AN AGENT FACILITATED DESIGN CONVERSATION SYSTEM FOR AIDING CREATIVE THINKING IN ARCHITECTURAL DESIGN

GEETA ARJUN
Faculty of The Built Environment
University of New South Wales NSW 2052
Australia.
geeta1arjun@yahoo.com

Abstract. This paper presents an on-going research aimed at designer support in the conceptual stages of architectural design. It is argued that collaboration plays an important role at every stage of the design process. Extending Schön's seminal theory of 'design as a conversation' (Schon, ...), the support of the conceptual architectural design process is proposed as a dialogue between the designer and the computational agents wherein the agents adopt the role of design team members. The dialogue is theoretically aimed at triggering the experiential memory of the designer and associating significant experiences from different domains of the design problem to stimulate creative thinking. The paper presents an outline of the proposed model for a design-conversation system implementing computational agents in a blackboard architecture environment.

1. Introduction

Over the years, we have seen the computer as a draftsman, modeller and evaluator. The applications suggest significant potential in the use of computers in architectural design. The computer has the potential to impact the stage of idea development in the conceptual design phase in architecture, by playing the role of an assistant to the designer. Architectural design is comprised of different artistic, functional, material, ecological, etc. demands, which may even be inconsistent, combined through architectural design in a novel way (Haapasalo, 2000). Such a discipline requires a collaborative team effort for exchange and negotiation of ideas from its early stages. To achieve the effect of collaboration as an individual activity would be to allow effective reflection-in-action, which builds on Schön's theory where each design move reflects the results of one's actions (Lawson, 2001).

This paper presents an on-going research that brings together work in the areas of creative thinking, cognitive psychology, design collaboration and computational approaches to creative thinking in design.

2. Creative Thinking

The dictionary meaning of 'creativity' is expressed as 'the ability to use the imagination to develop new or original ideas or things, especially in an artistic context'. The concept of creative design is often used to mean aesthetic creativity, but it can easily be of a functional or technical nature. In the context of Schön's seminal theory of design as a conversation with the situation, Schön describes the design process as being a complex set of moves, norms and the inter-relationships between them. When the design process is good, the conversation with the situation is reflective (Schön, 1995). It paves the way to a partnership between the designer and his design, wherein the designer makes design moves and the design situation responds, instigating the designer to *think* of new strategies and make new moves. This conversation goes on till the designer is satisfied with the outcomes. As can be seen, it is the knowledge in the design that triggers the designer's experiential memory to think of new strategies to employ. Fischer (1994) also sees Task Relevant Reminding critical for creative activities.

2.1. ASSOCIATIVE THEORY OF CREATIVITY

One concept leads to another through a process of triggering groups of associated information. For example, when a person sees a baby with its mother, he/she immediately recollects his/her own childhood and associates different memories to it. Haapasalo (2000) in his research on computer-aided architectural design states that designing is an activity where thinking is structured as chains. Margaret Boden, research professor of Cognitive Sciences from the University of Sussex, also states that many cases of creativity depend at least in part, on the mind's associative power (Boden, 1990).

2.2 REMOTE ASSOCIATIONS

Remote associations can be understood as recognizing something more than anticipated. This is supported by Schön and Wiggins (1992), wherein he states that when viewed from a slightly different angle, the conversational structure of designing is a means of harnessing our remarkable ability to recognize more in the consequences of our moves than we have anticipated or described ahead of time.

2.2.1. Mednick's Theory of Associative Hierarchies
In his study, Malaga (1999), has illustrated an interesting concept developed by Mednick of associative hierarchies in associative creativity. An associative hierarchy represents the strength of an individual's associations. He illustrates this with the example as in Figure 1, which shows two associative hierarchies around the word 'table'.
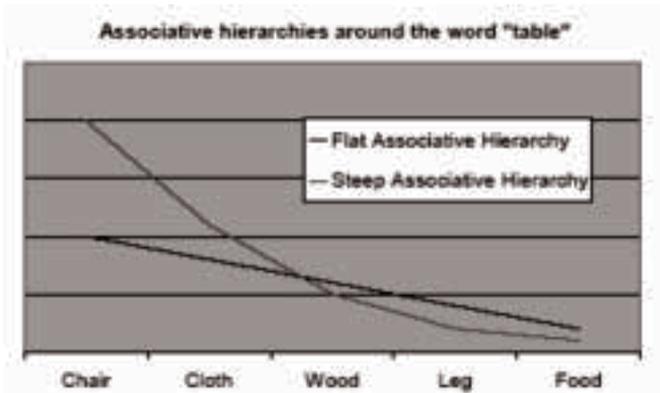
Figure 1. Associative hierarchies around the word 'table' (Malaga, 1999).

Mednick predicts that those individuals with relatively flat associative hierarchies are more creative than those with steep hierarchies. The person with a steep hierarchy has a very strong association between "table" and the typical responses of "chair" and "cloth". It is difficult for this person to recall the more remote associates (i.e., leg and food). According to Mednick, these remote associates are more likely to lead to a creative response (Malaga, 1999). The novelty in Jorn Utzon's Sydney Opera House could be considered an example of a remote association, wherein the idea for the roof form of the structure was derived from an orange peel.

