



1

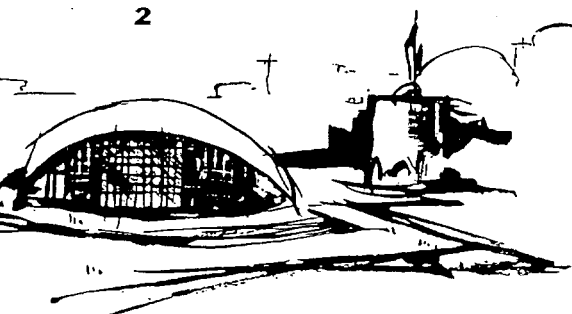
I would like to take issue with the implications of the phrase "design through structure." I hope that I will be allowed to take a critical stand without fear that the motives may be misunderstood by my architect friends or my engineer colleagues who know that I have worked for long toward a more constructive understanding of the relationship between structure and architecture.

The fact that many conferences are given over to discussion of matters of structure (recently, at a national gathering of young architectural teachers, the major topic was carried by a panel of engineers on the subject of structural forms) should be a reason for rejoicing and concluding that great progress has been accomplished during the last few years in again bringing together the two component parts of the building art that had been arbitrarily separated about a century ago by the discovery of mathematical analysis; a reason to surmise that a fresh love is blooming, and that, perhaps, out of this match, the new forms of the architecture of our time will be created.

Yet, upon closer analysis, one discovers something unusual; something one-sided in this courtship. It can be noticed that there has been a far more aggressive initiative on the part of the architect toward the engineer than vice versa, and I know of no architect who has been invited to speak about form at a gathering of struc-

\* Chief Engineer, Victor Gruen Associates. This paper was delivered at the 1957 Convention of California Council of Architects at Coronado, California.

2



## design and structure

tural engineers. I fear that the emphasis of purpose is being somewhat misplaced: that marriage is perhaps not intended! What should have been on the part of the architect primarily an effort toward better understanding of structure and structural principles, an attempt to make the acquired knowledge and sensitivity to structural behavior an integral part of his creative background, which would widen and enrich his design potential, has, instead, become merely participation in a kind of glorified refresher course, designed not so much at passing a higher standard of examination as to acquaint the architect with the latest tricks of the structural trade. Thus, "educated," he will be in the forefront, ready to grasp the latest form, the cleverest trick for incorporation in his very next project (and for publication in the earliest available architectural magazine). I fear that the too ready and uncritical interest of the architect in things structural betrays something of a forfeiture of his responsibility as a creator of environment and of his function as the maker of the physical forms of the society of which he is part.

Design, architectural design, the creation of environment, are ultimately the responsibility of the architect, and it is very seldom that structure alone is adequate to create environment or even to express architectural sensitivity. There are, of course, exceptions—some unconscious, such as the beautiful outstretched arms of the pylons supporting the suspension cables for the gas line across the Mississippi River—and some very conscious—such as Maillart's bridges (1), in their extremely sensitive response to the natural environment in terms of form and scale; a response that is revealing of Maillart's very rare twin gifts of design sensitivity and structural inventiveness.

Otherwise, in general, a structural expression alone, however brilliant, however imaginative, however "tensional" or

"tetrahedral," is not adequate or self-sufficient as an expression of architecture. Thus, "design through structure," should it become a prevailing trend, could mean the architect's withdrawal and surrender.

I do not imply by this, of course, that structure is not an essential part of architecture and that the ultimate form should not respond to and, in many cases, express the elements of structure. On the contrary, I rather take this for granted and go beyond. I believe that not only should we be understanding of and ready to develop the potential of new structural forms but we should also acquire the critical sensitivity necessary to exercise choice or rejection of structural forms and capable, if a choice is made, to carry through its implementation and its integration with the project as a whole. I believe that we should cease to drool, by reflex reaction, every time a new building is covered by a thin-shell dome or an entrance canopy is constructed with involved concrete shapes. I feel that it is time to develop a much more mature critical evaluation of the relationship between structure and form and cease to be taken in by the very novelty and cleverness of the forms that the structural engineer has evolved, with ingenuity and curiosity, out of available materials and techniques.

