ARCHITECTURE, STRUCTURE, MANUFACTURE

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Architecture and society

Architecture is known to be bound to create a special framework for any activity of society and its members, a humanized artificial environment, that is to say, an architectural system for the entire world of mankind, modelling it to express the given era and society.

It involves

— that architecture is naturally sensitive, responsive and flexible to historical-social changes, development;
— that it necessarily expresses its era, the involved social forces and even their state of tension;
— that it exhibits the scientific and technical facilities of the era;
— that it adapts its creative approach, principles and methods;
— that it accommodates itself by formulating and choosing its tasks, their quantity and scale;
— that its protagonists have always been probing the future, seeking for what is new, and vision it.

Consequently,

— rather than to be a real frame for life, a total and effective setting alone, architecture is also its aesthetic accomplishment.

This involves

— that the essentials of architectural tectonics cannot be simply material and technical but much more than that: human and artistic;

involving, of course,

— that in examining the present, the real, one has to look at the future, the expected.

The essential of architecture was formulated by WALTER GROPIUS to consist in reflecting its age and life, to feature the leading ideas of the period . . .

. . . by MIES VAN DER ROHE, to be a crystallization of the inner structure of its age, the slow development of its forms, the spatial projection of the period's will . . .

. . . and by LE CORBUSIER who, rather than to consider it simply as a construction to provide a certain technical facility, granted it the rank of an artistic feat.

It should be noted that the role of the contemporary architecture in creating, arranging and organizing spaces does not evolve primarily within the walls surrounding a building but it is manifest in a world of organic complexes of a multitude of buildings (mostly mass products of industrialized building) where the space sensation arises during motion in many directions within and among them; passing through a set of interopening, interflowing, expanding, opening (visually manifold, almost infinite) spaces, passing through narrowing, expanding, opening, evolving spaces between buildings, that is, in course of moving in space and time.

Architecture and structure

The social role, importance and aesthetic meaning of architecture is expressed, transmitted by the elementary or complex order of the created space cells, space bulks, rooms and big spaces,

while this order is formed by a simple or composite and, in fact, spatial system of walls, partitions and load-bearing structures, and this is ever truer and ever clearer demonstrating the relation between the two systems (spatial and structural) that is ever more visible and strict in our days.

This is why
the greatest architects of today — mentioning among them LE CORBUSIER, FRANK LLOYD WRIGHT, WALTER GROPIUS, MIES VAN DER ROHE —
- — independent of their actual method of creation, and
- — independent of their approach to the given problem, hence
- — independent of their selection for the basis of space-art and mass-moulding, hence, whether paths, fitting and nodes of the travel inside the building, or natural landscape, environmental features, or character, quality of the space, or a formal or structural order assignable to various contents, or a geometric or modular system bearing some spatial arrangement and providing it a logical frame, or building laws, production possibilities, mass-production approach and constraints were considered as to be primary;

in expounding their principles, in the access to, and solution of, their problems,
- — they all started from some sketching of the future, of some kind of prediction of social, scientific, technical and productional development, of assuming some transformation of the connection between man and environment,

— thus, they got to the recognition of a set of regularities, their systematization, so to say canonization.

This is why
mass composition, architectural shaping, floor-plan layout and structural system of a building truly reflecting today's architecture assumes or even requires simultaneity of conception, since

the factors quoted are strictly correlated, in multiple interaction, often determinative of each other, hence actually inseparable.

This explains why
outstanding creations of contemporary architecture reflect the identity of architect and structural designer, or at least their unanimosity in ideas, principles and conception (e.g. the works of Pier LUIGI NERVI),

namely, after the separation of external walls and load-bearing structures — that became unavoidable with time — the structures creating the big spaces in a rhythmic row or those forming the space itself by themselves, — load-bearing structures of huge dimensions or specific forms, or concomitant to large spans, — large cross-sectioned structures or structural elements of multistorey buildings — cannot be dissimulated, hidden or decorated, consequently, their fundamental character cannot be disguised.

This is why
the architect and the constructor share the duty to create structures so as to maintain simultaneous harmony between the architectural conception and the method of space forming — to truly and clearly reveal the taking up and transfer of loads, the state of stresses, to demonstrate equilibrium in such a way that the stress-laden harmony of the totality of the system becomes almost apparent;

— since the resulting spatially arranged structure becomes a real basis and vehicle for the peculiar art of imaging the human world, reflecting its contemporary social reality.

