

Architectural Exploration and Creativity using Intelligent Design Agents

Rabee M. Reffat

Key Centre of Design Computing and Cognition

Faculty of Architecture,

University of Sydney, NSW 2006, Australia

Email: rabee@arch.usyd.edu.au

Abstract: Architects and designers are normally interested in situations where differences make a difference. This paper presents the results of the developed system of intelligent design agents that supports design exploration and creativity within the domain of architectural shapes. Creativity in architectural design compositions can be viewed as an emergence of new forms and shapes or relationships between forms and shapes from which new concepts can be discovered.

1. Introduction

Architects and designers are normally interested in situations where differences make a difference. Faced with a set of alternative possibilities, designers seek those which are in some sense, “different” than others. Hence, it is useful to develop computer tools and methods to support conceptual designing. Conceptual design provides abstract, sometimes incomplete solutions. The intention of conceptual design to explore the best alternatives comes from the desire of inquiry. The output of conceptual design is one or more new design concepts that can be used as a basis for embodiment and detail design. Since it more or less determines the achievable technical merit of the design and its encountered costs, this early phase of design is the most crucial part of the whole design process.

Creativity and exploration are of paramount importance at the conceptual design stage. Conceptualisation progresses through the contextual domains driven by an internal logic, depending on the application field. For instance, composition and shape concept generation pre-

cedes the other activities in architectural and industrial design, while mechanical conceptualisation typically gives priority to functional concept generation (Horvath, 2000). In architecture, the design composition (as a drawn model) represents a description in advance and the most widely used language for this description is geometry.

Creativity in architectural design compositions can be viewed as an emergence of new forms and shapes or relationships between forms and shapes from which new concepts can be discovered. New concepts are discovered as novel organisations of the known. The desire for discovery is what helps to convert old ideas into new. This paper addresses the role of computers as active design exploration tools using intelligent design agents to assist in exploring and discovering new design concepts. Design concepts are composed of rich sets of categorised abstractions of the mutual relationships between observations and actions. New concepts emerge out of the interaction of old concepts and new situations in relation to the focus.

2. Design Creativity using Intelligent Agents

Intelligent design agents possess the following properties: autonomy, reactivity and proactiveness whereby they do not simply act in response to their environment, they are able to exhibit goal-directed behaviour by taking the initiative. For intelligent design agents to be capable of exploring and discovering new concepts they need to be mode shifters and adroit in any situation they encounter.

The notion of “displacement of concepts” (Schön, 1963) aims to juxtapose dissimilar concepts so as to create new perspectives through their synthesis. The underlying idea is that if one recalls similar objects or concepts together, because they are already similar, their juxtaposition may not create new meanings or perspectives. However, putting dissimilar objects together forces one to reconsider the objects in order to find some meaningful connection. Whenever this process is successful, the resulting insights are often quite novel and striking. The emphasis behind this mechanism is in moving away from similarity.

The notion of “displacement of concepts” is adopted and utilised in developing the structure of intelligent design agents. Hence, design agents exhibit the properties of mobility to travel and migrate between different computational design environments; i.e. mobile design agents. Each design environment has a different external representation of an architectural composition in the form of a floor plan. The interest in mobile agents is not motivated by the technology per se, but rather with the benefits they provide for the creation of distributed systems and the possibility of employing the cognitive mechanisms of juxtaposition of dissimilar “displacement of concepts” computationally using mobile intelligent agents and the great potential of achieving a creative

process for concept discovery based on reinterpretation for creation (Reffat, 2002).

The following sections in this paper present the results of the developed system of intelligent design agents that supports design exploration and creativity at the individual level of an intelligent design agent. The mobility of these agents within various design environments as a reflection of the notion of displacement of concepts to support design creativity at the collective level is not covered in this paper.

