

## Exploring the Ideals and Character of Structural Art

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### Abstract

*The Tower and the Bridge* [1] and other publications by David Billington have long informed and inspired the author and others who share Billington's passionate interest in the aesthetics of structures. The book describes "structural art" as the product of three ideas: efficiency (or minimum materials), economy (or construction simplicity, ease of maintenance, and integrated form), and the search for engineering elegance (shown by contrast and affinity with the structure's context.)

Aesthetic judgments are by their nature subjective and personal, and the author presents his own thesis regarding the ideals and character of structural beauty. The paper explores structures in nature such as egg shells, trees, and the musculoskeletal system of the human body as models for understanding both structural behavior and why we find certain engineered structures beautiful.

Using the competitive high jumper as a metaphor, the author demonstrates that high-performance athletes and high-performance structures share two characteristics: strength and efficiency. The requirement for strength sufficient to support design loads is common to all structures. High performance requires that this strength be provided efficiently, though, a virtue which is demonstrated through the minimal use of materials. By optimizing form and employing prestressing and other strategies, the performance of a structure is made efficient, and then has the potential to attain the grace seen in the best of both athletes and structures. In the same manner that we thrill to the edgy performance of an elite high jumper, the pleasure we take in viewing a high-performance structure often lies in the audacity with which a difficult goal of height or span is achieved using a minimum of material.

Economy of material use has obvious economic value, but is also the source of "leanness". The bare-boned absence of superfluous mass in a lean structure (or athlete) is a key element of its beauty. A necessary corollary to leanness is the quality of transparency. As the jumper's form cannot be appreciated if he competes while wearing a bathrobe, structural beauty requires that non-structural elements (such as facades or ductwork in buildings or railings and lighting on bridges) not obscure the clear expression of the lean and efficient form of the structure itself.

Billington wrote convincingly about the subjective nature of the aesthetic choices that underlie structural beauty. Paradoxically, when a subjectively chosen structural concept is refined through mathematical analysis and engineering judgment to create a beautiful final design, a radical and unique design may come to appear the obvious and predestined solution to its load-bearing problem. This quality can be recognized by those with no technical understanding of the structure's behavior. As the architectural critic Ada Louise Huxtable wrote of the work of Pier Luigi Nervi, "it is possible even for the laymen to feel the inevitable, correct relationship of structure to shape" [2].

### References

- [1] D.P. Billington, *The Tower and the Bridge*, Basic Books, 1983.
- [2] A.L. Huxtable, *Pier Luigi Nervi*, George Brazillier, 1960, pp. 9, 10.