

# Variations on the Virtual Design Studio

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## **Abstract.**

There are numerous approaches and techniques for setting up an environment for collaborative design. The most common approach is to extend the desktop environment to include tools for meeting and sharing files. This approach takes the individual work environment and adds tools for communicating with others. An alternative approach is to create a virtual world environment in which the collaborators meet, work, and organise their projects. This approach differs conceptually because it creates a sense of place that is unique to the project, sort of a shared office space. A variation on this approach is to create a virtual world that is the model of the product being designed. This is a more obvious choice when the product is an architectural design, but it can be extended to other kinds of design. This approach is essentially collaborating within the design. We present the three approaches and comment on their strengths and weaknesses.

## **1. Introduction**

Design studios, whether we consider fashion, architecture or industrial design, make extensive use of computing facilities, handling a variety of electronic documents and communications. Designers interact and discuss design projects, organise and structure the project data, transfer and share design representations, develop and publish design documentation. 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, 1999; 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.

The combination of elements of the desktop and place metaphors defines the type of virtual environment. The idea is illustrated in Figure 1, where examples of collaborative environments are positioned within the space with the key metaphors as a coordinate system. Although some virtual design studios follow one of the metaphors very closely to the exclusion of the other, many collaborative design environments have elements of both metaphors. In Figure 1 we show some examples of collaborative environments and how they make use of a particular metaphor. Virtual worlds, like StudioMOO<sup>1</sup> and Active Worlds<sup>2</sup>, are organised around the place metaphor. TeamWave<sup>3</sup> Workplace combines some advantages of the place metaphor with the dominating desktop approach. eRoom<sup>4</sup>, bridges the discontinuity of the workspace in distributed desktop environments – it adds communication and meeting features to the desktop and a simple way to work collaboratively on documents. Dragging a document from the personal desktop to the browser, which runs eRoom, makes the document immediately available to everyone on the team meeting, so that participants can discuss, edit, modify, search, etc.

Collaborative environments can also be considered in terms of the organisation of the processing and data storage. A centralised environment has all processing and storage centrally located and uses client software for access. A distributed environment distributes the processing and storage to the local computers and coordinates by data transfer. The border in Figure 1 illustrates the separation of these two classes of virtual design environments – centralised and distributed environments.

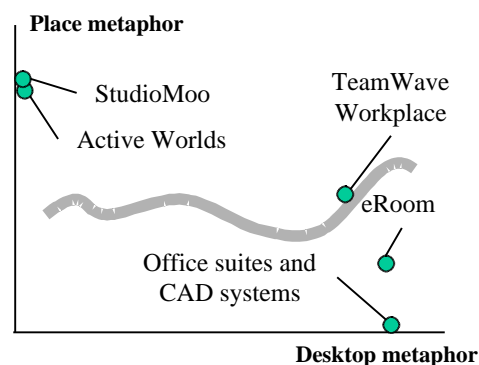


Figure 1. The use of the desktop and place metaphor in virtual design studios.

We present three variations on the virtual design studio. The first variation considers the desktop metaphor, where all the tools for the designers are available on the desktop. This variation is a direct extension of the personal desktop as used in the Windows and Macintosh operating systems to include tools specifically for collaboration. The second and third variations consider the place metaphor, where the differences lie in the way in which the place is modelled. One approach is to model

<sup>1</sup> A place in The Virtual Campus at the University of Sydney, <http://www.arch.usyd.edu.au:7778>

<sup>2</sup> <http://www.activeowrlds.com>

<sup>3</sup> <http://www.teamwave.com>

<sup>3</sup> <http://www.instinctive.com/>

the place as a studio or design office, in which the components of the place match the physical components found in a studio. The other approach is to model the design product as the place, so that the collaborators are working in the place in which they are designing.

## 2. Desktop Environment

The desktop metaphor refers to the use of collaborative tools as if they were lying on a working desk of a physical office. On the desktop, and nearby, a designer finds tools for drawing (eg. pencils, rulers), communicating (eg. telephone), archiving (eg. folders, filing cabinets), organising (eg. diary), finding information (eg. catalogues, archives), and so on. In general, he has access to all the office resources apt to perform the design task. On the electronic desktop – which is based on a metaphor of the physical one - all the functions are collected on the same interface, in this case, visible on the computer screen.