The interconnectivity of design domains in the conceptual stages of architectural design has been considered as an aspect of Associational Thinking. As derived from Schön's example of moves, a designer works in one domain. It is, however in the other domains that the designer discovers the unintended consequences and qualities of the design move. At the point of conceiving a design, a designer is not aware of all the domains that would be affected. Because of our limited information processing capacity, we cannot, in advance of making a particular move, consider all the consequences and qualities we may eventually consider relevant to its evaluation (Schön and Wiggins, 1992). The ability to simultaneously consider different domains while designing increases with experience. Particular views of the connectivity of design domains are inherent in design communities, and from their perspective, help to distinguish experts from novices (Schön and Wiggins, 1992). The relationship or connectivity between different domains gets restructured as individual designers gather more experience. This restructuring of relationships increases the scope of complexity in the design process itself, thereby opening up new avenues of thinking in the design process.

3. Design Collaboration

Associational thinking in design can be thought of as a collaborative activity. Fischer (1994) states that much of our human intelligence and creativity results from the collective memory of humankind. Collaboration has been an integral part of creativity in design. Designing in the field of architecture requires one to work simultaneously in different domains. For these reasons, architectural practices employ design teams rather than individual project designers. The former provide a rich collective experience from different domains. These collective ideas are shared in the team, generally through a phase called 'brainstorming.' Brainstorming, first proposed by Alex Osborne in the 1930s from management science, is a method of getting a large number of ideas from a group of people in a short time (Osborne, 1963). Brainstorming results in generation of creative ideas spontaneously, especially in a group discussion. Thinker, Edward De Bono, has proposed brainstorming to be a creative problem-solving technique to assist design groups in exploring the design space (De Bono, 1970). Relating parallel experiences from different domains of the design problem can assist in the making of new associations for creative solutions. Kvan (2000) points out that most 'collaborative' decisions are actually a compromise and that is not necessarily a bad thing. It can even lead to highly innovative solutions.

The aim of this research is to impact the stage of idea development in the conceptual stages of design, wherein the prototype serves as a catalyst for innovative idea generation. The design collaboration is concentrated on structuring diverse relationships among different domains of architectural design to form new associations. Seen in a positive light, the effect of collaboration in design would thus be to allow collective reflection-in-action, to build on Schön's description of individual design activity.

4. The proposed design conversation system

Extending Schön's 'design as a conversation' metaphor, the support of the conceptual architectural design process is proposed as a dialogue between the designer and the computational agents where the agents take the role of different members of the design team. The idea is that conversation can stimulate the designer's experiential knowledge, thereby enabling the designer to think from different perspectives in parallel, when making design moves.

Intelligent agents in general, and heterogeneous *multi-agent* problem-solving systems in particular, provide a useful paradigm for exploring, modelling, and perhaps even replicating complex design activities of groups and organizations. In particular, such a framework would facilitate communication, collaboration, partial knowledge, and uncertainty in the design process (Honavar, 2004).

Taking insights from Lawson's design-conversation system (Lawson, 1997), a

proposal is made for the application of an agent facilitated blackboard architecture system to support the discursive process for triggering a dynamic association of ideas. A blackboard is a global database for sharing information. A detailed design brief forms the organizing principle for the discursive process. Following the lines of Schön's normative design domains, it is proposed that the different elements of design, as expressed in the design brief, can be grouped under different design domains like site, form, building elements, etc. An agent may represent an individual design domain, whose knowledge base will contain words or phrases associated with that domain. A trigger provided by the designer or the domain agent will be posted on the blackboard. In response to the trigger, different agents will post their individual views on the blackboard. The designer is thus able to view the different triggers and relate to different ideas and experiences in that context. The system overall, is expected to assist the designer in making explicit the way of the mind in relating design concepts. It will highlight the role of 'partnership' between the designer and the computer in a creative design process.

4.1. KEY ISSUES FOR IMPLEMENTATION

- The system will be 'word-based' and take advantage of the evocativeness and flexibility of words in describing meanings.
- Central to the system is the database. The database can be an individual data repository, wherein each domain agent stores words and phrases associated with a particular domain.
- In this context, one of the possible agent architecture models being looked at is the Open Agent Architecture System (OAA). OAA is a domain-independent multi-agent system in which the problem is solved through the co-operative efforts of distributed communities of autonomous agents.
- OAA employs a blackboard style of communication. The agent library supports the creation, maintenance and use of databases in the form of data solvables. When a data solvable is publicly readable and writable, the group of domain agents for posting their views can think it of as a blackboard, i.e. a global data store that can be used cooperatively.
- The 'facilitator' plays an important role in OAA architecture. The designer's complex goals can be decomposed into sub-goals and passed onto the domain agents.
- At the point of conceiving a design, a designer is not aware of all the domains that would be affected. The advantage of OAA is that new domain agents can be incorporated into the system at any stage of the design process. The agents register their capabilities with the facilitator who maintains these on a knowledge base on the blackboard.

5. Conclusion

This research is currently in its early stages of implementation. The research involved a review of different agent architectures to arrive at a suitable choice of agent-facilitated blackboard architecture for the proposed theoretical framework. The future outcomes shall involve an implementation of the proposed design conversation system. The prototype shall be tested for identifying the satisfaction level of its objectives, beginning with a testing at the University level.

Acknowledgements

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