This is why
nowadays architecture and structure necessarily undergo changes in approach and scale, since otherwise the immensity of tasks resulting from the enormous and swift growth of space demands of society cannot be satisfied, neither as to large spaces, or the entity of small rooms within a building, nor as to the group of buildings organized into a settlement,

— namely, given the infinite widening of architectural space, the superposition of space cells of an incredible quantity and height, no architectural

idea can be formed if not by thinking in, or even starting from the primacy of structure,

— namely, it is exactly the structural development that disengages the space from the constriction of the system of solid walls, — that permits to increase the storey number almost infinitely, limited only by common sense, to fully open the façades and to shape them with no restriction, to create a bright glass architecture, shining crusts of metal walls, — to change room dimensions freely in time and space, — to reduce the formerly enormous dead loads and the space needs of the structure to a mere fraction, — to apply structures made of novel materials, in novel ways, to possess novel properties, — last but not least, to replace traditional building by industrial production methods and processes.

This is why

the manifold correlation and at the same time, separation of various structures, the change of their material, character and properties, the transformation of their order, mass and weight, together with the imperative demand of mass construction, inevitably leads to a change in approach and method of architectural and structural design;

— namely, it calls for no proof that buildings confined by thick walls with small openings, containing small rooms, surrounded by heavy walls require a design approach quite different from that for buildings confined by crust-like walls with nearly room-size openings, membrane-like partitions and consisting of flexible interior spaces realized with lightweight structures, able to bear point loads;

— namely, it is also self-intended that individual buildings erected by a traditional method have to be designed in a different way and with different materials than mass products of any industrialized technology;

in final account, this is why

the scope of the quoted strict and complex correlations between architecture and structure is made inevitably more intricate by a lot of new factors such as the change of materials and structures, of the approach to architecture, the acute, immense worry of mass construction, of the depressing labour shortage etc.;

— namely, it is self-intended, that the primordial theoretical problems of industrialized building still await development, material and mental bases of its practice await creation, technologies really suiting the immense tasks have to be found, actual bases of mass production have to be established (mentioning only the most essential ones);

— namely, no economical, reasonable or fine mass products are possible without taking into consideration, and developing the above.

Construction and manufacture

In the following context, *construction* is understood as the entity of all structures for load-bearing, confinement and partition, and manufacture, as their production on semi-industrial or industrial level,
irrespective

- of their main constituent (e.g., steel or reinforced concrete),
- of the method of connecting the units (e.g., monolithically),
- of how the load-bearing, confining or partitioning functions are coped with by the same structure as in case of load-bearing walls, or by separate structures as in case of frameworks and curtain walls;
- of where they were made (at the site or in a factory);
- of the construction method applied for the given building or structural system — involving the components approach to yield open systems, or the car-body approach yielding fully or almost closed systems;
- of what manufacture is based on, whether it starts from the end product, its structural skeleton or the surface of the structure, or of what it aims at: the building itself, its entire structure, or a part of it, or only its mould;
- of the end product character (mass product of a settled factory, individual product made at the site, or even an individual product made in a factory by mass-production methods),
- that won't deny the — often decisive — importance of the quoted factors in the design, the construction of the structure (structural system), and in final account, of the building as a whole.

These factors have to be examined one by one and in interaction, of course with due regard to the inherent peculiarity of building — actually, industrialized building,

that the product (that is, the building) can only be finished at the site,

- irrespective whether the production is concentrated in a settled factory or at the site, and

that — in order to avoid the often quoted noxious by-effects — the end product (i.e. the building) has to satisfy essential requirements of variability and besides, — to delay obsolence — to satisfy requirements of flexibility in use, depending on the character of the structural system,

- irrespective of whether it is a mass-product (e.g. assembled of prefabricated components, units), or an individual product (e.g. cast in the projection of in-situ position and lifted thereafter).

The analysis starts from the recognition

that each of the basic structural materials (in the usual sense of the word) has ist own producibility degree,

— namely, these are rather different in production methods, conditions, circumstances and equipment, in tools and means of moulding, shaping, working, — in achievable exchangeability by shape and dimensions, in tolerances and fits — in technical characteristics and structural behaviour (e.g. isotropic or anisotropic), — in possibilities of composition and assembly, — in the possibilities of modification, change, adjustment after completed, — and finally, by the need of surface treatment and surface protection,

that of course, the method of supporting (determining the freedom of shaping, space formation and space organization, of floor plan layout and architectural design) has many alternatives, each having its proper type, series, number of prefabricated units, not to mention the various shapes, sizes, weights etc.,