It is very important that this critique be developed and expressed in our architectural magazines: they have been very useful instruments in awakening the interest of the architect toward the structural forms and in bringing together the thinking of the engineer and the architect; yet they have been, in general, somewhat unsophisticated in analyzing the finished product that this new relationship has brought about. It is also very important that this critique be developed in the schools by giving added emphasis to the ability to *design*, and less reward to superficial cleverness. Of course, I do

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3

not advocate by this a return to academic formalism but, rather, a wariness of the trend toward eclecticism that has received disproportionate acceptance in the solution of classroom problems.

I believe we need more critique and more tolerance of critique. Of course, critique in all matters of design, and especially in the architectural field, is a controversial subject. Yet it is still the best tool for cultural growth.

When analyzing the combined product of architectural design and structural inventiveness, there are a number of different criteria of critique that can be exercised.

First, indeed, are the criteria of balance and harmony. The question should be raised, once a structural form is selected and expressed, whether its relationship to the building as a whole and to its surroundings is an accomplishment of total esthetic balance. Let us consider, for instance, the St. Louis Airport. (Incidentally, I hope that, by choosing as the first target an example toward the design of which I was a contributor, I will be given absolution for any other critical remarks that might follow.) In the St. Louis Airport, an old form (the Roman basilica) was revived in proportions and scale consistent with our new materials (reinforced concrete) to create a space enclosure of somewhat new expression. Very good, yet the question should be asked: does the form fit properly in the total balance of the building? Is a cross barrel roof set on top of a two-story building, its points of support resting on the very corners of a delicate-looking structure, a properly expressed form of the structural equilibrium of a classical arched roof?

Conversely, in the case of Nervi's Exhibition Hall in Turin, should we not regret the lack of sensitive communication between architect and engineer that has resulted in a most imaginative and satisfying roof enclosure for an otherwise

conventional and uninspired building?

A second design criterion is purpose. Is the selection of a structural form consistent with the use and purpose to which the building is to be dedicated? Undoubtedly, the answer will be positive when a thin shell vaulted cantilever is used (such as the stadium at Bogota) to shelter the spectators where uncluttered visibility is a prerequisite. Is the answer still positive if we question the choice of a thin shell roof for the MIT Auditorium Building (2) which, by the very nature of its purpose, must be totally enclosed and secluded from the outside; in which the acoustical requirements deny the expression of the structure from within, and in which the levity and gracefulness of the form selected was visible and evident only for the short period between the removal of the form-work and completion of the enclosure of the building? I consider a critique of this building in this direction far more important than criticism of its difficulties of structural behavior, which must be attributed to the daring of concept and which should be accepted as part of growth through experimental knowledge.

The third element of critique is scale. While we certainly can develop interesting and clever forms for the enclosure of any space, shouldn't we respond to a sense of propriety suggesting that, for the covering of relatively short spans, the effort in development of new forms is occasionally wasted and meaningless? The hyperbolic paraboloid, delicately balanced on its two points of support, holds a superb design potential for the covering of a large uncluttered space, such as a hangar or a major open shelter, but does it make as much sense when used by Catalano in his house (3) to shelter a plan of otherwise relatively conventional nature, which impairs the viewing of the fully expressed form by partitioning and separations, and in which the varied and

slight slopes of the ceilings in each room fail to express the basic concept that prompted the design?

The fourth criterion, and perhaps the most difficult to define, is the one of design consistency. When forms derived from structure are adopted, the problem of relating them to each other, to the various elements of a building, and to the surroundings of the building itself remains to be solved in terms of total architectural consistency, for the lack of which no amount of imaginative or technical brilliance can provide absolution. I saw recently the design of two projects of our friend, Candela. One, a fantastic, sensitive combination of vaults for a proposed large church project (4). The other, an industrial complex consisting of warehousing, office buildings, lofts, where an encyclopedic vocabulary of structural forms has been used, possibly with absolutely valid economic or structural justification. In the first case, I think the question of consistency would receive an enthusiastically positive answer; while in the second, architectural consistency seems to me to have remained unsatisfied.

I trust these remarks are understood not as critiques of individual projects or of individual architects or engineers. They are rather meant as a critique of us all; a critique, in a sense, of our lack of expressed critical response.

(Continued on page 230)

4

