Chapter

Collaboratively designing within the design

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.1 Introduction

Design studios are places where designers work alone or collaboratively on design projects. Most design studios are now incorporating some collection of computer-based tools for handling electronic documents and communication. Following the traditional office paradigm large amounts of project data files (such as drawings, documents, spreadsheets, databases, manuals, forms, communications, schedules and discussions) move around the studio from one computer workplace to another, where they are processed on the individual designer's "desktop". The use of file server technology is usually reduced to the most rudimentary operations of moving files from one shared disk to another. Sometimes the same information is unnecessarily duplicated, sometimes important files remain either locked on the personal computer or lost somewhere on a barely navigable list of shared directories on a file server.

We have developed and experimented with designers using computer-mediated collaborative environments (Maher, Simoff, and Cicognani, 2000; Maher, Cicognani, and Simoff, 1997), which we refer to as *virtual design studios*. Virtual design studios can range from simply using email for project communication to a collaborative virtual world. Different metaphors can provide the conceptual basis for the development and use of a virtual design studio. For example, the virtual design studio can build on the *desktop* metaphor, popular in computer operating systems. The notion of a *place* is another major metaphor used for setting up virtual design studios. In this paper we focus on a case study of the use of the place metaphor in a design project.

Virtual places, which include virtual worlds and virtual reality applications, can be defined as *computer-mediated dynamic world models that create a sense of place*. The Internet has been accommodating more than a dozen different technologies supporting multi-user text-based, and two- and three-dimensional graphical virtual worlds. When adopting the place metaphor, preparing a virtual design studio is much like designing a physical studio. The studio is set up to facilitate and support collaborative design activities.

One aspect of the virtual place metaphor is the establishment of the identity of the people in the place. In a physical studio, a person's appearance, personality, and knowledge become known through their interaction with others in the studio. This also occurs in a virtual place through the representation of individuals as an avatar or object ('character'[1]) that has various properties. An 'avatar[2]' (Damer, 1998) is a 3D model of the person and shows where they are, where they are looking, and what gestures they want to communicate. Object representations of a person include characteristics such as a verbal description, messages about their movements in the place, and links to web pages and publications help establish their identity and personality. The visual presence of the avatars brings a new dimension in communication in virtual places.

There are several approaches to developing a virtual design studio based on the place metaphor. The two approaches we have considered are: the design office and "desiging in the design". The design office approach involves the development of a design studio as an office space with a collection of private and public spaces for the individuals and tools for the management of the documents and models. Designing in the design involves the development of the model of the design as the collaborative environment.

We demonstrate this idea by describing a virtual design office and "design within the design" scenario in the Active Worlds[3]. Active Worlds provides a central server on which the model of the world is stored. Active Worlds provides an Internet based browser that allows users to navigate through the built environments of various virtual worlds. Accessed either as a visitor, or as a registered citizen, Active Worlds invites everyone to contribute to its construction by adding new buildings, special features – for example, teleporting tools – and objects. It is then possible to change the shape, colour, texture, location, and dimension of a specific object by using a building interface. New areas, which can be compared to new cities, can also be defined by the inhabitants of the virtual world.

.2 The 3D Virtual Design Studio

Developing a virtual design studio as an office in a 3D modelling environment involves a consideration of what people do and need in a design office and then translating that into a virtual environment. The desktop metaphor has created a prototype of what people need in a virtual working environment, however it does not create a sense of place or identity of the other people in the place. In Figure 1 we show the virtual design office developed as part of our project, and described in (Hong, 1999). The office is located within the 3D modelling environment and

[1] 'Character' as a term is used in text-based virtual worlds.
[2] Avatar is an ancient Sanskrit term meaning 'a god's embodiment on the Earth' (Damer, 1998).
[3] http://www.activeworlds.com

includes a meeting room in the centre, with a walking area around the meeting room for viewing the development of the 3D models for various projects. The workspace environment includes also asynchronous and synchronous communication areas, and Web information area.