— namely, it is not irrelevant whether the structures to be manufactured are linear or plane (i. e. bar-like or plate-like) or even spatial (i.e. box-like), whether they are simple or composite, low, medium or heavy-weight, homogeneous or heterogeneous, of raw or finished surface;

that the structurally or technologically imposed jointing methods may involve different production principles and different dimensions, different ways and sequence in the assembly of the building,

— namely, it calls no proof that it is an important difference whether industrialization of the monolithic reinforced concrete construction (where practically no jointing problems arise and where the co-ordinated system of moulds is the object of mass production) is spoken of, or the prefabricated framework construction (where the more or less monolithic connections have to be produced at the site applying dry or wet jointing methods), or steel or metal construction (where of course only dry methods of jointing can be used for hinged or moment-bearing connections). The analysis of the problems has to bear in mind that of course, the task, and most likely the principle as well, and even the technology of production differ if space confinement and load bearing are performed by the same or two different structures,

— namely in the former case the main task of production is to make load-bearing slabs for external and internal wall and floor units (to be superimposed in a given order), which are consequently identical or similar in character, and multilayered, inhomogeneous structures in general,

— while in the latter case, the separation of functions is already manifest in production, in so far as it requires basically two groups of products, such as self-supporting wall units and load-bearing frameworks that may be of different material and character.

Again, the analysis has to keep in mind,

that the place of manufacture basically influences the method of solving the

problem, since the architectural conception, the method of manufacture and assembly are all depending on whether production is concentrated at the site or in a factory:

— namely, in the former case the main task of production is to realize only one, or a limited number of buildings, to transport — instead of ready-made elements or structures — mainly materials (which is generally far more simple because it is not necessarily bound to high quality roads or specific vehicles of transportation), which again is equivalent to be obliged to take certain factors of uncertainty into consideration (such as weathering, quality deviations etc.), allowing, on the other hand, to manufacture bigger, more complicated and much heavier structures;

— namely, in the second case the main task of production is to mass-produce, consequently, to transport a very great number of ready-made elements or structures to the building site (which is generally a very complicated business because it is inevitably bound to high quality roads and special vehicles), granting, on the other hand, independence of weathering, best possibilities of quality control, while necessitating very careful selection of form, dimensions and weights of ready-made components;

that the open or closed nature of the actual building method or structural system is decisive for the manufacture,

— namely, open systems are featured by the possibility to produce great many varieties of the final products from a few types of units, the properties and location of which are not determined, hence, the manufacture is expected to mass-produce anonymous, that is, universal units;

— namely, closed systems are featured by the need to produce a relatively low number of possibly not too variegated units, the properties and location of which are determined to yield slightly different and limited number of varieties, hence the manufacture aims at the mass production of structural units needed for determined final products;

that the order of supports, their location, spacing, rhythm — irrespective whether open or closed structural systems — is decisive for the flexibility in use,

— namely, of course, a lower number and a reduced cross-section of supports, hence greater spans, sparser columns reduce the need of, and facilitate transforming inner spaces after a time.

This analysis has, of course, to take into consideration

that the selection of the starting point of manufacture is decisive for the industrialization approach, method, and even consequences: it is not irrelevant namely, whether the final product itself, the load-bearing structure or

the surface of the structure is started from; and what is actually selected for the object of manufacture;

- namely, in the first case, manufacture starts from the building itself, decomposes it into elements (by disintegration), then assembles these factory-made elements at the site (by additivity) and endeavours to produce a possibly great variety of final products with a relatively little variety and number of different elements;
- namely, in the second case, manufacture starts from the structural skeleton of the building (itself based on pure geometry reflected by a modular system), hence the elements to be produced are defined by the decomposition (disintegration) of the primary load-bearing framework, so that the manufacture aims at a great variety of the final product, partly by increasing the types and sizes of sections and by increasing the number of increments, and partly, by increasing the varieties in material, size and shape of secondary accessory units (partitions and masonry units);
- namely, in the third case, production starts from the surface of the load-bearing structures (walls and floors), hence the emphasis of manufacture is put on the production of the moulds which produce these surface elements, taking into account the modular system, thus giving the great variety of dimensions for the elements which will be used as permanent or reusable auxiliary structures, and attempts at a possibly illimited variety of the final product by using an identical system of identical units, and finally:

obviously, the analysis has to take into consideration

that the character of the resulting product (thus, a mass-produced building assembled at the site of plant prefabricated units, or an individual product made with mass-production methods, or even an in-situ individually produced individual product) has an enormous significance for the quantitative, qualitative and timely satisfaction of social room demands (particularly considering social evolution, change in way of life, wear or outdating),

- namely, the satisfaction of the well-known basic requirement of associating industrial production of buildings, structural systems with the freedom of creation, hence with the variegatedness of the final product is not easy to realize since the different methods of production are not equally suitable;
- namely, in the case of buildings mass-produced industrially, with a great number of repetitive buildings concentrated in huge urban ensembles, the product character has a special significance to finally become a problem determinative for the human macro- and micro-environment, since it appears at a social level and with a social weight, hence it can only be solved at social level.

