

COLLABORATIVE ARCHITECTURAL DESIGN AS A REFLECTIVE CONVERSATION

An agent facilitated system to support collaborative conceptual design

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Abstract. In this paper, definitions of collaborative design are discussed and understood in terms of a designer's cognitive collaborations to explore his/her experiential memory for remote idea associations. Based on Schon's reflective practice theory, Valkenburg and Dorst's (1998) description of collaborative team designing is adopted as a model for a proposed design conversation system. The design conversation system is aimed at triggering the experiential memory of the designer by associating significant ideas from different design domains to provide different perspectives of a design situation. The paper describes a proposed framework for the design conversation system incorporating computational agents in a blackboard architecture environment.

1. Introduction

Collaboration is an integral part of creativity in design for generating and evaluating design ideas. Valkenburg and Dorst (1998) have explored the concept of collaborative team designing using Schon's (1995) reflective practice method. In this method, they describe team designing as episodic and categorize these episodes into four activities – naming, framing, moving and reflecting.

In this paper, we propose a computational framework based on Valkenburg and Dorst's (1998) model of team designing. The designer converses with a team of software agents to recognize and analyze the possibilities of concepts for specific design situations. The conversation is

aimed at triggering the experiential memory of the designer through words/text.

2. Design as a Collaborative Act

Architectural design is a response to a wide range of demands such as aesthetic, functional, material and ecological, which though often inconsistent, are combined through architectural design in a novel way (Haapasalo, 2000). For these reasons, it is generally common for architectural practices to employ design teams rather than individual project designers. The former provide a rich collective experience from different domains. Brainstorming (Osborn 1963) is a well-established technique for collaborative creativity. Although research has shown that brainstorming can generate a vast array of ideas, this technique is often criticized for the lack of provision of analysis of the generated ideas (Lawson, 1997).

Kvan (2000) argues that to be successful, a collaborative project must establish a definition of the team, identify the desired outcomes, ensure there is a purpose in the collaboration and clarify the interdependencies of the members. Traditionally, architectural design has been generally regarded as a close-coupled process wherein the different members work closely on the design project providing their expertise at each stage of the design development. Gero and McNeill (1998) have shown that the design process is actually made up of distinct events that occupy discrete and measurable periods. Designers come together, provide the relevant expertise for a particular situation, go back to their drawing boards and come back later for further negotiation. It is cyclical. Further, Maher et al (1998) in their experiments on collaborative design also found that exclusive collaboration produced more effective results than mutual collaboration.

2.1. THE DESIGNER AS A TEAM OF ONE.

Even with collaborative design, a designer still has to think individually and collaborate with other team members. In design-oriented fields like architecture, the designer may consult with colleagues and peers, but the responsibility is personal with the chief designer's initial sketches given as a *fait accompli* (Goldschmidt, 1996). In these instances, the designer is expected to have an outstanding capability for integration, evaluation and synthesis of concepts. Therefore, we have two issues to look at in aiding conceptual architectural design: conversations within the designer's own thinking process and conversations with members of a design team.

2.2. AGENTS AND COLLABORATION

In this work, we recognize a strong parallel between collaborative design and the use of computational agents in general problem-solving. Agents are designed to interact with an environment that is continually changing within its own limits (Parunak, 1998). The design environment is a complex and dynamic environment and multi-agent systems provide a means to manage collaboration in this ill-structured context. Zambonelli et al (2003) distinguishes between two classes of multi-agent systems: *distributed problem-solving systems* in which agents operate to achieve a common goal and *open systems* where agents do not share a common goal, but are developed to achieve different objectives. Design is generally a loosely coupled process (Kvan 2000) in which domain experts contribute at different times based on their knowledge of a design situation. This corresponds to the use of open agent systems for a conceptual design stage.

3. Design as a Reflective Conversation.

In the conceptual design stages, architects produce drawings that are meant for their own understanding. In essence, they are conversing with the drawings. Following Schon's paradigm of 'design as a conversation' (Schön, 1995), a trigger springs out of the conversation, the architect makes a move on the drawing and enters back into the conversation mode, this time reflecting on the move. This conversation continues until the designer is satisfied with the result produced. The concepts that emerge from this conversation are richer when the relations or links between the different domains of design conversation get re-structured. This re-structuring is generally dependent on experience and, as Schön and Wiggins (1992) state, it helps distinguish experts from novices.