3. Intelligent design agents as active design exploration tools

An important characteristic of design is the phenomenon of exploration in the early stages of design configuration. A designer starts with an initial design idea and through the process of exploration other ideas emerge and design directions and concepts are discovered. Emergence has become the focus of much attention in the design computing research in recent years as one of only a small number of design processes that can expand a design space and hence facilitate creative designing. The word emergence has been used in many different contexts within various research fields including artificial intelligence and artificial life. This paper adapts Gero's definition (1992) of emergence: emergence is the process of making features explicit that were previously only implicit. Emergence is defined relative to a conceptual model of the observed phenomena held by an observer. In view of this definition of emergence any computational model of design emergence should include a means of observing not just the products of designing but also the process of designing in order to monitor significant changes in the representations used. However, determining emergence is not enough for the purpose of exploring ill-defined design spaces; in addition a means to determine the

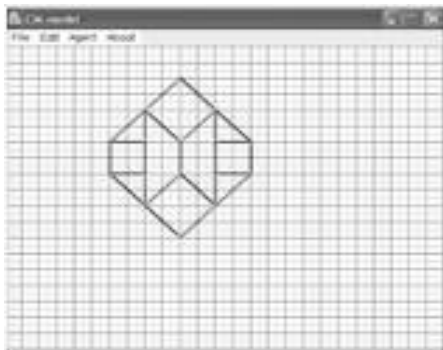
importance of emergent features is required (Saunders and Gero, 2000).

One way of doing this is by developing intelligent design agents that supports the design creativity by the way of emergent representations. Creativity is more than simple newness. Instead, it is a combination of newness and usefulness (Boden, 1991). Design creativity requires an expansion of a design space that might potentially leads to a generally useful property of emergent representations. Hence, the conceptual state space of the design agent must be extended. Creativity here means discovering new design situations (emergent representations) that could not have been predicted by the design agent from previous experience and hence expand its conceptual state space.

3.1 A digital grid for sketching initial designs

The developed intelligent design agent provides the human designer with a digital grid to sketch his or her ideas using this grid as shown in Figure 1. All the intersections on this digital grid are active points to draw an initial representation of a design composition. The design composition represents a single line floor plan of architectural spaces proposed by the designer within a specific boundary.

Figure 1. A digital grid for the human designer to sketch initial designs and the intelligent design agent explores and discovers emergent shapes and compositions.



3.2 Exploring the design space

The intelligent design agent commences its exploration and discovery process by recognising all the possible shapes within the initial design composition including explicit and implicit shapes (emergent shapes). In The initial representation shown in Figure 1, we have limited the recognition of shapes to six-sided shapes. The agent recognized 18 shapes as shown in Figure 2 (a) from the initial design that has only 10 explicit shapes; i.e. 8 emergent shapes are discovered. During the recognition process, the agent considers only repetitive shapes and ignores any shapes that are only recognised as singular shapes within the design composition.

The Intelligent design agent continues the exploration and discovery process by selecting a reflective shape from the recognised shapes to be the agent's focus. Within the current focus of the agent, the agent produces all possible representations explicit and emergent (design situations) that can be encountered. In this design, 11 reflective shapes were discovered. Hence, there are 11 foci for the agent to pursue and generate all possible presentations for each focus accordingly. Three of these reflected shapes and some of the possible representations are shown in Figures 2 (b), (c) and (d). These sets of representations are substantial expansion to the initial design space and provide a pool of creative solutions.

4. Discussion

It is quite useful to develop computer tools and methods to support conceptual designing especially to produce alternative possibilities to assist architects and designers realize design situations where differences make a difference. The results of the intelligent design agent presented aimed to support design exploration and creativity within the domain of architectural shapes. This was achieved by discovering emergent new forms

and shapes or relationships between forms within the initial design sketch proposed by a human designer. These new forms and shapes can be pursued as new design concepts.

