Theme 11–Philosophy of engineering and design

Do generative design systems may create architecture?
Assessing architectural design computer tools

Sara Eloy, Assistant Professor, ISCTE-IUL/ADETTI-IUL, Department of Architecture and Urbanism sara.eloy@iscte.pt

Pieter Vermaas, Senior Researcher, TU Delft, Department of Philosophy, p.e.vermaas@tudelft.nl

The aim of the proposed paper is to focus the role of recent technology, namely computer aided generative design, in the process of architectural design. From the outset, the research investigated the possibility of using some sort of expert systems, also known as knowledge-base systems, to solve design problems.

New developments in design processes aided by computers use generative systems to design more efficient, customized and adaptable design solutions for given contexts. In expert systems, knowledge, represented within a particular area of application, plays a decisive role in the ability to solve problems.

When an expert system and a designer expert are exposed to the same data, the performance of the former should be similar to that of the latter. Generative design system aims at embodying design knowledge in procedures expressable in computational algorithms or computer programs. The computerized automation of architectural design generation may reach solutions faster using a more efficient and accurate process, since the computer can manage massive amounts of data.

In a previous research a generative design system based on shape grammars was developed to enable the generation of housing solutions for a given context (omitted for blind review). Shape grammars are *"algorithmic systems for creating and understanding designs directly through computations with shapes, rather than indirectly through computations with text or symbols."* (Knight 2000) A shape grammar is a set of rules that apply step-by-step to shapes to generate a language of designs. Shape grammars are generative because they can be used to create new designs in the language and descriptive because they provide for ways of explaining the formal structure of the designs that are generated.

The developed system generates house layouts which are "legal" because they are in the design language and "adequate" because they satisfy the *a priori* set of design requirements. (Duarte 2001) This means that the generative system covers possible designs that real architects would arrive at without the system.

Although vast, the knowledge itself of an expert system is limited to the data entered into the knowledge database. According to Schon (1992), computers or algorithms rules see in a literal way and designers see in a judgmental way. The amount of variables required to incorporate the substance and the knowledge of an architect in any given case of design is, as it seems, uncountable. The possibility of incorporating the "judgmental way" in computers is under study. Matters such as space functionality, load bearing structure, aesthetic, fire safety, energy efficiency, are just a small part of the variables that architects have to deal with in a design problem. Since these criterions are necessary to the design process, their use allows judging the accuracy and efficiency of the generative design system.

In the mentioned design grammar the definition of conditions that are part of the shape rules was done to translate in a wider way the architect's goals. The major challenge was to identify the architect's design goals and to capture it into computational criteria.

In this context we could ask if these systems really reproduce architectural designs or if they eventually do it better than real architects since humans have limited knowledge unlike computers.

And simultaneously, we could ask where and when is the use of this tool of design profit to the goals of one architectural project?

Although design processes can be executed on an individual case basis for each particular client/problem, defining processes and rules to support the design allows a more effective answer, clarifies decision-making and speeds up the design process.

In the case e.g. of a mass housing design the use of a generative system would be cost-effective and it would generate adequate customized solutions. In this case the design system would be a social and commercially successful tool for designing houses in a more quick and cheap way, even though it would not generate the layouts that an individual more "artistic" architect would do.

To assess the potentials of using a generative system, as a shape grammar, to enable the design of the most accurate solution for a given problem, we propose to put designers "into the mode of doing" as Schon suggests (1992: 131). Previous experiments (omitted for blind review) proved that "designers know more than they can say, [and] tend to give inaccurate descriptions of what they know" (Schon 1992: 131). Observing designers in action may give some clues on how they access their knowledge in action.

References

Davis, Howard (2008): Form and Process in the Transformation of the Architect's Role in Society. In Vermaas, P.; Kroes, P.; Light, A.; Moore, S.A. (editors). Philosophy and Design. From Enginering to Architecture. Springer. pp.273-285.

Duarte, José Pinto (2001): Customizing Mass Housing: A Discursive Grammar for Siza´s Malagueira houses. Thesis submitted to the Department of Architecture in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy in Design and Computation. Massachusetts Institute of Technology, Cambridge, E.U.A.

Knight, Terry (2000): Shape Grammars in education and practice: history and prospects. [online]. Massachusetts: MIT, 14 September 2000. Available at WWW: <URL http://web.mit.edu/tknight/www/IJDC/> (accessed on 2009-03-21).

Freeman-Hargis, James (2003): Rule-Based Systems and Identification Trees. [online]: AI depot. Available at WWW <URL: http://ai-depot.com/Tutorial/RuleBased.html> (accessed on 2009-03-16)

Kroes, P.; Light, A.; Moore, S.A.; Vermaas, P. (2008). Design in Engineering and Architecture: Towards an Integrated Philosophical Understanding. In Vermaas, P.; Kroes, P.; Light, A.; Moore, S.A. (editors). Philosophy and Design. From Enginering to Architecture. Springer. pp.1-17.

Schon, Donald (1992) "Designing as Reflective Conversation with the Materials of a Design Situation" in Research in Engineering Design, vol. 3, pp 131-147