PRODUCT NAME	CLASS	YEAR
Virtual Immersion Surgical Training Environment	**HCI 1** **Project: Virtual Learning Model**	**Fall 2003**

PROBLEM SPACE

Today's virtual surgery training solutions offer limited, realistic training environments where remote collaboration is possible, making wide acceptance of the technology difficult. There are several surgery simulators today ranging from virtual immersion with haptic goggles and gloves to using a mouse in combination with a monitor. Often users are restricted to one physical location in order to experience realism, e.g., environments such as the Cave Automatic Virtual Environment. Other products might give up realism to have remote collaboration, e.g., environments like the Haptic Workbench from the Commonwealth Scientific & Industrial Research Organization. Current environments, like CSIRO's Haptic Workbench, give users a limited view of an organ or body part and do not simulate the emotional experience of operating on another human being. In contrast, CAVE provides a more realistic immersive environment with interaction between users, but it requires them to be physically present in the location where the simulation takes place.

GOAL

Remote collaboration allows users to practice or observe surgical procedures perhaps only available to them in distant locations. Also, realism allows users to experience more closely the feelings and emotion that are part of surgery. The ideal scenario is to incorporate both remote collaboration and realism. Both are vital components of virtual surgical training because they create a more authentic and thus effective learning experience. One approach to resolving these issues is to create a learning environment that allows students and professors to practice surgical procedures in an interactive and more realistic immersive virtual environment.

THE PRODUCT

The product offered to meet these requirements is the *Virtual Immersion Surgical Training Environment* (VISTE). This virtual immersion involves a student or professor working by themselves and interacting with only the environment, or potentially several users interacting with each other as well as with the environment. The environment consists of a mobile, virtual surgery pod that simulates all the equipment and personnel required to perform a specific procedure. This virtual simulation provides the opportunity for students and others to the knowledge acquired in lectures, videos and passive participation in real proceedings. VISTE also enhances classroom teachings and theoretical concepts that otherwise could be practiced only by trial and error on real people.

The target users of VISTE are medical students and faculty interested in enhancing their skills and learning new procedures. The virtual world provides these users with the ability to learn new surgery skills and react to unexpected situations introduced purposely by the simulation, testing the knowledge and reaction of users to real life situations. VISTE would be valuable to institutions of higher education; however it could also be used by colleges, high schools, and even grade schools to give children the opportunity to test novice-level versions of the virtual simulation.

The system uses the metaphor of a surgery room and surgical table. According to the results of our survey most people prefer "hands-on" learning style, which means that our system users may want a simulated real surgery experience that imitates a realistic 3D environment. During the learning process users should be instructed in a step-by-step fashion through the system's menu-driven interface that allows users to make selections without memorizing a long list of commands.

Users will manipulate instruments inside the simulation just as they do in the physical world. Consequently, the system will store all the information about the surgery, including the various medical devices used in certain procedures. A database will support this function, and there will be a virtual market place where users can go to download new surgery modules. Where applicable, the system function will be modularized. The system will give instruction to novice users and also provide shortcuts and flexible options for expert users. The following information includes essential components to fulfill the requirements mentioned above:

The project team searched the existing surgery simulation products available on the market. Most of them require users to wear some type of eyewear, such as goggles. In addition, they incorporate some kind of haptic table to simulate the surgery. One major drawback concerning the haptic table is that each specific surgical procedure requires a new table, leading to unwanted complexity. Because of this inconvenience, we chose to integrate a novel technology: flexible gloves.

***The Console*:** The console is the main component of the system. See Figures 1. The console contains two robotic arms that attach with haptic gloves, glasses and a touch screen. The console is a half-moon design, which allows users to reach the equipment conveniently. Inside the console, there are multiple processors that handle the heavy-duty computing required for of the simulation. Each processor is responsible for a different parts of the simulation, e.g. virtual environment generation and voice recognition.

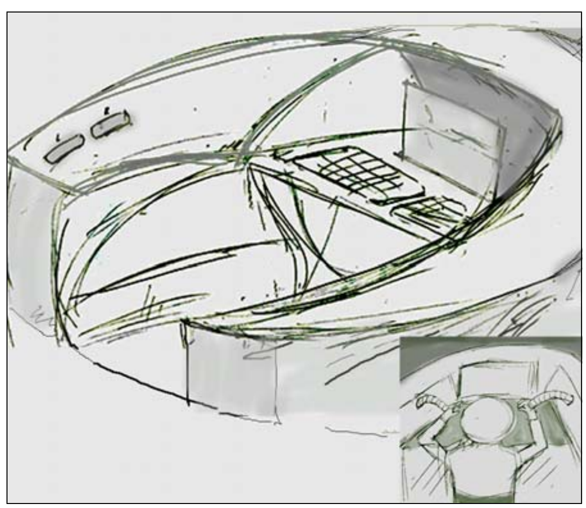


Figure 1. Prototype of console with the user's operating position.

Glasses: Virtual objects and images display on the glasses. See Figure 2. The lenses can become transparent to view the physical world, and users can easily switch from virtual world to real world. The glasses feature a movement sensor that can adjust the image when the user's head moves. The glasses are also equipped with an earphone and microphone for spatial audio. They use wireless technology and have a high capacity battery.