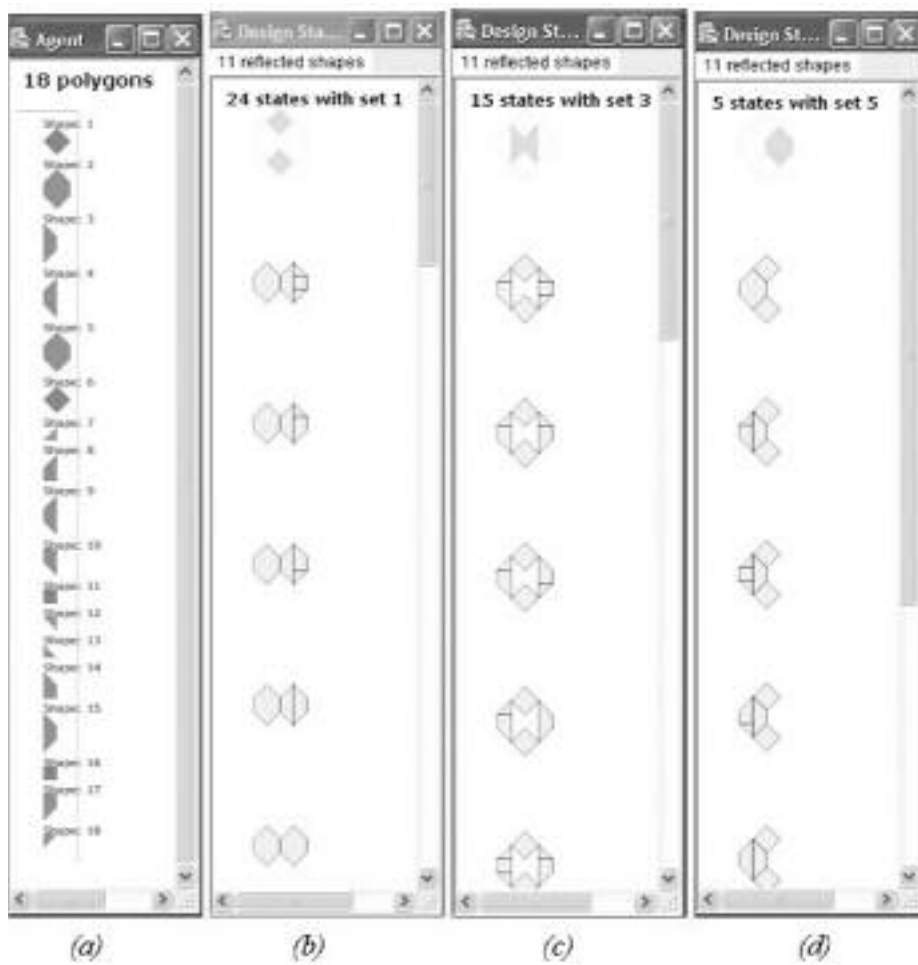


Figure . (a) 18 reflective explicit and emergent shapes discovered by the agent; (b), (c) and (d) some of possible representations for various foci of the agent.

Acknowledgment

The research is supported by the University of Sydney SESQUI New Staff Support scheme and the Australian Research Council, Discovery Projects.

References

- Gero, J. S.: 1992, Creativity, emergence and evolution in design, in J. S. Gero and F. Sudweeks (eds), Preprints Computational Models of Creative Design, Department of Architectural and Design Science, University of Sydney, pp. 1-28.
- Horvath, I.: 2000, Conceptual design: linside and outside, in EDIProd 2000, <http://dutoce.io.tudelft.nl/~jouke/docdb/docs/ediprod2000horvath.pdf>
- Reffat, R. 2002., Intelligent Agents for concept invention in design, in Gero J. S. and Brazier, F. (eds), International Workshop on Agents in Design, Massachusetts Institute of Technology, Cambridge, MA, USA, pp.55-68.
- Saunders R. and Gero, J.: 2000 , The importance of being emergent, Poster, Artificial Intelligence in Design '00.
- Schön, D: 1963, Displacement of Concepts, Tavistock, London.