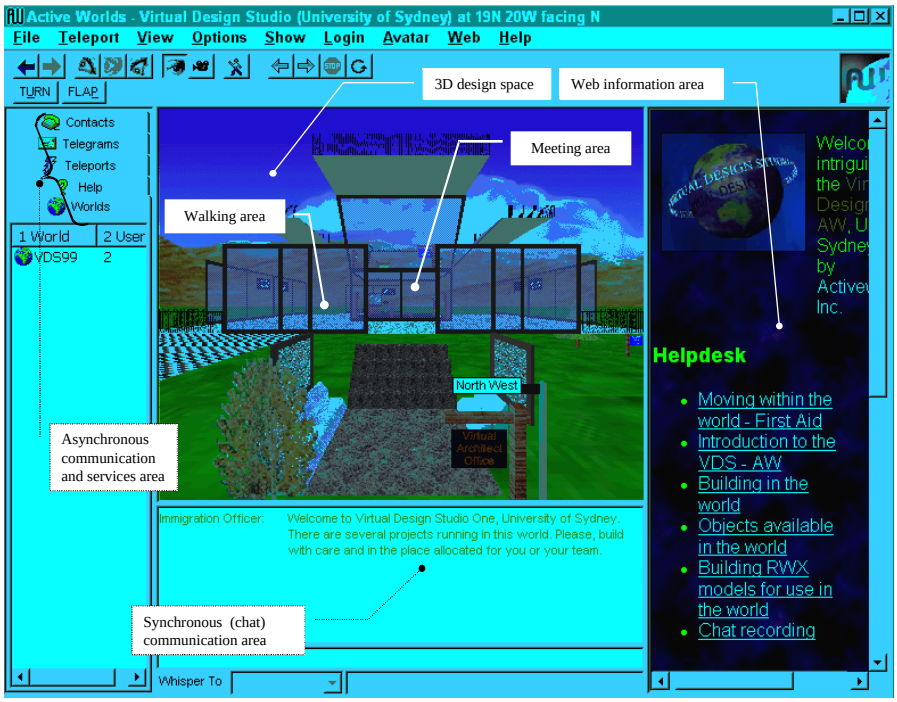


Figure 1. A virtual design office

The virtual design studio can also include a model of the product or building being designed. Although this is a relatively new approach, Woo, Lee, and Sasada (1999) show how such an immersive 3D environment can be used to evaluate design alternatives. The major feature of this kind of virtual design studio is the development of the design within the collaborative, multi-user environment. Designers can work alone or collaboratively building the model and discussing the design as they view the model. There is only one representation of the model so there isn't a problem with simultaneous changes to different versions. There is a *continuum of the process* – a person does not shift environments when designing alone or collaboratively, and there is a *continuum of the workspace* during the design session - all working information about the design is accessed and shared through the same environment. Traditional 3D modelling environments allow the designer to create a fly-through or animation for visualisation, presentation and discussion, but only the static 3D model can be modified.

Figure 2 shows a collaborative project in which the 3D model became the meeting place for the design team. The top left part of the figure is the meeting place with the 3D model of the building design and people represented as avatars.

Below the 3D meeting place is the talking interface that is like a chat room environment. The right part of the figure shows web pages that are linked to specific objects in the 3D model.

The project involved the design of a building for the Global Learning Centre at Stanford University. The design team consisted of graduate students in the Virtual Architecture course in the Faculty of Architecture at the University of Sydney, with a group of people at Stanford as the clients. The students were given a design brief outlining the intended use of the building, emphasising the requirement for flexible use of space. The students were also given a description of the existing building that would be modified for the new use as a Global Learning Centre. Materials for the project were kept and accessed only in electronic form.

