

The art of collaborative structural design: Structural art in the age of cross-disciplinary collaboration

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Abstract

Billington's concept of *structural art* [1] established structural engineering as a discipline with the potential for higher forms of achievement, transcending the mere routine accomplishment of tasks. To distinguish engineering art from other works of engineering, Billington [1] defined three primary criteria: efficiency, economy and elegance. Simultaneously, however, he also explicitly discarded collaborative design between structural engineers and architects as potentially resulting in structural artworks: "Almost without exception it seems that the best works of structural art would have been compromised had there been architectural collaboration in the design of the forms" [1, p. xvi]. Yet, many structural artists have extended histories of collaborating with architects, as outlined by Rappaport [2]. Structural art has also been identified in works of architecture, where engineering ingenuity in response to and in conjunction with architectural design intentions created works of exceptional coherence and innovation [3].

This paper questions the narrow understanding of the concept of structural art as restricted to works accomplished solely by structural engineers in the age of increasingly collaborative design processes and argues that it can be employed to describe and guide works of collaborative structural design. The paper examines several cases well documented in existing literature and traces in what ways works of collaborative structural art can extend and enrich an engineering-centric definition of structural art. From this analysis, architectural aspects of structural art are identified and described in more detail, such as the skillful definition of boundary conditions and a refined understanding of the aspect of engineering art described as aesthetics or elegance. From an architectural viewpoint, the preoccupation with elegance understood as beautiful shape, for example, seems too narrow: in architectural design, aesthetics or elegance are typically considered as subjective and difficult to determine and are thus rarely used as explicit guiding principles. Instead, design values that architecture may contribute to structural art are coherence (related to the concept of conceptual clarity proposed by Hines for structural engineering) and a focus on human experience.

The paper aims to further develop the discourse started by Billington's work, continuing and developing it for the changing contexts, design processes, toolsets and workflows the profession(s) face in the 21st century. Drawing on existing literature, the paper further emphasises the relevance of education in establishing design values allowing exchanges across disciplinary boundaries and discusses experiences made over several years of promoting shared values in cross-disciplinary structural design education.

References

- [1] D. Billington, *Tower and the Bridge: The New Art of Structural Engineering*, Basic Books, 1983.
- [2] N. Rappaport, *Support and Resist: Structural Engineers and Design Innovation*, The Monacelli Press, 2007.
- [3] G. Nuñez-Collado, J. Garzon-Roca, I. Paya-Zaforteza and J. M. Adam, "The San Nicolas Church in Gandia (Spain) or how Eduardo Torroja devised a new, innovative and sustainable structural system for long-span roofs", *Engineering Structures*, vol. 56, pp. 1893–1904, 2013.