

A Paper on Architecture and Engineering

Carlos Ferrater Lambarri, with the collaboration of Alberto Peñín

I'm well aware of the dissociation that has occurred in recent years between architects and engineers.

That's why, in collaboration with Alberto Peñín, I decided to prepare this keynote lecture to emphasize the fruitful relationship that's existed between engineers and architects throughout modern history, and which has entailed the greatest technological and constructional revolution of all time. I think history has adequately demonstrated that this collaboration has been possible, in so doing giving the lie to the alleged counter-position between architects and engineers.

Engineering and Architecture

"Design is the work of many individuals; the myth which has it that technology is the result of a predetermined logic is not true. Rather, it is the outcome of a complex process in which a great deal of information is analyzed, in order to finally be able to choose. What is most important are the individuals and their talent." This is how, in his book *An Engineer Imagines*, Irish engineer Peter Rice described the process of building the Pompidou Centre, which he worked on with the architects who came up with the design, the industrialists who participated in the process, the companies that made it happen, and even a member of the competition jury, like the famous builder Jean Prouvé.

This collective procedure is not about a particular way of doing things—rather it describes the only way of dealing with the act of building since the mid-twentieth century. Its complexity in technological, constructional, instrumental, and content terms explains why the act of building is no longer considered an individual act.

In *Theory and Design in the First Machine Age*, the historian and critic Reyner Banham studied the capacity of the Modern Movement to harness the attributes of new technologies by opting for the standard model and by understanding technique as an operative tool rather than a creative discipline.

In the field of structures new figures appeared, figures we might call designer engineers. Most visible among them was Pier Luigi Nervi, with his ribbed structures, heir to Freyssinet's research into prestressed concrete in 1928, who created the Palazzo del Lavoro in Turin in 1961, or Riccardo Morandi, probably the first deconstructive engineer, with his underground hall in Valentino Park, constructed in Turin in 1960, or Félix Candela with his slim concrete membranes that reproduce ruled geometries, and who gave us a significant text, *Towards a Philosophy of Structures*, or Eladio Dieste with his vaults of ceramic units that Guastavino made into patents that are still in force today. Neither can we forget the contribution of Eduardo Torroja, who turned building in concrete into a more sophisticated activity, and as well as the famous problem of yield in the Frontón de Recoletos has left us such texts as *The Reason and Being of Structural Types*. Torroja claimed that with the imagination alone one cannot construct a great building, since reason is required, in the same way that it is not possible to arrive at logic and determinism via a deductive process, thus announcing the

necessary convergence between two contributions that have to be complementary and which would lead us to analyze cases of mutual influence between architects and engineers. We could cite Le Ricolais, whose researches into natural structures were such an influence on Le Corbusier, who was also fascinated by Eiffel's Garabit Viaduct from the end of the nineteenth century, or the interaction between Walter Gropius and Konrad Wachsmann when it came to prefabricating houses that were buildable in seven days, or the engineer Fazlur Khan, who at the age of 60 planned rigid roofs hanging from curved cables up to 304 meters in span, who in 1977 constructed the extraordinary airport in Jeddah, consisting of fabrics tensioned by cables, and who designed a bi-tubular structure for high-rise buildings used by SOM in umpteen buildings.

In *The Architecture of the Engineer* Carlos Fernández Casado pointed to a freedom from the obsession with calculus due to new mathematical methods and the progressive use of computers. The "liberated" engineer, he argued, would be able to establish common areas with architecture so as to arrive at a more efficient collaboration and to relaunch the essence of the profession by opening the field of experiment up to processes that intervened during the process of building work.

Javier Manterola, currently head of the Carlos Fernández Casado studio, indicated a more pragmatic position to us. After a period of collaborating with architects like Javier Saenz de Oiza, Rafael Moneo, and Vazquez Molezún, he turned his interest towards his own discipline, especially towards bridges, "those that defeat the devil." Bridges that he admired, like the Forth Bridge in Scotland, which weds technical prowess to the transformation of the location, and which would give us an opportunity to indicate cases of a fruitful relationship between engineers and architects, such as the 2004 Millau Viaduct by Michel Virlogeux and Norman Foster. And as the finest of Louis Kahn's buildings cannot be understood without the contributions of engineer August Komendant. Buildings like the Phillips Exeter Library in 1972 or the Kimbell Art Museum, among others, in which Komendant conceived the structural system of transverse cycloid arches that facilitated the entrance of overhead light in the longitudinal axis of the false dome, enabling him to construct one of the most beautiful buildings of the twentieth century.