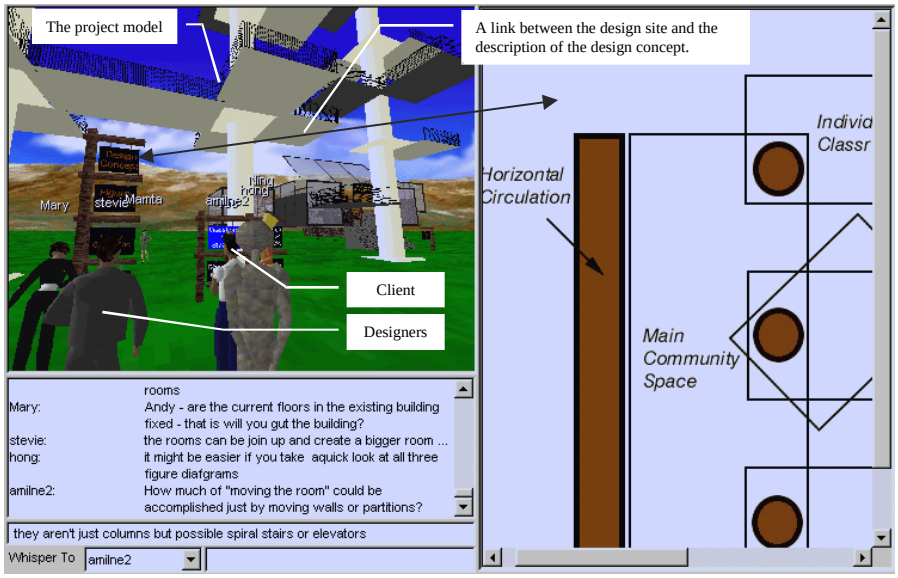


Figure 2. The Stanford project design site

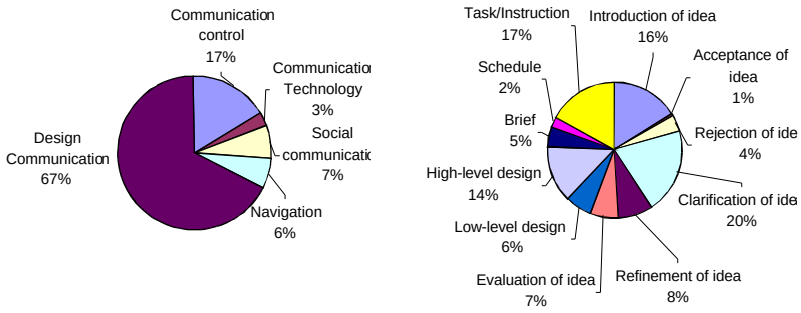
There are number of features that characterise the "design within the design" in a virtual design studio. The first group are connected with the spatial location of the design elements. Designers organised design objects on the site, introducing simultaneously the spatial relations between the objects and between the designers and the objects. They have a common reference and orientation. The second group is connected with populating the space. Having an avatar representation of each designer "within the design", collaborating designers are aware about the presence and to some extent about the activities of their partners. Collaborators can see and interpret each other's actions, distance from each other and from the design objects, and finally each modification of the design. These features of the designing within the design may influence the design communication that occurs during the design process.

.3 Communication During Team Meetings

Communication in the 3D modelling environment depended on visual contact with others in the meeting through the avatars and discussion in a chat-like window where people “talk by typing”. We analysed the discussion in order to characterise the concept of “designing within the design”. Our analysis used the recorded discussion as a transcript and employed a combination of the coding schemes proposed by Simoff and Maher (2000) and the coding scheme introduced by Gabriel and Maher (1999b). Gabriel and Maher (1999a, 1999b) developed a coding scheme for analysing one hour design sessions in an experimental setting of two designers. Our analysed discussion is slightly different because the design team included more than two people and the team worked together before and after the one hour discussion.

