# CoViD, A System for Collaborative Virtual 3D Design

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**ABSTRACT**
Many important decisions in the design process are made fairly early on, after designers have presented initial concepts. In many domains, these concepts are now realized as 3D digital models and, in meetings, the stakeholders evaluate these potential solutions. Frequently, the participants in such a meeting want to interactively modify the proposed designs to explore the design space better. Today's systems and tools do not support this, as computer systems typically support only a single user and computer-aided design tools require significant training. This paper presents a new system to facilitate a collaborative 3D design process. The new system, CoViD, consists of two main parts. The first part is an easy-to-use conceptual 3D design tool that can be used productively even by naive users. The second part is a novel infrastructure for collaborative work, which offers an interactive table and several large interactive displays in a semi-immersive setup. The synthesis of both parts forms a new platform for collaborative virtual 3D design.

**INTRODUCTION**
Today, digital 3D models are critical in many domains, such as architecture and urban planning, industrial design, entertainment, and many engineering areas. Many important decisions surrounding a design are made in the initial phases, after the designer(s) have proposed one or more initial versions of the design in a meeting. However, today's computer design tools are not easy-to-use and are limited to a single operator, and are hence not good tools to support the interactive modification of designs in a meeting. Traditional tools for 3D design require a significant training. Part of this is due to the large number of functions available to support every possible 3D design activity. The other issue is that traditional 3D design tools expose the technical foundations of computer graphics directly to the user, which is not very accessible to most people.

One common solution to offer multiple users access to an interactive design system is to use one (or more) large display, typically via projection. However, most large display systems allow only one *active* user at any given time. The reason is that most software packages can only handle input from a single user. This leads to the "driver" problem, i.e. that one person controls the content, and hence the meeting. This person is usually the one most adept in controlling the system, but not necessarily the best designer. Also, some stakeholders are often "left out" by this process, as the computer skills of participants usually varies significantly.

This paper introduces a new system that aims to make the collaborative 3D design process more productive. The factors mentioned above currently render 3D design a suboptimal and time-consuming process. To illustrate the problem gains, we present the following "traditional" scenario: Imagine a family wishing to redesign their living room with the help of a professional designer. After an initial consultation, this designer comes up with several concepts and presents them to the family. The family picks two designs and proposes some modifications to adapt them to their needs. Several days later, they meet again over a refined version of the designs. As the designer may have not have addressed all concerns fully, this process is usually iterated a few times. At last, a final design is chosen and the designer elaborates it further so that other people can build the desired living room configuration.

With a collaborative 3D design system, this process could work as follows: After the initial consultation, the designer brings digital versions of several concept designs to the meeting with the family. All participants sit on a fully interactive system, which allows each of them to directly modify the digital model of the initial concepts. While the technical system may support fully simultaneous operations, the normal social protocols encourage the members of the family to take turns and to work constructively with the designer. Based on the direct visualization of the 3D design, the family and the designer quickly agree on one alternative. Then the designer again elaborates the final 3D design and passes it on to others.

As this example highlights, the possibility to quickly manipulate a 3D digital model in a collaborative setting enables a much more rapid design process. This paper presents a system that targets this scenario.

## COVID – A SYSTEM FOR COLLABORATIVE VIRTUAL 3D DESIGN

CoViD (COllaborative Virtual 3D Design) consists of two main parts – the SESAME conceptual design tool and the MULTI collaborative setup.

### SESAME - Sketch, Extrude, Sculpt, And Manipulate Easily

SESAME is a simple-to-use 3D design tool, which enables even novices to create interesting 3D designs.

The user interface of SESAME is based on drawing familiar 2D shapes in a perspective view onto 3D surfaces and then extruding any closed contour in the 2D drawing to create many familiar 3D shapes. Furthermore, users can sculpt objects by drawing on their surface and then extruding "into" an existing object to remove material. The system uses several novel forms of visual guides and snapping to facilitate the creation of most common configurations. A simple navigation interface allows user to quickly change the viewpoint.

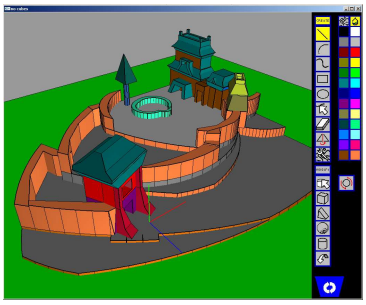

**Figure 1. SESAME user interface, the palette on the right offers access to all operations of the system.**

SESAME allows users to quickly reconfigure a 3D scene via a novel 3D movement algorithm, which leverages the fact that "floating" objects are rare in reality and also recent results from research into primate vision. Finally, the system also offers advanced grouping mechanisms to facilitate the manipulation of common scene configurations.

The user interface of SESAME has been evaluated via a series of user studies. E.g. SESAME has been shown to be simpler to use than traditional CAD systems [2], and competitive with sketching with pen and paper [1].

### MULTI – Multi-User Laser Table Interface

In general, the stakeholders in a design project make important high-level decisions in a meeting. However, for effective collaboration, the participants in such a meeting need to be able to see a visualization of the current design proposal(s). If this visualization is interactive, the participants will in general be able to reach better decisions, as they can explore the design space better. In 3D design, large displays are a necessity, also due to the role of secondary information. Clearly, a top-down view, similar to a plan view, is beneficial, yet a perspective view is also desirable.

MULTI is designed for groups of 5 to 7 active participants and features an interactive table large enough to comfortably seat 5 people. The table has a ledge with enough space for laptops, paper, and other work artifacts. Three interactive wall displays arranged as a continuous display enable work on large-scale designs, support the ability to use one or two of them for secondary information and allow even more users as a "passive" audience. All surfaces are back-projection screens and projectors and cameras are placed behind the screens (both for the table and the walls).

The main interaction devices of MULTI are several computer-controlled laser styli. The laser spots observable at any intersection of the laser beam with the projection surfaces are detected by a set of cameras. Each stylus works both as a pen as well as a remote pointing device. The button on a stylus is configured to work as the left mouse button, which makes it very natural to interact with standard GUI applications. The styli are distinguished by synchronizing the laser diodes with the cameras and time-multiplexing them with distinct patterns [3].

### CoViD: Merging SESAME and MULTI

SESAME was modified to support multiple views at the same time. The displays of MULTI are associated with various views of the 3D design in CoViD. The tabletop surface is best used for a view of the design from the top, akin to e.g. the view afforded by a map of a city. The vertical surfaces are better suited for a "side" view of the 3D model and typically two or all three wall displays are used together to provide a large-scale perspective view of the design. As additional information is often critical, we allow users to display and interact with additional information on one (or more) of the wall screens a browser window, typically on one of the two "side" walls.

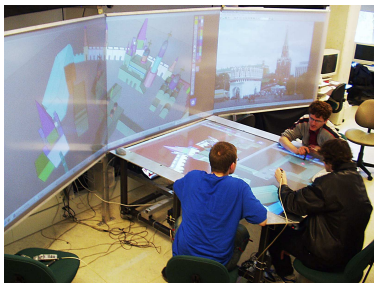

**Figure 2. The CoViD system in action.**

Also, SESAME was adapted to enable the use of laser styli and support for multiple simultaneous users was added. Furthermore, several tablet PC's are available in the system as another means to access auxiliary information or to allow people to transition between group and individual work.

Evaluations of the initial version of CoViD have shown that it provides an effective collaborative design tool. However, several issues were raised, e.g. around the design of the laser styli and will be addressed in future work.

## REFERENCES


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