



Square Wheels or Round?

Professional Relationships in Transition

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Architects are creative, but egotistical, flaky, and self-promoting. Engineers are thorough, but inflexible, stubborn, and socially awkward. Do these stereotypes that architects and engineers have of one another accurately represent the two professional cultures, which are viewed from the outside as highly collaborative? To a certain degree, they do.

I have wrestled with this question for a long time, since I am both an architect and an engineer. My opinion was first formed over thirty years ago, when I taught structures to architects at the University of Pennsylvania. Every term the class grades fit the bell curve perfectly—at one end of the continuum, a few students had no engineering aptitude or interest whatsoever, and at the other end a small number had a firm grasp of engineering concepts as well as an avid interest. All had the potential of becoming excellent architects.

One student was exceptionally curious about how engineering principles affected architectural form, investigating this issue by interviewing the structural engineers who were consultants for the most famous New York architects at that time. He was disappointed to learn that this question was of little interest to them. They were unanimous in their view that the role of the engineer was to serve the architect. I have come to believe that views on engineering (and engineers) vary widely among architects, while views on architecture (and architects) are rather narrow among engineers.

This variation in viewpoint can perhaps explain why, in some cases, architects and engineers collectively produce work that clearly shows how their disciplines have informed each other. It can also explain the frustration and bitterness some architects have toward engineers and vice versa. Have these dynamics existed historically, and will they persist into the future?

In the past, the measure of good architecture was taken as a mixture of “commodity, firmness and delight”; engineering principles (firmness) significantly influenced built form. The parabolic arch and flying buttress were based on engineering principles discovered by trial and

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error, which led to daring forms in Gothic times. The development of steel technology and vertical transportation allowed tall buildings to be built. Notwithstanding their stereotypical characteristics, architects and engineers depended on each other to produce excellent work. Innovations in firmness led to delight.

Firmness, however, is no longer a precedent for delight. Louis Kahn once said something to the effect that a sculptor may sculpt square wheels on a cannon to express the futility of war, but an architect must use round wheels. Architects are not particularly interested in round wheels today. Gravity-defying shapes are appearing all over the world. Commodity, too, has in some cases been decoupled from delight, resulting in a function-free, often provocative architectural vocabulary. The reason these decouplings are possible is another engineering innovation: the computer. It is now possible to model mathematically just about any shape an architect can imagine. The limits of the architect's imagination itself are being advanced with the help of the computer, too.

Engineering is still serving architecture, but the collaboration is a bit different. As long as the architect has left enough *poché* for the

engineer's structure, ductwork, pipes, and wires to inhabit, technical constraints no longer exist. Buildings thought impossible ten years ago are now safely built.

The force of gravity is, however, the same now as it was in Gothic times, and the principles of engineering to resist gravity, wind, and earthquakes are *a priori* truths. The ingenuity of the engineer, still serving architecture, is now used to create amazing yet inefficient buildings that not everyone can afford. Only "starchitects" are able to do aesthetically innovative architecture, while the journeyman architect is subject to value engineering as cost control becomes more difficult in the face of rising material and labor costs. Can this trend possibly persist?

In some parts of the world, yes. The gap between rich and poor will likely continue to grow, and the wealthy will continue to consume conspicuously. Competition for the tallest and most highly differentiated buildings will provide demand for architects to dream up structures of pure delight. Engineers will continue to serve architecture and will help figure out how to build these stimulating edifices.

Elsewhere, the now almost mainstream

desire for sustainable architecture may recouple both firmness and commodity with delight, demanding more interdependence between architect and engineer. Sustainable design gives a new meaning to "less is more," and a truly sustainable design will need input from various perspectives to succeed. Professional stereotypes need not change, but the future may lead to a paradigm shift concerning how buildings are designed. In fact, one could argue that architects need to maintain their traditional role as purveyors of delight, since early attempts at integrated, sustainable design seemed to completely sacrifice delight for commodity and firmness. Solar paneled roofs "need not look like castoffs from the space program," as William McDonough pointed out in *Cradle to Cradle*.

One scenario is a shift to a highly collaborative process led by the architect, with input from various engineers at the inception of the basic design concept. Many design firms employ a process like this already, but I would speculate that few are architectural design practices. Although large A/E companies employ both architects and engineers, true integration of talent is probably rare, in

part due to the variation in viewpoints architects have of engineers and *vice versa*.

Another scenario could develop for economic reasons. Almost every man-made object we encounter daily is mass-produced, with one notable exception: buildings, especially large buildings. Although a building is an assemblage of many prefabricated components, each building is unique, lacking the refinements that make airplanes or cars, for example, more efficiently produced as lessons are learned from a prototype. Like cars and airplanes, beautiful buildings could be created that are much more sustainable than buildings we currently construct, and they could cost less, too. In this scenario, the roles of the architect and the engineer would certainly change. Production and fabrication engineering, for example, would wield a large influence on formal expression, traditionally the architect's purview.

Mass production of large buildings would be objectionable to many, of course, and could lead to a more banal visual environment than anyone could tolerate. In fact, it has already happened. Eight of the twenty-five tallest buildings in Sao Paulo are identical, built over a span

of a few years, and are clearly the product of building economics alone (you can see illustrations of these buildings at skyscraperpage.com).

Yet another possibility is an almost complete decoupling of architecture and engineering. Future buildings may be simple structural armatures with dynamic skins of programmable LED's powered by sustainable energy sources, a logical extrapolation of what can be seen today in Times Square and many Asian cities. Delight provided by these buildings will constantly change based on the imagination of the future architect/programmer, almost completely freed from the constraints of traditional engineering.

This last scenario may be a bit too futuristic, but I believe that some form of paradigm shift in design is likely in the not too distant future. I believe it will be driven by mandates for sustainable buildings and will cause architects and engineers to be more collaborative. Architects will and should continue to lead the charge, but not in the traditional manner we now accept as standard practice. Architects will need to accept new constraints, and engineers will need to define these constraints with wide margins, so that they can be inte-

grated into a design that is both physically and aesthetically sustainable.

Closer collaboration should not be difficult. I have found the close collaboration between architecture and engineering to be quite natural, since I inhabit both worlds. I am, however, occasionally asked how I reconcile the differences between these disciplines in my own mind. This question comes from architect or engineer colleagues (mostly architects), and I have found it puzzling. I have never been asked this question by clients or professionals in other fields.

If demand for sustainable buildings enters the mainstream, new building forms will need to respond to new engineering constraints. Despite the professional stereotypes that will never change, collaboration between designers and engineers will become the norm as it already exists in other allied fields. The architect will once again return to using round wheels. ●