Using the desktop metaphor, each personal computer has a set of tools, as each personal desk has its own set of tools. Integration, in order to enable collaboration, involves determining a compatible set of tools so that information can be transferred from one computer to another. The integration of communication technologies, project management, and publishing design documentation can be realised in several ways - through the core of Web technology, an office suite style integration, or the development of software for complete coordination with a server, supporting data and communication needs on the desktop.

Using Web technology, due to the loose integration, the VDS environment can accommodate a variety of platforms. The loose integration brings considerable complications in the transition from individual to collaborative sessions and vice versa. Most of the management of design representations, documentation and other information is done manually. Virtual design environments based on the “design office automation” paradigm include highly integrated applications for design, text and image processing, communication, scheduling, and information management. The high level of compatibility between objects and corresponding applications in these environments sensibly increases the automation of collaborative information management. However, in both cases there is a discontinuity between individual and collaborative design sessions.

The use of the notion of a “room” (Greenberg and Roseman, 1998) simplifies the flow between individual and collaborative design sessions, and between asynchronous and synchronous collaborative design sessions. In this context, each room can be viewed as a different arrangement of a desktop. The idea is implemented in TeamWave Workplace<sup>5</sup>. Unlike the typical desktop arrangements when designers use one tool for communication and another for design, the “room” in TeamWave Workplace acts not only as a meeting place but also as a design area. In asynchronous collaborative design, project participants can update and leave design developments in a particular room (or desktop). The arrangement of different tools on such desktop can follow particular pattern of design development. On the other hand, the use of common tools in a common environment works both for synchronous and asynchronous collaboration.

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<sup>5</sup> <http://www.teamwave.com>

The architecture of a virtual design environment, based on TeamWave Workplace is shown in Figure 2. In general, each workplace can be equipped with server, which supports the workplace activity. Thus, designers have the choice to organise sessions at any point of the environment. The configuration of such environment depends on the project. When different teams work on different projects, or competitively on a common project, each team can select a workplace server for the teamwork. Alternatively, when design groups work cooperatively on a single project, they can use a dedicated server for placing all project work. The individual servers still remain the “test-bed” for individual and team collaboration, and results are then transferred to the project server.

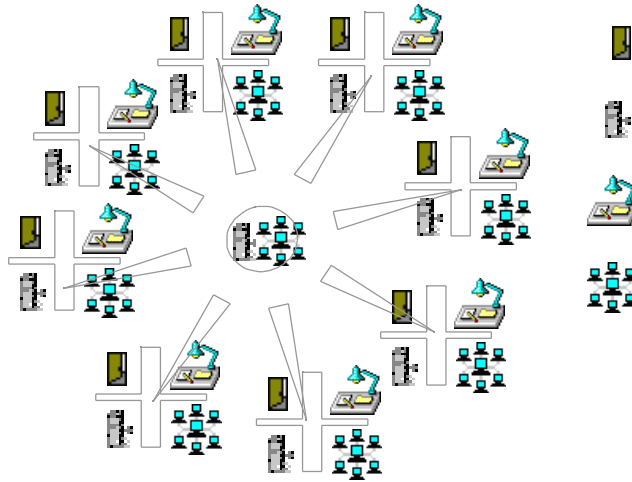


Figure 2. Architecture of a collaborative design environment based on TeamWave

TeamWave Workplace provides a variety of tools which support team management and coordination (e. g. address book, message board, calendar, meeting roster, post-it notes), design representation sharing (e. g. web browser, file viewer, file holder), design collaboration (e. g. image whiteboard, brainstormer, concept map), and presentation and cooperative decision making (e. g. slide projector, voting tool). Although CAD systems and other design modelling support remain external to the collaborative environment (in Figure 2 they are denoted as “Local Workplace”), the desktop approach integrates the CAD support under the same metaphor.

The room/desktop is both the working place and the information container, thus there is also a “doorway” for linking rooms, which defines a structure for the organisation and access to design information, as shown in Figure 3.

