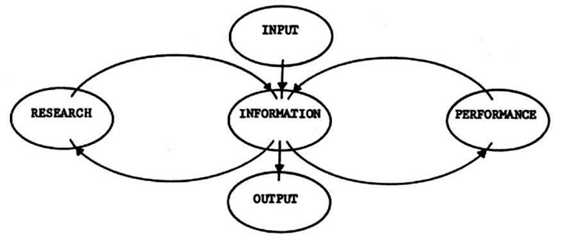




EDUCATION FOR BUILDING RESEARCH

In presenting the case history of the work of one single man as an example of the evolution of thought and action and a reflection of the development of social, technical, scientific, political and economic changes of the society in the middle of this century, it is understandable that this work took place in three, clearly separated stages. It began with performance, the application of skill, and experience, and after abandoning these approaches, moved into research and analyses, abstract studies of functions of social, economic and technical forces to understand better the meaning of form, function, space and motion; this consequently necessitated moving the center of gravity of action into the area of education, training and basic studies of fundamentals.

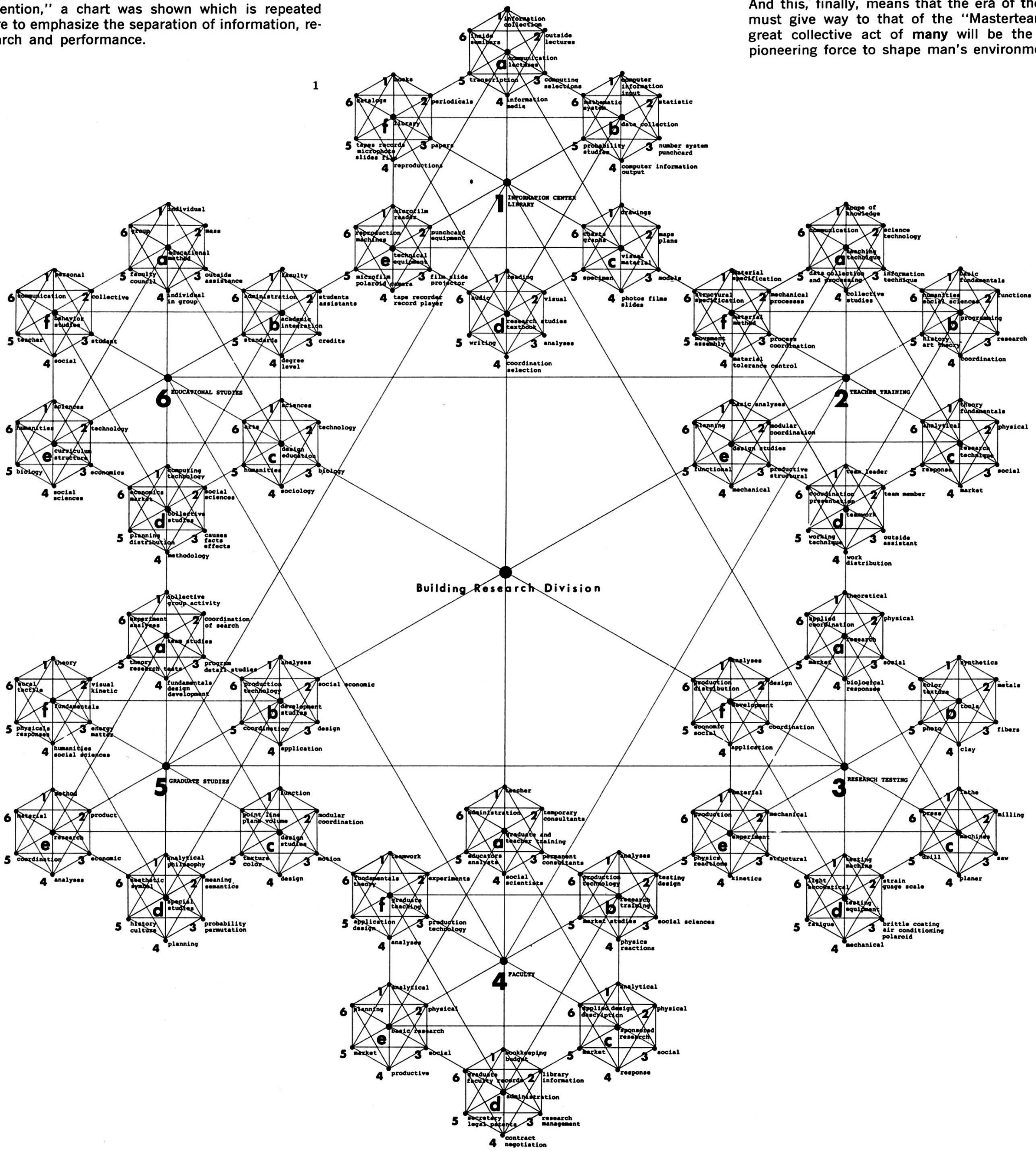
In the contribution to the April issue of **Arts & Architecture** under the title "Research: The Mother of Invention," a chart was shown which is repeated here to emphasize the separation of information, research and performance.



