German National Research Center for Computer Science (GMD)
Scientific Visualization Department - Supercomputer Center (HLRZ)

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The Responsive Workbench

A virtual working environment for architects, designer, physicians and scientists

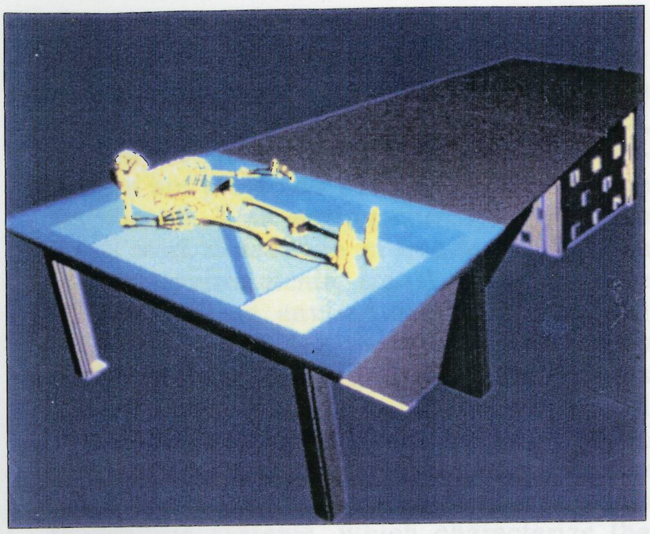

Fig. 1: Scheme of the Responsive Workbench

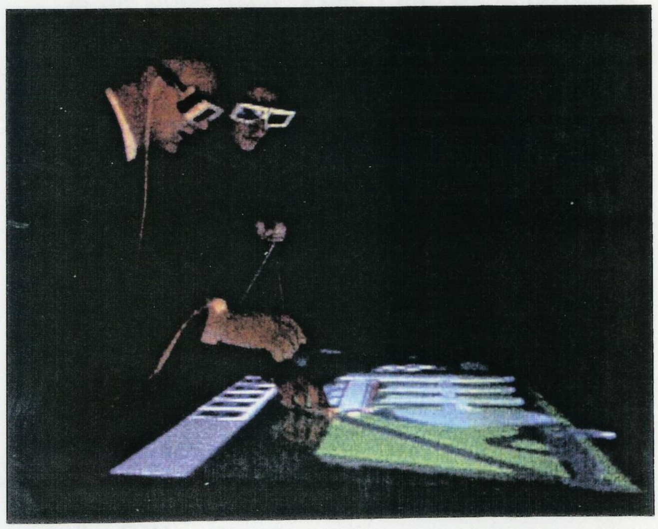

Fig. 2: Cooperative work of two architects

General concept

The standard metaphor for human-computer interaction has been based on the daily experience of a white-collar office worker. For the last 20 years more and more enhanced desktop-systems have been developed provi–ding the user with tools such as line and raster graphics, WIMP GUI´s, and advanced multi–media extensions. With the advent of immersive virtual environments the user finally arrived in a 3D space. Walkthrough experiences, manipu–lation of virtual objects, and meetings with synthesized collaborators have been proposed as the special human-computer interfaces for the scientific visualization process.

There is another approach to the design problem for future human-computer interfaces. Based on the early ideas of Myron Krueger non-immersive interactive multimedia environments have been developed. Basically, they are centered rigor–ously around the user´s point of view. Application-oriented visuali–zation environments have been proposed and built to support a specific problem solving process. The computer acts as an intelligent server in the background, providing necessary information across multi-sensory interaction channels.

The "Responsive Workbench" concept has been developed as an alternative model to the multimedia and virtual reality sytems of the past decade. Analyzing the daily working situation of such different computer users as scientists, architects, pilots, physicians, service people in travel agencies and at ticket counters, we recognized that almost nobody wants to live with simulations of their working worlds in a desktop environment. Generally, the users want to focus on their tasks rather than on operating the computer. The future computer system should use and adapt to the rich human living and working environments. It should be designed to work as a part of a responsive environment. The Responsive Workbench has been designed in an interdisciplinary group incorporating a designer , an architect and physicians from the beginning.

The architect's point of view: The ultimate design environment is and will be the designer's desk, ``The tableau is the place where objects come together" (J. Beaudril–lard). Design is a process which is based on a dynamic, free floating interaction between brain, eyes, hands, and the environment., `The hand is the exterior brain of the human" (I. Kant).

Comments of physicians: The center of interest is the patient or the education process, not the operation of computer equipment. The typical working situations are cooperative tasks amongst specialists around a table whith the patient on the table top, e.g., in surgery, radiation treatment, and medical education.

Scenario

Virtual objects and control tools are located on a real "workbench" (see Fig. 1). The objects, dis-played as computer-generated stereo-images are projected onto the surface of the workbench. This setting corresponds to the actual work situation in an architect´s office, in surgery environments, etc. A guide uses the virtual working environment while several observers can watch events through stereo shutter glasses (see Fig. 2). The participants operate within a non-immersive virtual environment. Depending on the application, various input and output modules can be integrated, such as motion, gesture and voice recognition systems, which characterize the general trend away from the classical human-machine interface. Several guides can work together in similar environments either locally or by using broadband communication networks. A responsive environment, con–sisting of powerful graphic workstations, tracking systems, cameras, projectors, and microphones, replaces the traditional multi–media desktop workstation.