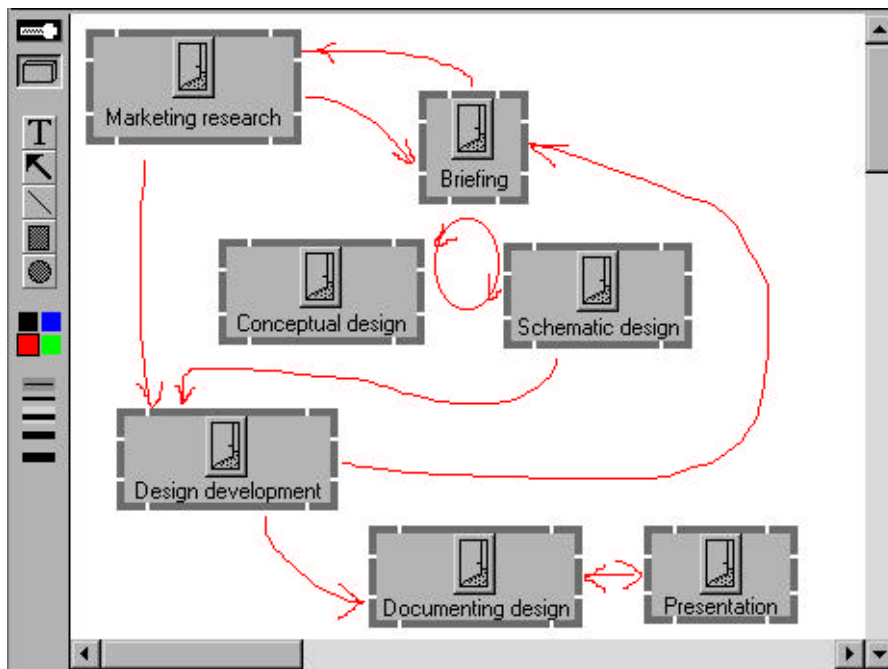


Figure 3. Structured access to different parts of the virtual design studio according to the model of the design process.

Figure 4 provides an example of synchronous collaborative design session. Communication in the desktop environment is attached to the room, following the chat model. The synchronous communication support includes an image whiteboard and person-to-person chat, which can be recorded and included as part of the design representation. The use of image white boards supports visual reasoning while designing. The chat area supports verbal discussion during collaboration. These two aspects of a virtual design studio play a significant role in the development of a design representation (Gabriel and Maher, 1999).

