Computer-aided design optimisation and process simulation

Computer-Aided Design Optimisation and Process Simulation

Y. Liu, H. Hofmeyer, B. de Vries

Eindhoven University of Technology
Department of the Built Environment

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.

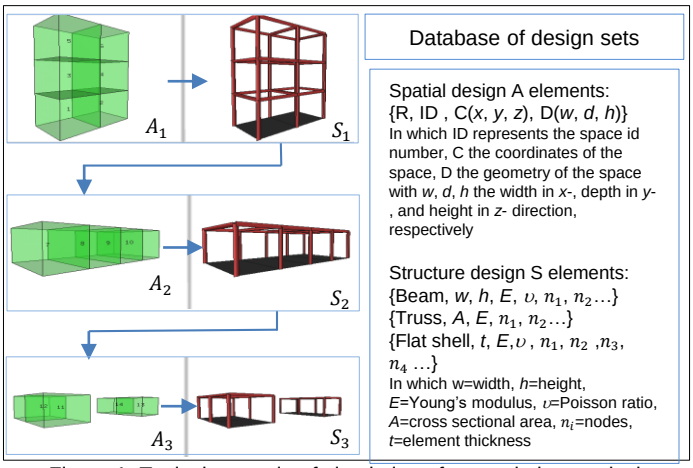

Figure 1: Typical example of simulation of co-evolutionary design

This project extends the toolbox by a database which contains partly optimised "spatial design (A_n) - structural design (S_n)"-sets. On one hand the database will be built and maintained (1) by running the toolbox and storing its outcomes; (2) by letting designers construct good sets (themselves or via working with the toolbox); (3) by "machine learning" from existing sets within the database. On the other hand the database will be supportive to the toolbox by providing an alternative technique for the transformations and optimisations.

To illustrate this, an overview of the workflow tool which enables computer-aided design optimisation and process simulation is shown in figure 2.

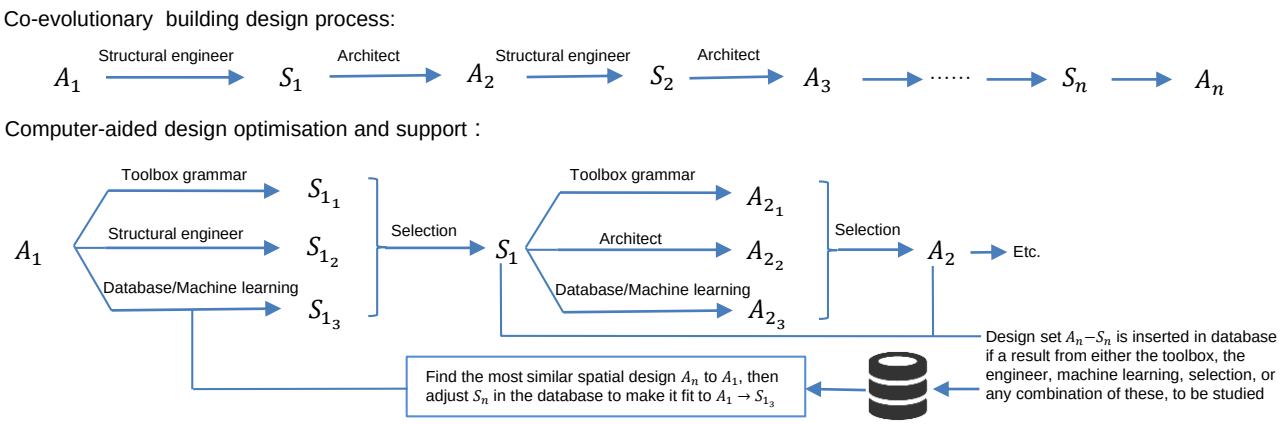

Figure 2: Computer-aided design optimisation and process simulation

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

[1] Hofmeyer, H.; Davila Delgado, J.M., 2015. Co-evolutionary and Genetic Algorithm Based Building Spatial and Structural Design, AIEDAM - Artificial Intelligence for Engineering Design, Analysis and Manufacturing 29, 351-370.