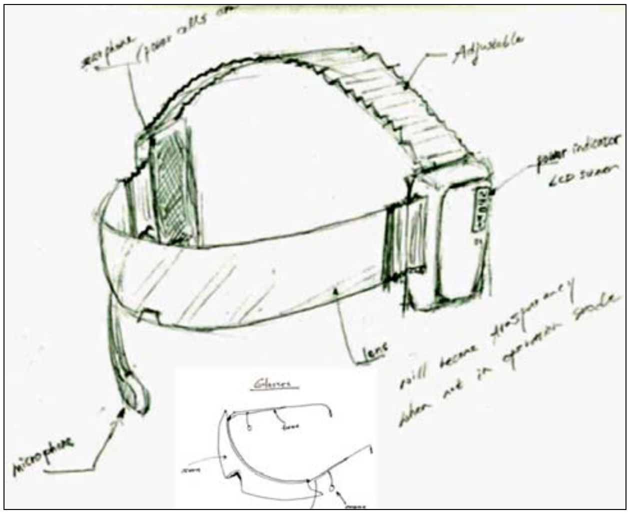


Figure 2. Prototype virtual glasses for a surgery training session.

Gloves: The gloves are woven from flexible plastic, made with nanotechnology. See Figure 3. Every plastic particle is activated by electric current. The gloves become soft or hard, making the user feel the shape of an object (operating instrument) by providing these gloves provides tactile feedback for the user.

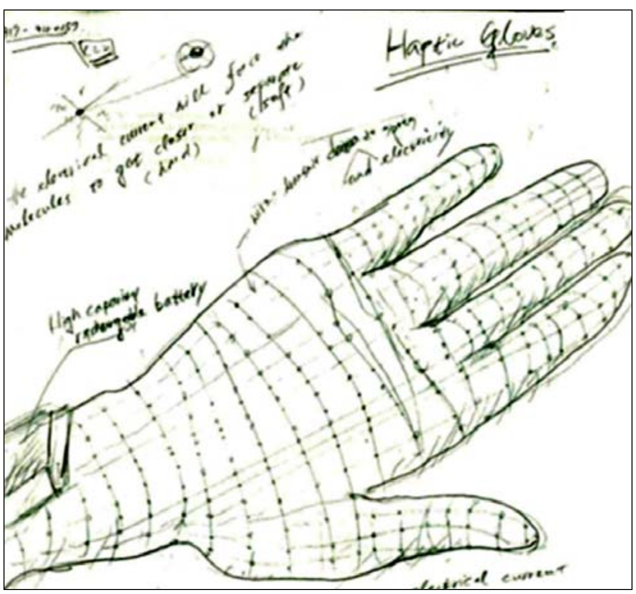


Figure 3. Two variations of the flexible glove prototype concept.

Display: The touch screen displays all of the instructions before a user enters into the virtual world. See Figure 4. Users can set up all the preliminary processes on the screen and then follow the instructions touching the selections displayed on screen. Users with limited computer experience can successfully operate the system with minimal effort.

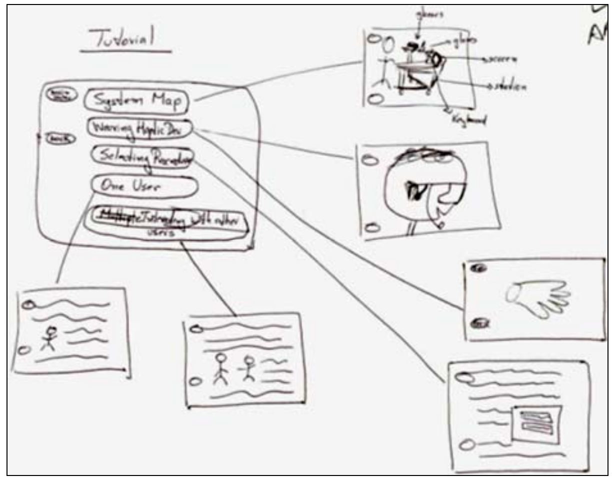
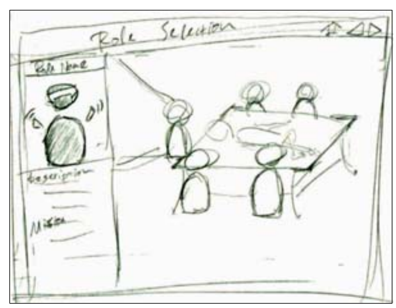


Figure 4. Prototype interface for operating the virtual system.

Learning Scenario: To develop the cognitive walkthrough a common scenario was designed and a whiteboard was used to sketch the physical system and application framework. One of the team members distributed this information and each of the other team members was to navigate through the various steps and provide feedback for improving the interface and application flow. By discussing our first impressions of the initial design we were able to suggest modifications for the final product. The scenario being tested is one of real-time collaboration in a virtual surgical environment between two students and one professor. See Figure 5. The goal of the simulation is to give the students access to a virtual cadaver and, through the guidance of the professor, train them how to perform various surgical tasks. Our scope will allow us to demonstrate only a few of the movements and tasks needed and complete step-by-step surgical instructions.



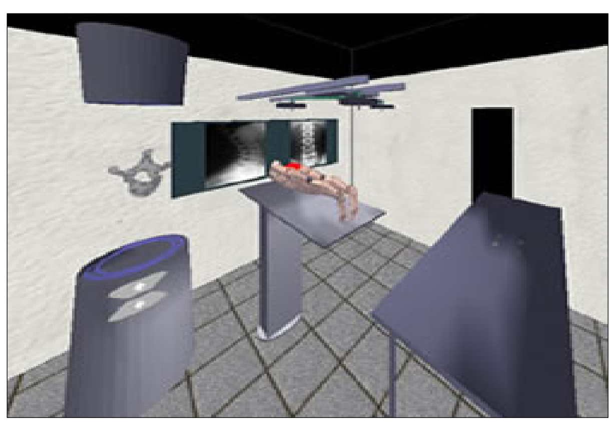


Figure 5a & b. Learning scenario with instructor and students (a) and virtual surgical table with patient (b).