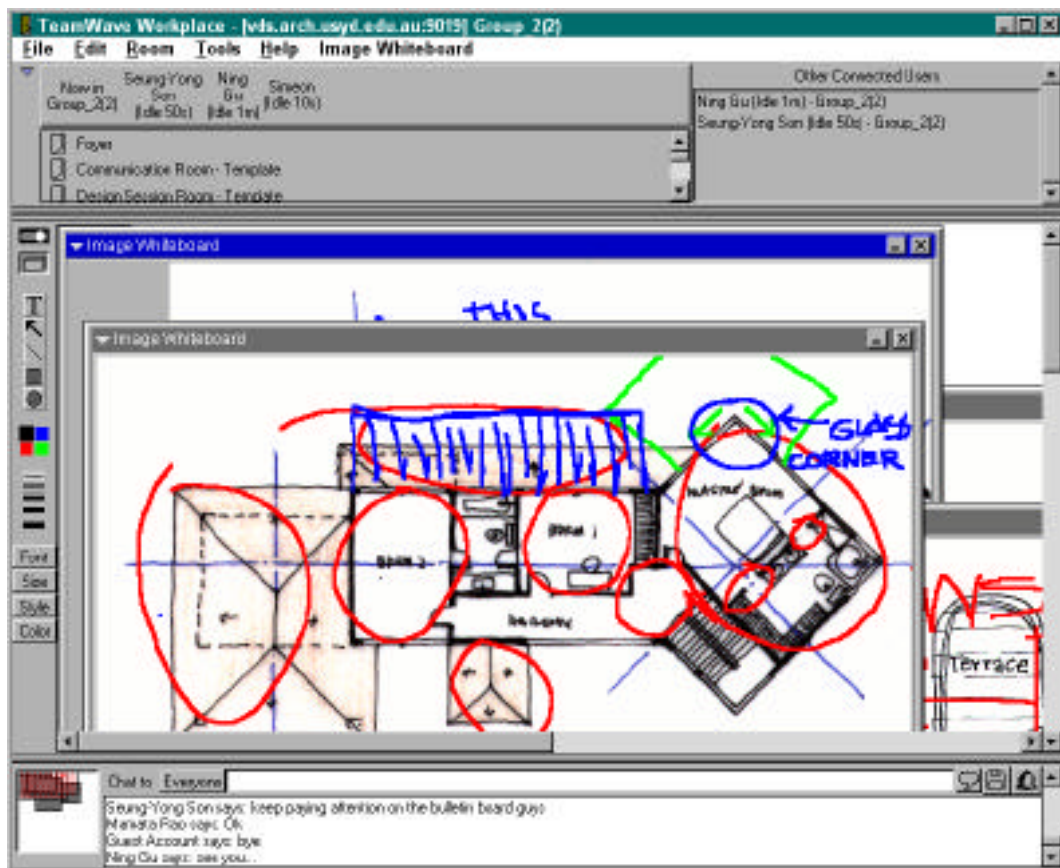


Figure 4. Collaboration within virtual design environment based on TeamWave

The advantages of the desktop metaphor are the abundance of tools already available for supporting the design process and communicating with other computers and people, and the familiarity of the desktop approach. The major disadvantage is the lack of coherence in the virtual design studio: the tools are disjointed and support different types of activities. A minor disadvantage is the lack of collaborative 3D modelling tools<sup>6</sup>. Since the desktop metaphor is an extension of the personal desk and workplace, the sense of community and common purpose is not well developed in this environment.

### 3. Virtual Places

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. A virtual design studio differs from the physical design studio in a significant way: the virtual studio can react to the people's use and presence, and it changes and responds automatically; a physical studio is passive and is changed only when people physically change it.

<sup>6</sup> This is a minor disadvantage because it may only be a matter of time before such a tool is developed and available on the desktop.

Using the place metaphor, it is possible to design and develop tools which have counterparts in a physical studio such as slide projectors and telephones. However, the virtual place is not limited to activities possible in the physical world. For example, to move from one area to another in a virtual place a person can “teleport,” that is, specify the area he wants to go by a command (eg. 'teleport office') and then be relocated to the area. A person in a physical building is not able to “jump” from one area to another without passing through contiguous rooms.

There are several approaches to developing a virtual design studio based on the place metaphor. A critical characteristic is to create a studio as a place that people go to when working on the design project. Here, designers may have a personal space as well as a public space for meetings and presentations. The place metaphor can be implemented as a text-based virtual world or a graphical virtual world (Cicognani and Maher, 1998). The distinction between text-based and graphical virtual worlds lies in the underlying representation of the place:

- a text-based virtual world that uses an object-oriented representation has properties and verbs to define the world where one of the properties could be a 3D model, and
- graphical virtual worlds are represented as a 3D model with the possibility of actions and other non-geometric properties.

StudioMOO is an example of a virtual design studio that is part of our multipurpose education virtual world, The Virtual Campus<sup>7</sup>. StudioMOO is based on the LambdaMOO software, an object-oriented MUD (Multi User Dungeon or Dimension). MOO environments started as role playing games environments, and have become one of the preferred software packages for the development of virtual worlds. Virtual communities (eg. LambdaMOO<sup>8</sup>) and virtual campuses (PennMOO,<sup>9</sup> Diversity University<sup>10</sup>) have been implemented starting from the basic LambdaMOO software.

StudioMOO, shown in Figure 5, illustrates the interface to a room. The metaphor of the physical studio is very strong, providing an intuitive use of the various objects in the studio. StudioMOO is text-based with a Web aware interface. The Web aware interface, continuously updated, that can include images, text, and 3D models, these being in VRML (Virtual Reality Markup Language). The Web part of the studio, written in HTML, is automatically generated by the underlying software that supports the central studio, and it is updated each time a change occurs in the environment. The Web interface, on the top of the screen, is integrated with a text-based window, on the bottom of the screen, and a series of icons on the left and right sides. Links on the Web part present more information about an object, or lead to other areas of the virtual world.

