

Biomimetics and topology optimization in architectural teachings: case studies

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Abstract

Topology optimization is a useful design tool for structural engineers [1], while at the same time it is a descriptive design tool for architects: it is the merging of objective design development and descriptive design results, bringing together the disciplines of architecture and engineering. Given the optimization of structural geometries, the link to biomimetically inspired structures is obvious, since nature produces optimized structural geometries, with the process of development being subject to studies of modern optimization tools [2]. Studies of topology optimization often produce design results with an organic impression, such as grid shell geometries [3] or branched structures [4], [5].

This paper relates to a previous publication at the IASS conference 2015 [6], where studies have been categorized according to classical elements of structural engineering. In this study, the geometries are categorized by objects found in nature, and relating them to elements of structural design by carrying out studies of topology optimization. The process previously dominated by the categorization of elements of structural design is now dominated by geometries, re-designing elements of natural structure and relating them to form and forces [7].

The studies take off with the analysis of the geometries of natural structures, such as sponges, diatoms, corals, mussels, nut shells or sea urchins. In a second step, the geometries are "re-designed" using methods of topology optimization, with the aim of understanding their load bearing behaviour. Finally, the relation to classical structural theory is driven by connecting geometrical elements to structural elements. The aim of the study is a holistic approach of understanding of structural behaviour through studies of natural structures using modern design technologies.

References

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