At the University of Southern California in Los Angeles the opportunity has been found to pursue this ultimate goal: to build the foundation for a bridge which leads from programming of progressive educational methods to teacher training, to graduate studies, and in so doing, creates the cadre of trained research experts who, based on comprehensive, international information-retrieval, and in closest collaboration under the assumed new academic order of interdisciplinary study systems, shall become the creative analysts and designers for the rational and the emotional cycle of the society of man.

The charts shown here are part of a study sponsored by the Graham Foundation for Advanced Studies in the Fine Arts in Chicago; they indicated the basic structure of the Institute of Building Research of the School of Architecture of the University of Southern California. They also reveal the need for the simultaneous re-structuring of academic principles and techniques in the university as a whole, while emphasizing the almost overwhelming complexity and dynamic interrelationship of problems which cannot be avoided or overcome by shortcuts. And this, finally, means that the era of the Master must give way to that of the "Masterteam"—the great collective act of **many** will be the creative pioneering force to shape man's environment.

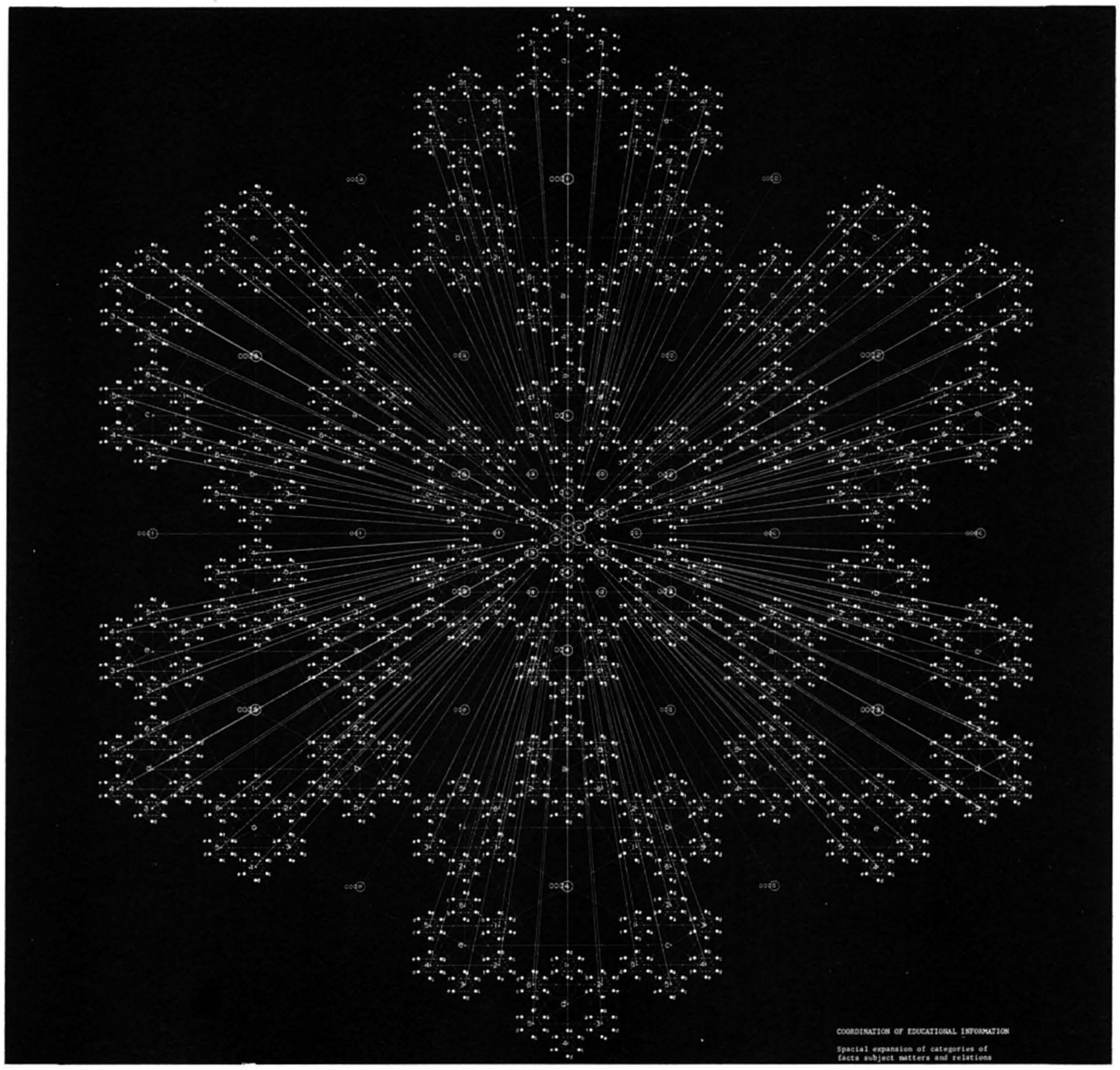
1



1. The basic distribution of activities of the Building Research Institute of USC, subdivided in the following categories: (1) Study center for educational training and study methods (2) Teacher training division (3) Graduate school (4) Research Institute (5) Information center (6) the structure of the faculty team to serve those diversified activities.

2. Symbol of unlimited expansion of any given problem or task simultaneously reaching in all directions.

3. The projection of such organization chart into the assumed structure of an academic institution by which such building research institute may be closely connected with engineering, sciences, social sciences and regional sciences as organism in its own equilibrium between the department of architecture and the structure of the consuming society.



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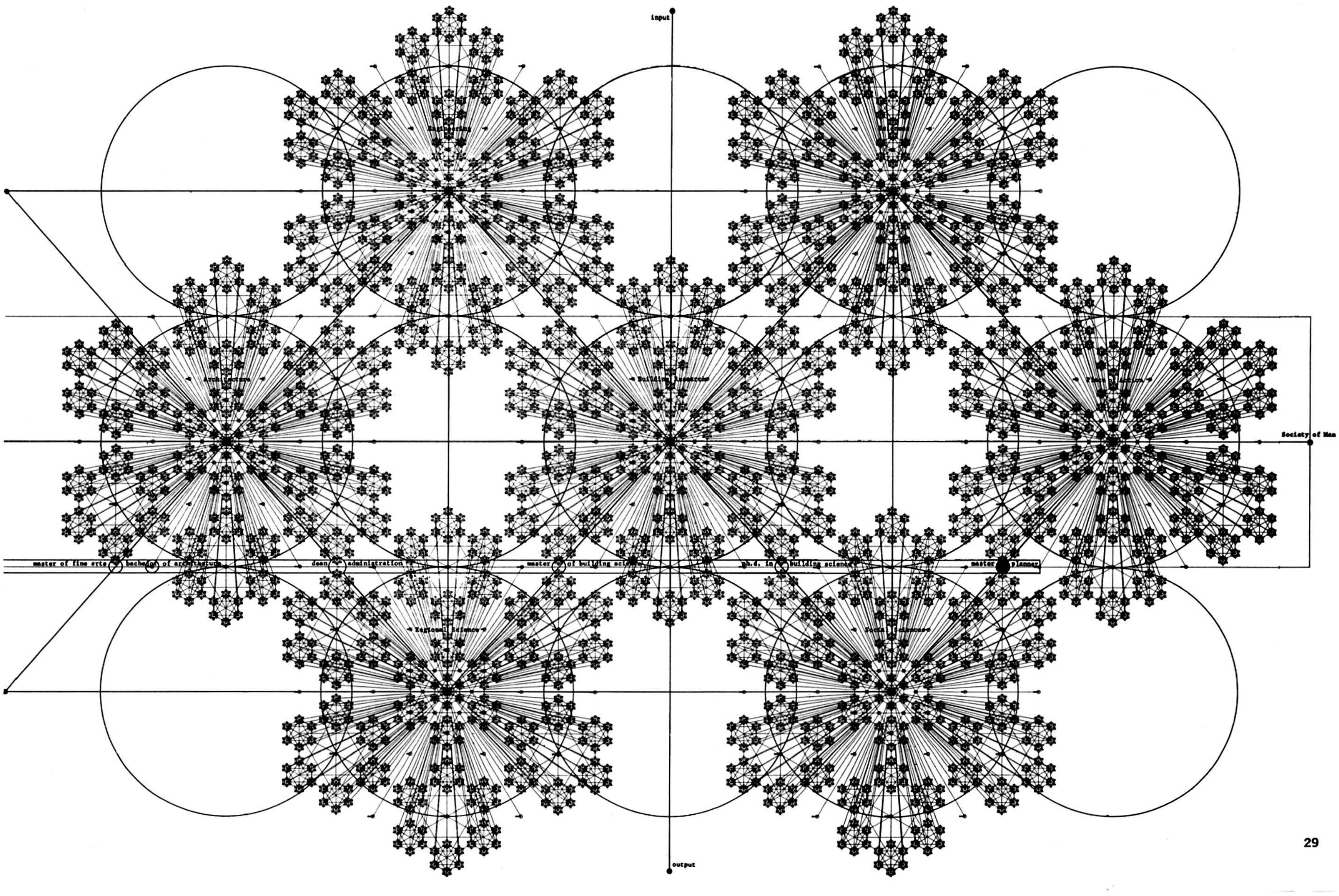