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<sup>7</sup> <http://www.arch.usyd.edu.au:7778>

<sup>8</sup> [lambda.moo.mud.org:8888](http://lambda.moo.mud.org:8888)

<sup>9</sup> <http://www.english.upenn.edu/PennMOO/>

<sup>10</sup> <http://moo.du.org:8000>



Figure 5. The studioMOO interface

StudioMOO is based on the idea of users joining a common environment, being able to share not only the environment tools, but also documents, files, slides, and information in all the forms allowed by the TCP/IP set of protocols. Equally important, each person that enters the VDS can see who else is there, much like a physical studio.

The various tools in the studio are available as icons. The function of the icons shown in Figure 5 are show in Table 1. These of icons can be defined when the studio environment is designed. Custom tools can also be added by each user, in order to adapt the environment to their needs.

Table 1. Tools available in studioMOO



Is used to start video broadcasting, with the possibility to send and receive video from other designers in the studio;



a telephone-like tool, which allows a user to talk privately with a person in his office;

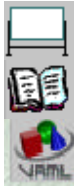


Gives the view of the room that the user is visiting;



Represents a slide projector, which can be used to show slides based on the HTTP protocol (for example, HTML pages, images in various formats, or text) to everyone else looking at the same "screen projector;"





a whiteboard like tool, used to write text, which can be seen by everyone in the same room;  
This tool gives access to a web site of information related to the studio;



a VRML representation allows navigation through the space, and it also gives the possibility to select active objects in the environment. So, for example, a door can lead to another space, or an object can open a link to a web page.



Gives access to an email system.

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. In studioMOO each user provides an icon or picture, which represents his/her presence in the world. Other characteristics, such as a verbal description, messages about their movements in the place, and links to web pages and publications can also be defined to establish their identity and personality.

The advantages of a virtual design studio as a place are the development of a community environment similar to the physical studio and the extensibility of the environment to provide facilities that are not possible in a physical environment. The most obvious aspect of a virtual studio that cannot be provided in a physical studio is the ability to participate in studio activities from a distance. Other aspects include the development of a dynamic and interactive environment that responds to the needs to the designers. The main disadvantage of the virtual place as a professional working environment is the relatively scarce knowledge and diffusion of the software, compared to the desktop approach. Other disadvantages are the lack of support for document management and CAD tools. These disadvantages are not inherent in the approach and would disappear with further development of the place metaphor in a virtual design studio.

#### 4. Designing within the Design

The consideration of graphical virtual worlds can lead to a similar environment as studioMOO described above, where the virtual place is the studio, except the place is represented and used as a 3D model of a physical place. Given the 3D modelling capability in such worlds, we can reconsider collaborative design as "designing within the design". That is, the virtual design studio can be the model of the product or building being designed. We demonstrate this idea by describing Active Worlds<sup>11</sup>.

Active Worlds provides a central server on which the model of the world is stored. Clients on each of the computers connected to the world allow a person to connect and enter the virtual world. This client-server model for Active Worlds is illustrated in Figure 6.

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<sup>11</sup> <http://www.activeworlds.com>

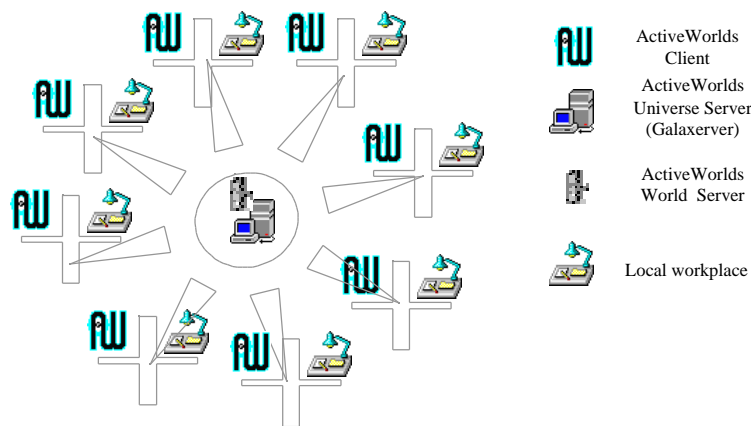


Figure 6. Architecture of virtual design environment based on ActiveWorlds

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, dimension of a specific object by using a building interface. New areas, which can be compared to new cities, can also be defined by users. Each person in the virtual world assumes a digital embodiment known as ‘character’<sup>12</sup> or ‘avatar’<sup>13</sup> (Damer, 1998). The visual presence of the avatars brings a new dimension in communication in virtual places.