In light of the above, we must mention that due to the limitation of individual short-term memory, designers, including experts, always have production-blocking problems in terms of creative ideas. Techniques like idea association or memory triggers are often used to make up for the limitations of human short-term memory. Many of the design techniques used to promote creative thought are based on the simple idea of shifting the designer's attention and changing the context within which the problem is perceived.

Valkenburg and Dorst (1998) came up with a rich model that explores Schon's theory of reflective conversation in team designing. In their method, the basic elements of designing are actions and the team's design ability is making intelligent decisions about those actions. Four types of actions are proposed: *naming* relevant elements in the design task, *framing* design issues

and sub-issues, *moving* (associating ideas and concepts) and *reflecting* (knowing what to do next). This is illustrated in Figure 1.

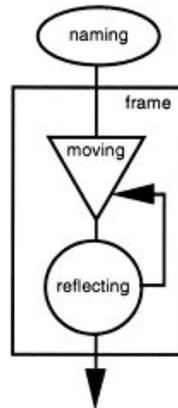


Figure 1. The mechanism of reflective practice; the four design activities and their interplay (Valkenburg and Dorst, 1998)

Architects work with words or texts that are products of linguistic choices and construct reality in particular ways (Markus et al, 2002). Language provides new perspectives on a design situation. The advantage of words rather than pictures in expressing early design ideas is their ability to sustain a range of interpretation (Lawson and Loke, 1997). The first body of text that the architect uses in a design project is the 'design brief', wherein the client communicates his or her ideas to the architect. This marks the beginning of the design conversation, with written words communicating assumptions or possibilities for the design outcome, as envisioned by the client. The architect continues the conversation by making objective and subjective judgments of the brief and then going on to analyze those judgments. Designing depends on such qualitative judgments (Schön and Wiggins, 1992).

4. A Proposed Framework for a Multi-Agent System to Support Conceptual Design

In the light of the above discussion, we here outline a proposed framework for a multi-agent system that supports conceptual design by imitating a collaborative conversation in which the agents act as experts across a variety of domains to suggest associated concepts that we believe may trigger the experiential memory of the designer and thereby promote more creative thought. The proposed framework aims to support the conceptual design

stage where the designer is beginning to develop the design brief and starts evolving conceptual design ideas for the situation presented by the brief. For our prototype, it is proposed that the knowledgebase for the multi-agent system will incorporate the knowledgebase of IDEAs, a web-based tool hosted by the Department of Health, UK, aimed at supporting professionals in various aspects of healthcare design process (<http://design.dh.gov.uk/ideas/>). Within this framework, the design brief evolves as the design conversation proceeds and forms a dynamic and ever-changing environment for the proposed prototype. In keeping with Schon's principle of treating every design task as unique, the environment changes to suit the evolving requirements of the design brief, as it is refined through a conversational process.

A *blackboard* style architecture is proposed for the multi-agent system as illustrated in Figure 2.

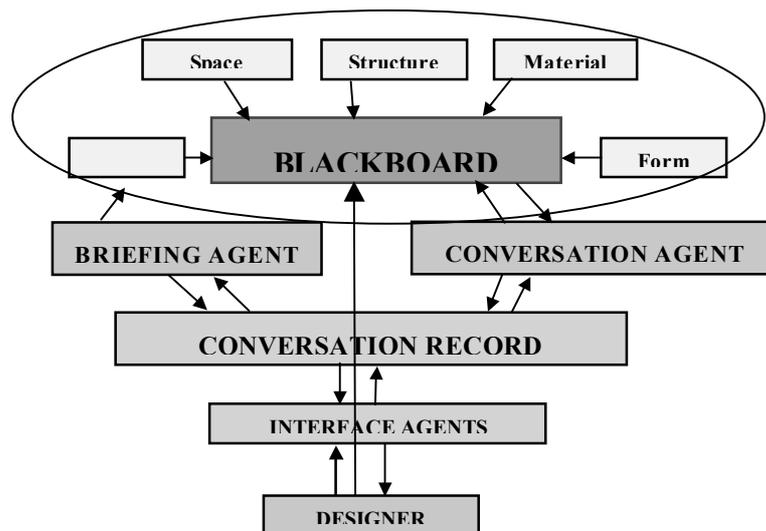


Figure 2. Proposed Agent Architecture for Conceptual Architectural Design

A blackboard is a global database for sharing information and is used by the agents to put forward different ideas. In this prototype, we propose to use MICA as the multi-agent architecture. MICA is based on the blackboard architecture where a group of agents use the blackboard to share knowledge and communicate (Kaddous and Sammut, 2004). The agents that form the multi-agent system would include *domain* agents, a *briefing* agent, a *meta-level conversation* agent that manages the conversations, *interface* agents

and the designer them self as the *human* agent who is the controller of the system. All these agents work in collaboration with each other by continuous monitoring the blackboard.

