A form finding issue in parametric modeling

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Abstract

This paper focuses on the development of form finding as a part of a parametric designing toolkit, which aims to make the designing process much more efficient. A special interest is placed on the form finding methods, which have been developed since 1960. In the current paper are several existing approaches compared and evaluated. Well-known methods such as the force density method, dynamic relaxation, thrust network analysis and more resent ones , like genetic algorithm approach are presented and compared on the simple 2D example and 3D shell. Both the mathematical structures as well as the physical basis of the suggested methods are shown. Finally, it is shown how each method approaches the initial equilibrium problem for different boundary conditions and how those methods can be adopted in parametric modelling framework.

Keywords: form finding, parametric modelling, force density method, dynamic relaxation, thrust network analysis, genetic algorithms, branch node matrix

1 Introduction

Free form in last two decades has become one of the most popular architectural designing approaches. One major reason is the development of parametric CAD software, which allows for creating very sophisticated, sculptural forms. Such top architects like N. Foster and Z. Hadid are still breaking new limits in evaluating shapes that result from employing parametric designing. There also exist several types of structures that have benefitted greatly in their designed from the form finding. Structures like kinematic gridshells or thin concrete shells require from engineers not only great knowledge in the field of structural engineering, but also taking part in conceptual phase of designing. The problem in the intimal design step is the lack of specific information about load, boundary conditions and most important the topology. Equally, one crucial determinant obtained in the feasibility analysis is time.

Theoretical foundations of form finding methods have been developed since 1960 and its definition is strongly connected to shells, gridshells and membranes. The principle is to transfer load to the supports purely through axial or in-plane forces. The S.Adriaenssens et al. [1][2] provide great comparison of existing methods for shell form finding. Beghini et al.[3] consider structural topology optimization approach as a tool for exploring architecture. Their notion is that this framework can eliminate the question of whether form follows function or vice versa.

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