Figure 7 shows part of the interface to a virtual design studio designed in Active Worlds. The studio is described by the visualisation of a 3D place. Navigation is similar to walking, the person controls their avatar with the arrows keys to indicate movement and direction. The avatars can gesture to communicate emotions like happiness and anger. Verbal communication is achieved in a chat window.

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. This kind of discussion and collaboration is usually only possible after the design is completed and the construction or manufacturing phase has started. There is a continuum of the process – a person does not shift environments when designing alone or collaboratively. Traditional 3D modelling environments allow the designer to create a fly-through or animation, but only the static 3D model can be modified.

<sup>12</sup> ‘Character’ as a term is used in text-based virtual worlds.

<sup>13</sup> Avatar is an ancient Sanskrit term meaning ‘a god’s embodiment on the Earth’ (Damer, 1998).



Figure 7. Design and communication within the design

The major advantage of the graphical design studio that is also the design is the dissolution of the boundary between the environment for designing alone and collaboratively. Other advantages are:

- Visual navigation within the design when designing; and
- Immediate feedback, providing for reflection.

A disadvantage of this approach is the lack of synchronisation between the views that different designers have and the potential for losing the context of communication. Figure 8 shows the view from one person as being very different to the view of a person in Figure 7. The person in Figure 8 has chosen to zoom into the design. Discussing the design while looking at such different views would be difficult.

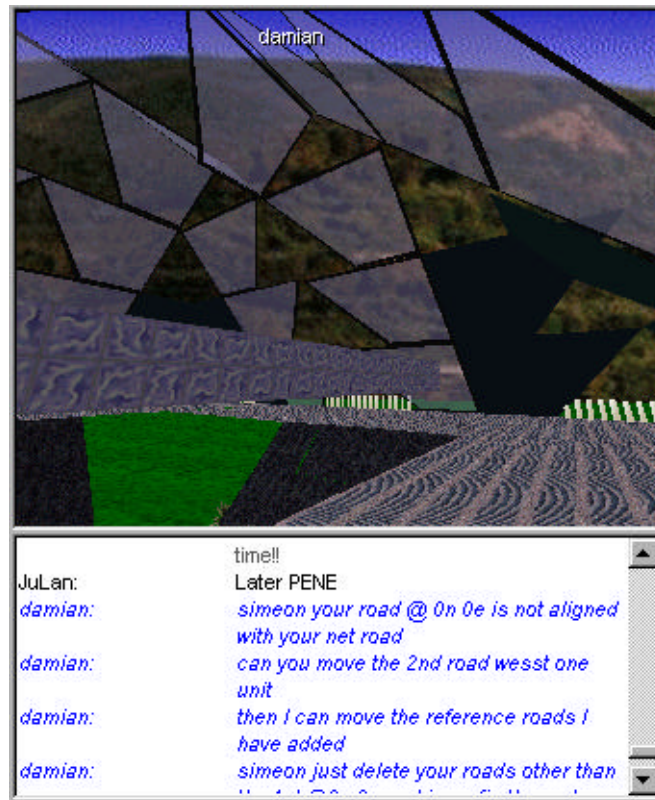


Figure 8. Zooming within the design

## 5. Conclusions

The use of computer-mediated environments for collaborative design is becoming an essential aspect of design projects. The decisions being made to incorporate collaborative environments into existing desktop environments is typically done on a tool by tool basis. This paper presents three alternatives for creating a virtual design studio. By considering the collaborative environment as a design studio, a more coherent environment can be developed. We present the desktop metaphor as the most common and well supported metaphor of computer-mediated collaboration. We compare this approach to the use of the place metaphor, in creating a virtual place for collaboration. Once there is the possibility to create a sense of place that has similar functionality to the physical studio, we can then consider variations on the meaning of the place. We demonstrate two variations: the place is modelled on the physical studio, and the place is a model of the object or building being designed. The comprehensive support for all aspects of computer-supported collaborative design is not as well developed in virtual worlds, but the development of a community of collaborators has the potential to facilitate communication and collaboration.

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