We envisage that a designer would begin by entering in the requirements of a generic design brief through the *interface* agents. These requirements are recorded in the conversation record and then captured by the *briefing* agent through internal reasoning mechanisms. The task of a conversation agent is to acquire and filter data before forwarding it to the blackboard or to the conversation record. The style of the conversation is based on Valkenburg and Dorst's (1998) design model and begins by *naming* an important aspect from the design brief that then becomes the focus or theme of the conversation. This is followed by *framing* one or more design issues that are relevant to the chosen design aspect. The designer or the domain agents can initiate the 'framing' process. As the conversation proceeds, the domain agents and the designer capture keywords from the conversation record and offer their responses based on their analytical judgment of the situation. Domain agents perceive data (keywords) posted onto the blackboard by the conversation agent. This data triggers their individual reasoning operations for choosing a relevant association.

Based on the study of Rhodes and Maes (2000), the triggering and reasoning actions of the agents are proposed through employment of 'just-in-time information retrieval agents (JITIR)' that proactively present information based on a person's context in an easily accessible and non-intrusive manner. Features of the environment in the person's current local context are used as predictors or proxies for usefulness; in this case it's the contextual keywords. While the domain agents converse, the briefing agent captures appropriate exploratory ideas from the conversation record and adds them to the design brief, this in turn is being continually reviewed by the domain agents thus doing a loop in the briefing process. The brief develops and the conversation is able to take new directions.

Following the idea of design process to be episodic (Kvan, 2000), it is proposed that the designer can work on one or multiple agent conversations simultaneously. At some point of time in the conversation, the designer may choose to carry out a new conversation on a different issue. The designer does this by informing the conversation agent, who in turn initiates a new conversation board.

A design conversation is also based on an 'ontology', a design world in which the designer realizes the design situations. Agents in a design conversation need to share a common understanding of the designer's world. Schon's normative design domains along with IDEAs considerations provide the backbone for conceptualizing the design ontology for the proposed multi-agent system. Designers create their design worlds, as Schön (1992) states, through the processes of appreciation, by which is meant the active

sensory apprehension of the stuff in question and the construction of an order to that stuff including the naming and framing of things, qualities and relationships. We focus on the latter objective part for the formation of design ontology to classify and relate the different knowledge requirements for conceptual architectural design.

4.2. DOMAIN AGENTS

The architecture of the domain agents would be based on the following proposition: a domain agent detects a keyword during the conversation and then looks for associations in its knowledge base and compares the association with the updated brief from the briefing agent. It then detects a novel or a remote association based on the brief and enters the idea on the blackboard. Based on IDEAs, domain agents represent the different architectural considerations for the design of a healthcare centre. A possible conversation fragment could be as follows:

The designer frames a design issue around the ‘entrance’ for the healthcare centre to begin the conversation.

DESIGNER - The entrance needs to be friendly and welcoming.

VIEW AGENT - There should be uninterrupted and clear views of the entrance from the approach to the site.

MATERIAL AGENT - Natural stone and timber building materials can make an entrance friendlier.

BRIEFING AGENT – What is your (designer’s) interpretation of welcoming?

DESIGNER – The entrance area should be uncluttered and spacious.

LIGHT AGENT – Well lit entrances create a feeling of spaciousness.

5. Conclusion

This paper suggests a computational method for deployment of a design brief within a multi-agent system to accelerate the production of richer concepts through a reflective exploration of the brief. The team-design paradigm of naming-framing-moving-reflecting provides a powerful mechanism to drive an exploratory conversation of ideas in the conceptual stages of architectural design.

Novices and experts alike can use the prototype, each benefiting from the system from their own perspective. The system is expected to learn with each design session and this learning is added to its future conversations.

An added advantage of the system is that new domain agents can be incorporated into the system at any stage of the design process. This

supports the ill structured nature of conceptual design stages wherein the problem domains are rarely clearly identified.

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