The inherent contradictions of the closed systems of prefabrication and the future trends of evolution

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The industrialisation of building basically changes the whole aspect of architecture. The process itself was set off by standardisation, but it is only for the last decade, when the new structural systems appeared in industry, that it has begun to shape architecture. The approach towards industrialising building, met the unanimous approval of contemporary architects; since without up-to-date techniques architecture can not be kept on an up-to-date level. Seeing however the architectural results, deriving immediately from the adaptation of structural systems, they want to go further. They are looking for new methods, which—without compromises on the account of industry—can produce better architectural solutions.

The architectural efficacy of structural systems and its scale

The essence of the problem in architecture is whether from standardised units, we can assemble buildings which, though structurally unified, are different in function, distribution and aesthetic appearance. As the factory-made units of building themselves can not be shaped, the shaping of the building can only be based on their *additive* quality. Thus, when evaluating the available structural systems, the architect can only scale their efficacy from an architectural point of view, on the possibilities offered by the system to create various assemblies. Consequently the architectural efficacy of the structural systems can most suitably be scaled by the *number of variations* possible.

The open and the closed systems of prefabrication

The tasks of architecture today are solved by two great basic conceptions all over the world. The one sets out from the modern possibilities of metalworking and particularly from that of steel, and keeps the assembly of the units on the level of the assembly of machines. Because of the unrivalled structural endowments of steel, this conception has never stressed uniting elements into one large unit. Instead, it strived to maintain the principle of component and was the first to realise in architecture the open system of construction. It met first with success in industrial architecture, by creating large undivided spaces, relatively independent from the function.

The other conception experiments with different forms of stabilized and reinforced, natural or artificial materials which can be found anywhere, but first of all with reinforced concrete. The essence of this technique is pouring concrete into large moulds, either in the factory, separating manufacture from the site, or taking manufacture itself to the building-site and basing the whole operation on in-situ manufacture. In both technologies, it strives to produce and to assemble large elements, possibly on maximum degree of readiness, and maintaining the principle of coach-work in production, it establishes the closed systems. Availing itself of most favourable facts of manufacturing flats requiring small, divided spaces to a given function, it unites the manufacturer and the contractor into one body and with the building activity it actually meets its own demands.

Satisfying architectural requirements

The decrease of the available manpower, observable all over Europe and the requirement to meet the ever-increasing demand in housing as effectively as possible, inevitably directed the progress towards the closed systems. From the point of view of satisfying social requirements it turned out to be the most effective tool on governmental level, and in the forseeable future it marks one of the basic methods of building activity. If we want to make further progress towards industrialised building, we have to demand better architectural efficacy from the structures applied to building dwellings. As the number of variations depends first of all on the structural systems, the sizes of the units of the system chosen will be of vital importance. The way of the more efficient architectural solutions leads through the units. It is not indifferent whether the structural system operates with plane or space units and whether these units are of medium size, of parameter-size or even larger. The increase of the sizes of the units namely decreases the flexibility of the structural system, and this again leads to the decrease of the architectural efficacy. This paper analyses the architectural efficacy of the closed systems through revealing their inner contradictions and on the basis of the conclusions tries to outline the possible further trends of evolution.

The inner contradictions of the closed systems

Panel systems. The panel building method, one of the most widely spread practices in contemporary industrialised housing is based on the slab as a principle of construction. Its basic units, namely the large panels, are slabs of parameter size in two directions, constructed with different methods, of ceramic or of hydraulic materials, with reinforcement. This is regarded as the leading idea for manufactured houses. Thereby however, the architect has to adapt himself to the severe restrictions of the structural system. He has to accept that these plane-units can only be jointed along the edges, can only have openings on the surface, etc. The architect uses these slabs to produce cells, more accurately said: boxes.

Seeing that his units, the floor and wall panels, are of parameter size in both directions, the boxes constructable will automatically be of parameter size in three directions. The number of variations designable on the basis of the structural system will depend on the sizes (range of sizes) of the spans and widths of the floor panels. The claims for creating varied plans for dwellings will strengthen the tendencies towards increasing the spans. The tendency towards increasing the span, whilst maintaining the slab as principle of construction is one of the inner contradictions of the panel-building method.

Space-unit building method. The space-unit building method, the other endeavour in contemporary industrialised housing is based on the box as principle of construction. The architect here uses factory made, stiffened space units: boxes. He regards this as the starting thought for industrialised housing. He accepts that these space units can only be jointed at points and along lines, and uses these boxes for assembling the building. Seeing that his elements, the space units, are automatically three dimensional, and what is more, are of parameter size in three directions, the minimum reasonable growth in dimension starts with the parameter-size. The tendency towards increasing the sizes of the parameters, whilst maintaining the box as principle of construction is one of the inner contradictions of the space-unit building methods.

The further trends of evolution

The tendency towards technical progress intensifies the inner contradictions of the closed systems. The original process, which with panel constructions only meant to manufacture elements in the factory and assemble them on the site, has turned into manufacturing complexes of elements, transporting them to the site and assembling them. The architectural efficacy of the structural system goes on decreasing.

The limited architectural efficacy of the closed systems averted our attention to looking for newer methods. We wanted to establish a basically new building method, with new principles of construction, in which the reinforced constructions applied to housing approach to steel constructions on the level of assembly. We examined if we could derive solutions of jointing from reinforced concrete technology which are similar to those of steel constructions *in principle.*

The tissue-structural, cellular building method

We established an open system which puts the emphasis on the elements and leaves the final result, the building open. In this building method, instead of putting the emphasis on the usual manufacture of the frame, we manufacture the elements of the *surface*. We came to the conclusion that we have to transform reinforced concrete technology in a way that instead of the panel, the profiles – so well proved in steel structures – should mean the most favourable form of manufacture for the elements.

The building material is reinforced concrete, but with this technology the weight of structure can be reduced extremely significantly, from one-third to one-fifteenth. We developed a specific, *complementary* building method, i.e. we adapted that variant of modern technologies which combines the factory production of the elements and components with a kind of technology of pouring.

In order to achieve small weight and proper structural rigidity the *cellular* form of structure proved the most practical. When constructing the system we first manufactured the final surface and then we elaborated the forwarding of the thin concrete to this surface. If the concrete meeting this surface required ribs, then we formed the negative of the rib in the surface-element.

For the manufacture of the surface elements we of course chose a material of low specific gravity. Gypsum showed the most suitable, so we determined the form of the concrete by the form of the gypsum elements. The concrete itself meets the gypsum in the phase of pouring, when as a consequence of the moisture-absorbing capacity of the gypsum, the concrete poured in, gets immediately stabilised. It freezes on the gypsum.

Thus in this structural system we determined the *tissue* of the concrete by the negative channel-system of the gypsum elements, and determined the form of the structure by the *cells*.

The construction of the modular spaces required for the dwellings was based on the *additive* quality of the elements. With the new technology, founded on new principles of construction we succeeded in multiplying the architectural efficacy of the structural system.