Architecture and manufacture

From those said above it is obvious that

(provided it is true) architecture creates a spatial frame and order of the entire time-dependent world of man and society in the full meaning of the word, and (provided it is also true) the possibility of forming architectural spaces is determined

- partly by the social space demand, practically the involved, rather variegated functions defining the organization order of spaces and space compositions, in general as a relation of the kind "form follows function",
- and partly, by the strict and consecutive set of relations between a structural material, the formation of structure, the system of structure, the architectural design, the building method (in case of mass-product: manufacture) and that in general as a relation: "form follows structure" or indirectly: "form follows manufacture";

(then it is also true that) the social space demand (of given magnitude and quality) can only be satisfied by those structural systems and building methods (in case of mass-production: processes of manufacture)

- that develop from an architectural, structural design approach and method, soberly considering factual circumstances, realistically reckoning with possibilities, taking also expected development into consideration and even adapting themselves to it, and
- that can add up a totality of systems able to meet bilateral requirements of exigencies and of satisfaction in the full meaning of the word,
- that may create in their entity (and in the foreseeable future) a possibility of replacing "form follows manufacture" by "manufacture follows content and form", thus,
- helping to eliminate (as soon as possible) the contradiction between the ever increasing needs of architecture, and the rather restricted construction techniques,

and (no doubt it is also true that) the future of architecture

- in the age of mass-building, of the alienated, endless, infinitely confuse, giant settlements

cannot be told apart from the future of contemporary building technique (or better that of to-morrow), i.e. of manufacture,

- namely, no people living by the milliards in the wilderness of modern towns, at the foot of building mountains, on the riverside of roads flowing with dazzling traffic can be granted a tiny but separate world each, if not by mass-production methods, tools and technique, meaning, in final account,

that the most important and most typical, that is, essential features of architecture are defined by the principle of mass-production and the manufacture will have to keep the homocentric approach absolutely intact.

Architecture and architects

Those said above justify, or better, impose the question:

— What are the conditions for the architect of today to solve actual problems through making use of actual possibilities, but with a view to, and being at the service of, to-morrow?

Answer:

1: The creative approach has to be changed through the completion of the process of transformation already begun,

— namely, functions of a building cannot be considered as constant any more but are to be determined with a view on the changing social background and the changing times, taking future in mind;

— namely, the building and its structures cannot, in most cases, be considered as individual and unbound creations, but they are to be designed as a clear structural system based on a reasonable modular reference grid, on the careful analysis of expected effects and stresses, and on the comparative evaluation of reasonable alternatives, taking into consideration aspects of mass-production, manufacture, economic efficiency, aiming at flexibility in use, equilibrium between wear and outdating.

2: The creative (architectural and structural design) method has to be changed, making use of existing facilities,

— namely, examination and evaluation of steady interactions between time-dependent, increasing exigencies and facilities of industrial development, — the elaboration of up-to-date industrial methods through re-evaluating the well-established standards of traditional craftsman-like structural solutions, building methods and quality standards, — the replacement of design for the absolute (indispensable) technical minimum by design and dimensioning methods corresponding to, and realizing the principle of technical optimum, helping to find the best alternatives, are preconditioned by the transformation of the design process as a whole, and (where possible) by the computerization of the involved operations.

3: As a continuation of the initiated process, techniques of building have to be changed,

— namely, this is the only way of loosening and opening the closed building

methods and structural systems, of developing highly variable and flexible systems, — substitution of mechanized production methods by automated ones apt to reasonably produce variegated products, and — last but not least — of correctly proportioning means to targets.

As a conclusion, to recognize, to realize, and at last, to apply day by day all those said above is a great task, a rewarding work, a worrisome trouble and an immense responsibility of architects, determining the social significance, and expected to grant the social recognition, of their work.

Summary

Some ideas are presented on the transformation of old to new, on the entity of aspects to be reckoned with in today's architecture, and on the responsibility of architects.

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