Architectural Design and the Building Industry

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INTRODUCTION

By way of introduction, let me make some general remarks about architects and industry, and particularly about the gap between them. Architects very often complain about the prevailing poor craftsmanship provided by industry. They comment that their beautiful buildings turn out so badly because of this low level of craftsmanship. However, they are really begging the question, which should be: In the industrial age, is it proper that we should still be talking about craftsmanship at all?

Unfortunately, while architects also complain that industry is not very responsive to their designs, industry complains about architects, claiming that they are completely out of touch with production processes.This is not a new problem. Fifteen years ago, Norman Foster gave a talk in Berlin in which he called architecture "the art of making." He started his talk with an image of a person sitting at a potter's wheel, throwing pottery. He explained how this craftsman was able to form the pottery at will, but was still dependent on the wheel. The audience thought that this image of an antiquated technology was strange for an architect like Norman Foster. But this image is very important because one has to understand the system of a potter's wheel in order to understand that the pottery comes out the way it does.

Many architects—if I may continue to use this image—behave as if they thought that they could make square bowls on a potter's wheel! You have to be in touch with the technology and the machine in order to understand how things are actually made and what the processes really permit. Today, technology looks very complex, so we tend to think of industry as a kind of black box. All that we know (or think that we need to know) is what are the inputs and what are the outputs. What happens inside is too much to even dare to ask about.

At the turn of the century, architects were very enthusiastic about the new means of building. Indeed, many architects went into the field of industrialization. With the wisdom of hindsight, it seems to us that they all made the mistake of thinking that the product that should be industrialized was the house or the building itself. Buildings were put together out of a kit of parts in such a way that each of the elements had to fit into a specific position within the total system.

Interestingly, this approach has not changed much over 70 years; even in HUD's Operation Breakthrough competition, similar systems tried to get into the American market. This is more like solving a puzzle than real system building. It can be called the "first generation of industrialization." In contrast, Conrad Wachsmann (he had been the chief designer of a prefabricated housing company in Germany) thought of a house or finished building in terms of modular coordinated, exchangeable parts, where each of the parts that he produced could be assembled into different positions within the final building. I call this the "second generation" of building systems.

Conrad Wachsmann, it should be remembered, set up a new factory in Los Angeles after the Second World War, called the General Panel System. In *The Turning Point of Building* he wrote that the design of a building should not just be the design of floor plans and elevations; it should also include the system behind the building and it might also involve designing the machines to produce the system parts. Furthermore, it could also mean building the whole factory! Unfortunately, Conrad Wachsmann's company went bankrupt—and it is possible to speculate that it failed because Conrad Wachsmann did not go far enough and should also have incorporated the marketing of the system in his concept.

By the early 1970s, it was time to rethink all the prevailing ideas about building systems; there was an emerging wish for a "third generation." The tone was set by Ezra Ehrenkrantz who recognized that architects do not know enough about how building components can be manufactured to properly design them. He designed an approach which drew and advantage from this shortcoming. He reasoned that as we are not part of industry, we should join up with it. In the Schools Construction Systems Development (SCSD) project, Ezra Ehrenkrantz set up a system of rules for the modular coordination of parts and associated them with a set of performance specifications. He then induced specialized component producers to assume the task of designing the components for the system, by inviting them to compete for a large aggregated market; they carried out the component designs in full knowledge of their own production methods.

OPEN SYSTEM BUILDING

Because I was not backed up by a major building program such as the SCSD schools, I wanted to see whether it would be possible to build with components that are generally available on the market. This meant ascertaining first of all whether these available components are actually compatible with each other and then setting up a catalogue of them. It should subsequently be possible to choose factory made components for each project from within that catalogue. The aim in preparing the catalogues, I should mention, was to allow for alternates for each of the subsystems. In this way one could arrange one's choices specifically for each project.

The next step in the system design process was to determine the modular grids. Somewhat naturally, the four inch/one foot/four foot system (which was already widely accepted throughout the United States) was chosen. At the same time, another important principle was established, namely that instead of creating jointing problems and then having to solve them, it would be better to try to avoid joints —notably by having the structure independent of the infill.

Of course one had to test the system. Appropriately, it was called TEST—Team for Experimental Systems Building Techniques. It was first used to build my own house on a very steep site in the middle of Beverly Hills. This difficult site had, of course, some major repercussions on how the building should be built. I chose a steel frame to enable as much pre-manufacturing as possible, with only simplified assembly remaining to be done on the site. Despite the difficulty of the site, the structure was put up in two days; other operations followed, working on the platform provided by the structure, i.e., under much easier conditions.

I was interested in studying how the components were produced and so, as a matter of principle, went into the factories to see what machinery was needed. As one might expect, I found that the more specialized the parts were, the less industrialized they were. Conversely, one could establish a rule saying that the more industrialized or the more automatic the production is, the more flexible and the more versatile it is, and the greater the choice for the designer.

Returning to my experience with my own house (experience that I found to be true in my other projects too), it is inevitable that the whole system cannot be put together completely out of prefabricated parts. There are always pieces that have to be specially made and they are proportionally much more expensive. The important principle here is to make sure that this higher cost applies to small or relatively insignificant parts. In another instance (my own offices in Braunschweig), I used a cladding system developed by a friend of mine working with industry. In that case, it became necessary for me to respect the rules of his system and adapt my own designs to them. For example, I could not simply change the height of the panels; it was impossible for me as an architect to say "I want the standard product but it must be two centimeters longer!"

Understanding production processes actually enriches one's design possibilities; for example, in another one of my projects, I used rounded corners to the façades which are clad with horizontally corrugated sheets. It may seem surprising to bend sheet metal against the direction of its stiffness, but it is now technically possible and it also makes sense in that it simplifies the structure. The lesson is: To be able to design with details of this sort, we have to be in touch with industry as much as possible, to find out what the new technologies are and what one can do with them—particularly if the associated costs can come right down.

APPLYING THE OPEN SYSTEM PRINCIPLES

One of my most recent projects is a skywalk built for the Expo 2000 and the Hanover fair. This connector way links the station to the Expo. It is 340 meters long and it had to be built very fast. We designed the skywalk so that a crane could lift long sections into place—pre-manufactured in the factory and assembled at the site near to the final location.

All parts were designed on the computer, with working drawings (also on the computer) fed directly into the production process. All the jointing pieces were made in the factory for easy bolting on site, since there was to be no welding on site.The escalators were shipped in as one piece, and elevators prepared fully in the factory ,but actually assembled on site.The glazing was curved sheets, twice 2m x 25 high by 2m x 25 wide, the mullions were only 5cm x 4cm so that the bent glass is effectively taking up the wind and snow loads. As one might expect, this was not allowed by the codes, so we had to build a mockup in the factory and show that the glazing system can bear the required loads, including being able to stay in place after breakage. The glass was actually very strong, being two sheets of 6mm, providing a very thin and flexible laminated glass. This particular innovation only became possible through collaborating with manufacturers who have the knowledge and the facilities to take a design right through to testing.

This skywalk was a cheap building, but people do not realize how simple the building really is. Nor can they know how much of the design was determined through the production process, by working closely with the manufacturers.