The coding scheme of Gabriel and Maher (1999b) looks at various types of communication in design collaboration: communication control, communication technology, social communication, and design communication. Of particular interest is considering how the collaborative environment influences collaborative communication. In this case study, we extended the coding scheme with two categories - *Communication mode*, with "Global" and "Individual" as subcategories, to capture dynamics within a team; and *Navigation*, to capture the interaction with the environment. Another modification of the original coding scheme is the addition of "Synchronisation" as a subcategory of the *Communication control* category, which depicts moments of synchronisation of the focus of all designers of the team (for example, "Can everyone see the concept drawing?").

The session analysed in this case study has 176 utterances. The diagram in Figure 3a shows that the designing within the design session is characterised by a high proportion of design communication with respect to the other communication categories. The dominant category in the design communication, as illustrated by the diagram in Figure 3b, is the communication of design ideas, combined with high-level (conceptual) design decisions. Gabriel and Maher (1999b) observed similar results in their CMCD-b session where designers used text based communication. To some extent this means that the 3D presence within the design does not decrease the intensity and concentration of text-based communication, identified by Gabriel and Maher (1999b). The higher percentage of task management communication may be due to the teamwork and the length of the design project in comparison with the one-hour duration of the CMCD experiments in the Gabriel and Maher study.



a. Across categories b. Design communication

Figure 3. Categories and amounts of communication in team meeting

The dynamics of design communications is shown in Figures 4 and 5. These graphs represent parallel timelines (each time point corresponds to an utterance) for each category of design communication. The graph in Figure 4 shows that designing within the design is characterised with fairly intensive introduction and clarification of ideas during almost the whole session. The fairly low final acceptance and rejection of ideas can be explained by the quick visualisation and illustration of the concepts in the 3D modelling environment. Figure 5 shows that the design communication at the end of the session was focussed on task management.

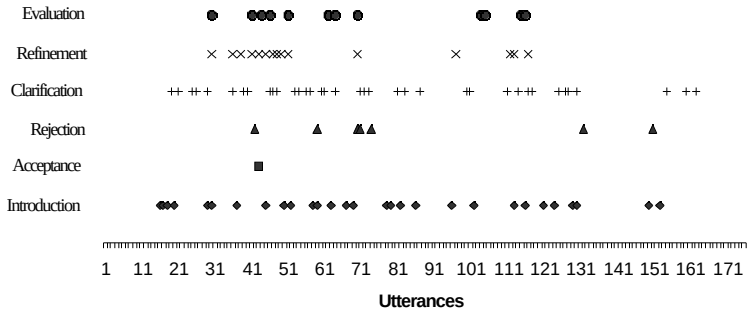


Figure 4. Communication of design ideas during the session.

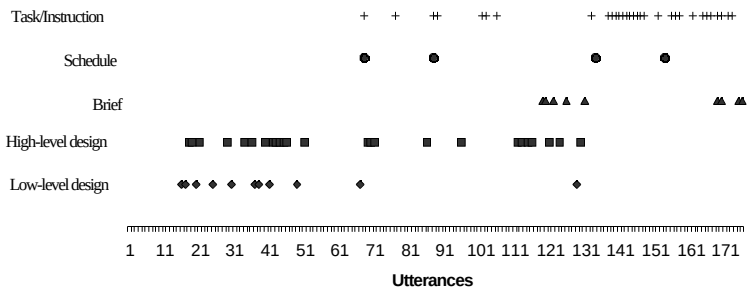
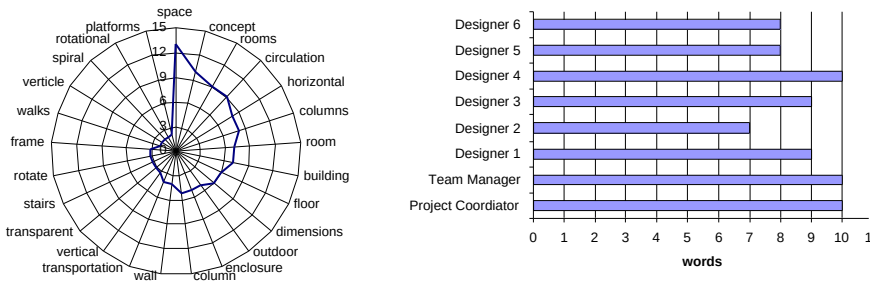


Figure 5. Communication relevant to the design scope and tasks.