It would have been impossible to implement the challenges of Louis Sullivan in the 1889 Auditorium Building in Chicago, in its day was the tallest building in the world, without the crucial collaboration of Dankmar Adler, in its structural as well as acoustic aspects. The buildings created in collaboration by architects and engineers that have become masterworks in the annals of the twentieth century are legion.

In his writings, few in number but intense, Arup dismantles the myth that creativity is an individual issue. His membership of the AA (Architectural Association) in the 1950s led to his first collaborations with highly creative but currently very underused architecture studios like Aldo van Eyck, the Summersons, the Smithsons, and the Tecton studio of Berthold Lubetkin, with which he constructed the extraordinary penguin pool at London Zoo in 1934. With Lubetkin Arup shared a belief that the Modern Movement took structural expression to be intrinsically virtuous and esthetically superior, while for them the challenge consisted in transcending the structural criterion and allying it with social considerations. And from this approach was born Arup's faith in architecture, on considering it unnecessary to force calculations to an exactitude that exceeds the tolerable.

As Kenneth Frampton announced, it is true that aside from some small or lackluster assignments the architect will have very few opportunities to exercise control over any undertaking, since this will depend more on the coordinating capacity of computers, and it will be the skill of the engineers and the architects that establishes the tolerance levels of the construction processes.

We will illustrate this with an episode from history. When Jørn Utzon assumed that the spherical solution for the false domes of the Sydney Opera House was a success, it was also the years of work of the then young engineer Peter Rice that got the architect out of the predicament he'd been in following the competition. Well, years later the same Peter Rice, now a mature and experienced engineer, managed, in the words of Renzo Piano, once the risky and programmatically provocative, urban gamble of the Pompidou Center had been surmounted, to implement a constructional solution. The introduction, in the purest Parisian tradition, of cast iron triggered a series of decisions, from the choice of systems like the *gerberette* system, which the German engineer Gerber had used in the nineteenth century in a bridge, to the materialization of the schemes of Archigram in the prelude to High-Tech. Peter Rice would also surprise us years later with the structural solution of Kansai Airport in 1994, also by the architect Renzo Piano. Thus we can see how some of the most iconic buildings of the twentieth century are due to the combination of architects and, in this case, a single engineer.

But let's press on with our tale. Agustín Obiol, an architect specializing in the calculation of structures, following the tradition of this city, tells us that it is basically with the appearance of computer applications of the method of finite elements and of numerical analysis that the first quantum leap is produced in the scenario we have described.

As of now, one of the engineers who has given most thought to these matters is Cecil Balmond, who trained in England and is the regular collaborator of architects like Rem Koolhaas, Toyo Ito, and Álvaro Siza. Balmond, the author of books like *Informal* and *Element*, one of the people in charge of Arup in its most recent phase, was of the opinion that only by uniting architecture and engineering was it possible to face up to the challenges of designing and contemporary construction.

As for the structural concept, in *Informal* Cecil Balmond is at pains to define the theoretical parameters of a new structural process in which the object tends to disappear, boundaries are blurred, and where there is no hierarchy but instead interdependency when dealing with the geometry of complexity.

To end, we shall consider what the attitude and the framework for conjugating a fruitful relationship between the two disciplines ought to be. As far as attitude is concerned, we might underline the fact that it has been experimentation that has fostered and invigorated the collaboration between engineers and architects, a collaboration that was probably born in the Beaux-Arts "ateliers" of Paris at the end of the nineteenth century, and which carried over into the Bauhaus spirit, which consolidated the concept of collective creation and which was also postulated in the Weimar school via Walter Gropius, who wrote *The Scope of Total Architecture*, which connects with engineer Ove

Arup's highest aspiration, when emphasizing the fact that integration, coordination, and conclusion will be the basis of construction, understood as a collective phenomenon in the new society.

And I end as I began, by highlighting the collective nature of the act of building, which aside from being a specialists' labor of synthesis, has architects and engineers sharing the same intellectual substratum in their interventions.

Images of the paper:

<https://www.dropbox.com/s/7nwjbo7gaoq8bxx/2016-05-30%20CONGR%C3%89S%20ARQ%202016.pptx?dl=0>