Structural Art

By Jon A. Schmidt, P.E., SECB

In the September 2008 issue ("Philosophy and Engineering"), I noted that some definitions of engineering characterize it as an art, rather than a science. Reader responses that affirmed this view led me to reacquaint myself with a book that I purchased at the Smithsonian Institution during my student days at The George Washington University in Washington, DC – *The Tower and the Bridge: The New Art of Structural Engineering*, by David P. Billington (Princeton University Press, 1983).

As the subtitle indicates, Billington certainly subscribes to the idea that structural engineering is – or at least can be – an artistic endeavor. He begins by outlining what he sees as the three leading ideals of structural art:

- Efficiency: the scientific dimension – minimizing material while still ensuring safety.
- Economy: the social dimension – minimizing costs so that the project can go forward.
- Elegance: the symbolic dimension – maximizing aesthetic expression.

Billington suggests that there are three types of designers who work with forms in space: engineers, architects, and sculptors. All must address the same three dimensions, but the priorities of each are different. For the engineer, the scientific dimension takes precedent – the structure must not fall down – but the other two are still relevant. What distinguishes structural art from architectural art is whether the constructed form primarily reflects structural considerations (controlling the forces of nature) or architectural considerations (defining the spaces to be used by people). The prototypical examples of each are public bridges and private houses, respectively.

The bulk of the book provides an historical overview of structural art. Examples that Billington discusses, which he deems to qualify for this distinction to varying degrees, include:

- Iron bridges by Thomas Telford, Robert Stephenson, and Isambard Kingdom Brunel.
- Steel bridges by James Eads, Gustav Lindenthal, and Othmar Amman.
- Reinforced and prestressed concrete bridges and shells by Robert Maillart, Pier Luigi Nervi, Felix Candela, Eugene Freyssinet, Heinz Isler, and Christian Menn.
- Skyscrapers by William Jenney, John Root, Louis Sullivan, and Fazlur Khan.

The central case studies that provide the book's main title are two structures that both came into being at the key moment of industry transition from iron and masonry to steel and concrete: the Eiffel Tower and the Brooklyn Bridge. Gustave Eiffel and John Roebling were quite conscious of the importance of aesthetics; in fact, they wrote on the subject at some length. These projects epitomize what Billington identifies as the three principles of structural art: function follows form (not the other way around), economy stimulates creativity, and a single designer's personality is central to the completed work.

This is not to say that structural artists never rely on anyone else in the process of creating their masterpieces. In fact, there is some controversy over whether an employee of Eiffel, Maurice Koechlin, was the Paris spire's true designer; and of course it was Roebling's son Washington who, assisted by his wife Emily, actually supervised the construction of the East River span. Billington's contention is that subordinates can (and often do) take the leader's conceptual ideas and work out all of the details, but the primary credit properly belongs to the one whose vision and personality made the project a reality.

Here we see a division of labor between the inductive and deductive aspects of engineering practice. Engineers are often characterized as problem solvers, but we are also problem definers – we must first determine the configuration of elements before any calculations can begin. Analysis then proceeds to demonstrate that the final design satisfies all identified strength, stability, and serviceability requirements. As it turns out, great structural artists usually base their initial arrangements on an almost innate sense of proper form, honed by previous experience.

Billington obviously focuses on prominent examples of structural art, and few of us will have the opportunity to contribute something of that caliber during the course of our careers. At first, I found this realization to be mildly disappointing. However, the book closes by noting that structural artistry has much in common with play – you have to follow the rules and get along with others, but can do so in a way that ultimately results in surprise and joy. With this in mind, all structural engineers should strive for efficiency, economy, and elegance in our designs, which will ultimately benefit the profession, our clients, and society as a whole.▪

Your Turn

Do you agree or disagree with Billington's criteria for structural art? What are some of your favorite examples of structural art? Whom do you see as the top structural artists practicing today? Submit your responses by clicking on the 'Your Turn' button at **www.STRUCTUREmag.org**.

Further Reading

*David P. Billington was the subject of a "Great Achievements" article by Richard G. Weingardt in the September 2006 issue of STRUCTURE® magazine, which is available in the archives at **www.STRUCTUREmag.org**.*

The Executive Committee of the SEI Business and Professional Activities Division is considering the establishment of a new Philosophy Committee. An informal kickoff meeting will take place on Wednesday, April 29 from 6:30 to 8:00 PM at the Structures Congress, in the Bosque Room of the Renaissance Austin Hotel in Austin, Texas. All are welcome! For more please contact the author at ***jschmid@burnsmcd.com***.

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