In addition to coding the types of communication, we considered the distribution of communication content by performing a text analysis of the transcript. The major focus of the design team was on the concept of a light construct with enhanced circulation. The list of most frequently used concepts, shown in Figure 6a, demonstrates that despite the available visualisation of geometric forms, designers need to explain and refine the semantics of these forms. For example, the horizontal circulation caused a major discussion (indicated by the relatively high frequency of related terms), when the idea of the vertical transportation came across fairly easily from the model (indicated by the relatively low frequency of the relevant keywords).



a. Key concepts b. Average length of utterance

Figure 6. Text statistics of the design session utterances.

We expected that being within the design would allow the designers to explain design ideas with fewer words, based on simple references to the objects. The average[4] length of utterances is less than a dozen words. More than a third of the words in an utterance goes to the class of stop words (words that are part of the grammatical form and do not carry semantic meaning). To some extent this

[4] We used median as a central tendency estimator to avoid the biases of occasional very short and/or long utterances.

supports our initial hypothesis, however, further investigation is required for more rigorous conclusions.

We also considered the threads of conversation during the team meeting. Despite relatively short phrases, the communication within the design was fairly focussed. As shown in Figure 7 the first half of the session is characterised by low level of local threads between individual designers. The substantial increase in the individual threads in the middle is an indicator of potential asynchronisation of the design session, correctly detected by the project coordinator. The work of the team had to be synchronised also, when the attention of the designers was divided between the model of the design concept in the virtual world and an external illustration of design concepts (utterances 115-120).

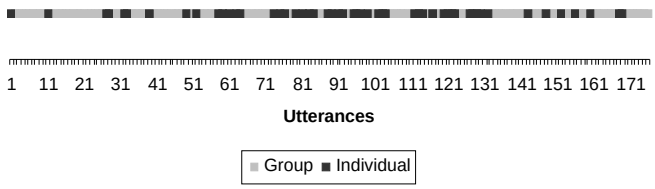


Figure 7. Changes in communication mode during the design session

4. Designing within the Design

The use of a 3D model as the basis for a design project is not new. Many CAD systems are now emphasising a shared model approach to design projects as well as sharing documents relevant to the project. The concept of designing within the design goes further than a shared 3D model by making the 3D model the meeting place for the design team. In addition to the model of the design, the avatars representing the design team are in the 3D environment. In this sense, designing within the design is substantially different concept from the traditional design approach.

When designing in 3D virtual worlds, the initial emphasis seems to go towards the form, due to the existence of objects with "prefabricated" forms. The design process is more like building than drawing. The collaborative potential in this type of environment is not well understood. Our observations of this type of environment indicate that the ability for the client to move around the design while discussing the project with the designers made it easier to understand the design. The traditional alternative is to discuss the design while looking at drawings or prepared 3D projections or animations.

In this paper we analysed the discussion that took place in the team meetings. Our initial results show that the discussion in this environment is heavily influenced by the type of talking supported by Active Worlds. That is, the participants talk by typing rather than by speaking. Our results show that there is a

large percentage of the communication devoted to the introduction of new ideas, possibly due to the lack of interruptions in a talk by typing environment. We also noticed that the discussion was primarily focussed on high level decisions rather than the details of the design model.

An important conclusion is that the development of 3D collaborative modelling environments does not restrict the ability of the participants to have successful discussions about the design. The existence of the participants in a 3D model of the design enhances the design communication environment and allows changes to be made and visualised immediately. The added value of having the participants represented as avatars moving around the model is the ability to see where another person is looking while discussing the design.

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