RESEARCH:
THE MOTHER OF INVENTION

KONRAD WACHSMANN

Continued search after truth, to enlighten insight and understanding, to establish facts or principles, is the imaginative process which can only produce meaningful results if removed from any kind of applied activity. To search is man's instinctive urge, explaining his drive to invent, and therefore his society is structured accordingly.

Man's civilization and future are based on his inventions.

Beginning with the first industrial revolution, the history of civilization took a turn in a direction never achieved by man and apparently superior to all other times, through man's capability to control scientifically thoughts and facts, materials and methods, data and causes. Machines followed electrical energy, and the master craftsman, the toolmaker, made industrialization a technical, social and political issue.

The National Science Foundation has said, "The greater the breadth and quality of our basic research and scientific knowledge, the better will this nation be able to lead the rapidly changing international situation and to prosper in the years ahead." Prosperity shall not only be meant in a physical sense but also as a cultural and humane achievement.

The great need for intellectual, scientific, and economic resources is evident, and only universities represent these basic resources. The industrial community, singly and collectively, utilizes the available resources of knowledge. "The more advanced technology of tomorrow will utilize knowledge that springs from the basic research of today. The quality and quantity of tomorrow's manpower for research and development will be determined by today's education and science and engineering."

The question is, Is this society entitled to apply such principles to the art of building? Or is it still necessary to wait for some unpredictable future before man again is permitted to measure his achievements in building on the highest level with the same yardstick of depth with which he looked at the Parthenon or the Cathedral of Chartres? Will the final answer be the collective, impersonal, universal, comprehensive effort, or the individual act of self expression which would make any further research unnecessary?

But with all permissible optimism, if research is necessary, then we have to accept that the creative act of man requires new formulations! Just as much as the doctor prescribes the medicine, and the pharmacist sells it and does not make it himself, so it is inconceivable that the architect, designer and builder can design and build and at the same time engage themselves in research!

In order to establish an appropriate context for the development of research in building, social and economic trends toward such endeavor must be of course considered. The most apparent indicator of these trends has been government, industry, private research organizations, colleges and universities, and other non-profit institutions.

A distinction must be made between basic and applied research since the nature and amount of financing is influenced by this difference. Basic research comprises original investigations for the advancement of knowledge independent of immediate commercial objectives, that is, research for the sake of knowledge in non-profit organizations such as is generally conducted in universities. Applied research, while concerned with inquiry, has limited objectives with respect to products or processes and is bent on achieving commercial goals. It is interesting to note that while industry uses the least basic research and the largest amount of applied research, colleges and universities channel the most substantial amount of funds to basic research.

If basic building research is to find adequate financing, where should it originate? The private architectural office, limited by the lack of long-range or adequate resources and by the profit motive in research, is far from adequate for significant basic research.

