Computer-aided design optimisation and process simulation

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Objectives
This project focusses on design in the built environment, with the expectation that after specifications the developed method also aids other design disciplines. The enormous consumption of energy and materials has to be halted by highly optimised artefacts, and this can only be achieved if both the designs itself and the design process are taken into account. This project aims to obtain these optimised designs by considering three scientific challenges: (a) providing a workflow tool to assist the design process from an operational point of view; (b) showing which approaches are promising to provide optimised designs; (c) showing via the verification phase how to create a fruitful environment so designers appreciate the assistance without being enforced to use certain designs.

Methodology
Problem (a) will be approached by regarding a design process as co-evolutionary [1]. For problem (b) and (c) existing scientific workflow tools will be extended by a database, which contains (partly) optimised "spatial-structural design" sets. This database will provide designers, besides their own creations, alternative optimised designs. A toolbox exist to cyclically transform and modify a spatial design into a structural design and vice versa, which provides optimised designs and supports the design process. An example of its outcome is shown in figure 1.

Co-evolutionary building design process:

A1 → Structural engineer → S1 → Architect → A2 → Structural engineer → S2 → Architect → A3 → … → S_n → A_n

Computer-aided design optimisation and support:

A1 → Toolbox grammar → S1 → Structural engineer → S2 → Database/Machine learning → S3 → Find the most similar spatial design A_i to A_1, then adjust S_3 in the database to make it fit to A_1 → S_4 → A_1

Future work
(a) The proposed database will be implemented in the toolbox, and machine learning will be developed to find similar designs and fit the accompanying designs to the designs under investigation. (b) The resulting toolbox will be studied as shown in figure 2 via case studies in student design studios.

References