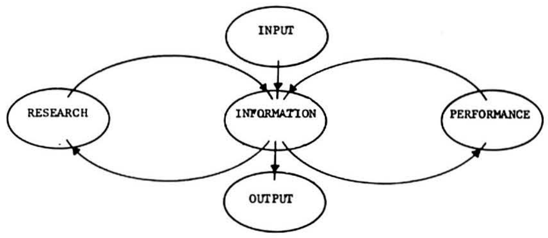
In what "coherent area of science" is the realm of building research founded? Evidently for building research to be accepted among the fields commonly included in government research funding programs, some objective definitive criteria must be established for the inclusion of building research on an equitable level with other fields, especially in the sciences.

The area of building research cannot be categorized so simply, however, since it overlies many fields of science: physics, mathematics, life science, structural, mechanical and social sciences, etc. It may be necessary to supersede some contemporary classifications with combined categories comprising the area of building research to establish the field as a "coherent area of science" acceptable to research funding institutions.

The imprinting of existing technology grows in size and complexity with increasing knowledge. This intellectual capital, reflected in better methods and better products, is more important than the accumulation of physical capital. The body of knowledge in regard to building has increased so much that most of the time spent in studies is absorbed already before proportionately necessary time and energy can be spent in ordering or planning. Knowledge, then can only be the sum of incidental experiences more or less unrelated or out of context.

Some of the investment in basic research which enlarges the body of knowledge at the university level grows increasingly faster than the expenditure for education. Therefore, it must be the challenge of the universities to restructure the method of learning.

It is obvious that no single man can do this. It is less obvious but equally true that a group of professional people cannot do this. The daily production, for instance, of the early farmer was needed to replenish his exhausted energies. Only from the day on which a certain surplus is built up can the growth of a civilization start. Only on the day society, in full recognition of all facts, is willing to equip and feed scientists can building science and building research start to grow (see diagram).

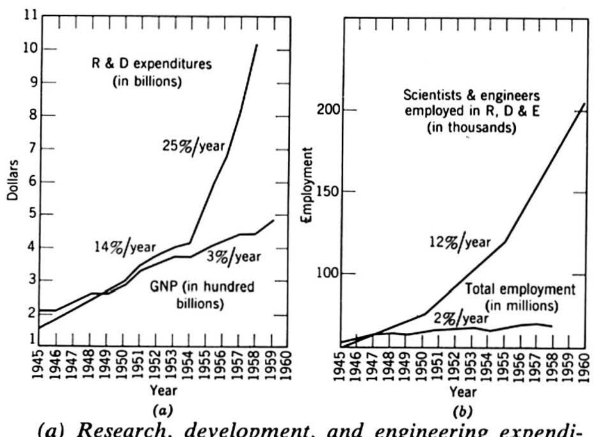


This diagram separates clearly the three areas of human endeavor: research, information, performance. It is self-explanatory and may be the basis for better understanding of the structure of a continuous process for the exchange between building research and performance, resulting in planning and design in their meaning, more fitting to the aims, challenges and purposes of the contemporary civilization.

How much all this has to do with the art of building is obvious. Art should be only based on knowledge, on the highest level of scientific or technical performance.

A new framework of man's thought, study, search and analytical investigation of the meaning of building should be structured within a college or university, which then may not be the same anymore in the traditional sense. A new order may prevail; an inter-disciplinary system without the barriers of faculty specialization, exploding in universal, international and comprehensive planned research. Such continuous search after truth may take place, leading to the answer of the eternal question WHY? in an educational organism which every university should have: an institution of building research.

Written in collaboration with John Bollinger and Peter Rodemeier. Graphs below by the National Science Foundation.



(a) Research, development, and engineering expenditures. (b) Growth of employment in research, development, and engineering.

Basic Research, 1957-58—Intersectoral Transfers of Funds Used for Performance (in millions).

Funds for Performance of Basic Research By / Funds Provided By	FEDERAL GOVERNMENT	INDUSTRY	COLLEGES AND UNIVERSITIES	OTHER NONPROFIT INSTITUTIONS	TOTAL	PERCENT DISTRIBUTION, BASIC RESEARCH SOURCES
FEDERAL GOVERNMENT	$111	$42	$240	$30	[illegible]	51
INDUSTRY		$230	$14	$5	$249	30
COLLEGES AND UNIVERSITIES			$111		$111	13
OTHER NONPROFIT INSTITUTIONS			$27	$25	$52	6
TOTAL	$111	$272	[illegible]	$60	$835	100
PERCENT DISTRIBUTION, BASIC RESEARCH PERFORMANCE	13	33	47	7	100