Two scenarios have been realized so far:

- Design and discussion process in architecture, landscape and environment planning:
  An architectural model is shown on the workbench, in our case the area around the buildings of our research institute (see Fig 3 and 4). In front of the table two architects discuss the model, moving around buildings or other objects, such as trees in the virtual world (see Fig. 2). Additionally lightsources can be set by the data glove to simulate different times of the day. For this environment the concept of active objects appears to be essential, e.g., cars driving around, pedestrians walking along the street. Objects such as trees can be added and translocated. The problem of generating an animation path for each object is easily solved by an additional Polhemus, which can be moved around in the virtual world like an object to be animated. The Polhemus generates the position, orientation and velocity data for the animation path.
- Surgery planning and non-sequential medical training:
  This application shows a real sized model of a patient, called the transparent woman, in a teacher/student scenario. The patient's skin can become transparent and the arrangement of the bones becomes visible (see Figs. 5 and 6). Now it is possible to pick up a bone with the dataglove and examine the joints which it connects with, or take a close look at the bone itself (Figs. 7 and 8). A different scenario is surgery planning with virtual bodies origi–nating from real data sets from CT or MRI measurements. Applications in minimal invasive surgery are in preparation.

Future applications and systems extensions

Immediately, during the discussion of the RW concept, the set up of the whole system, and the realization of the first application scenarios, we came up with the following ideas for improvements and extensions:

- enhancement of I/O and rendering tools for the RW system;
- inclusion of other applications, suited to this specific environment;
- design of appropriate responsive environments for other classes of end users.

The RW system is designed to demonstrate the ideas and power of future cooperative responsive environments. Further applications under consideration running on this virtual workbench will be an adapted ``virtual windtunnel" for car design, the simulation of air and ground traffic on airports, a training environment for complicated mechanical tasks, e.g., taking apart a machine for repair, landscape design and environmental studies via terrain modeling, and modeling of virtual objects (``virtual clay"). These applications also rely on the workbench metaphor, but require specific interaction and I/O tools.

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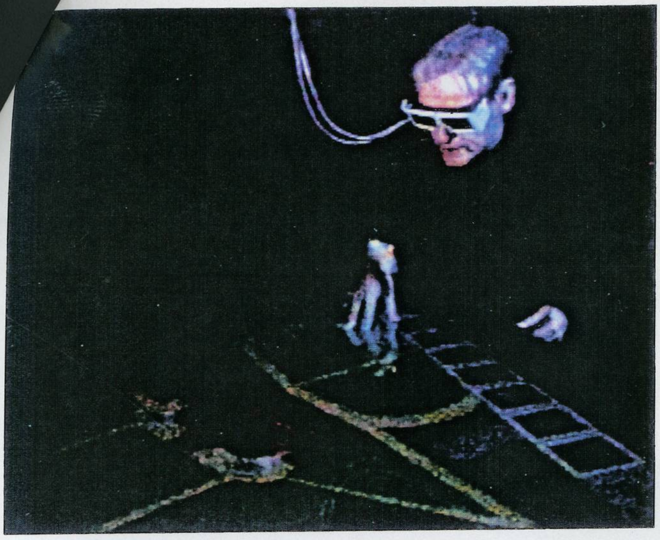

Fig. 3 Architectural Planning on the Responsive Workbench

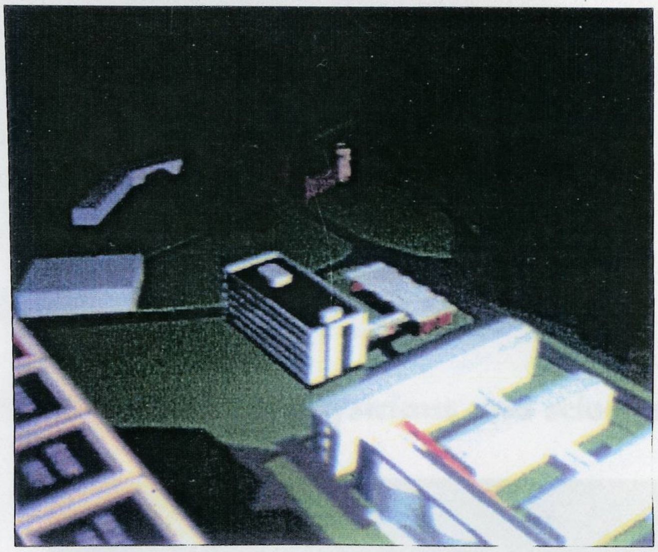

Fig. 4 Architectural Planning - from the user's point of view

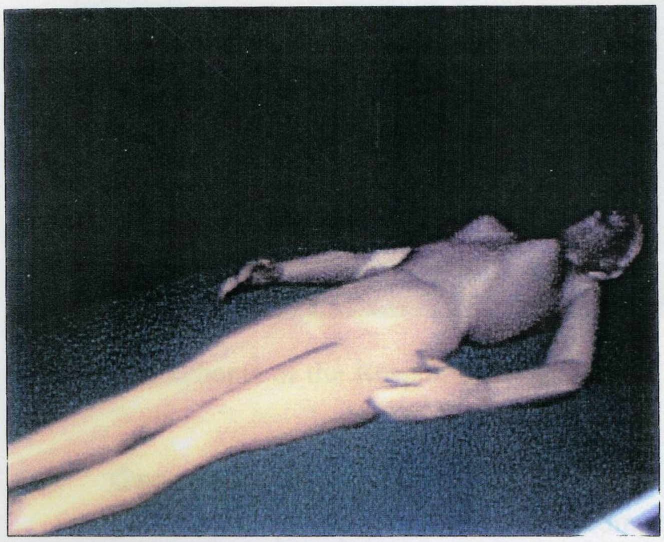

Fig. 5 The virtual patient on the RW-system

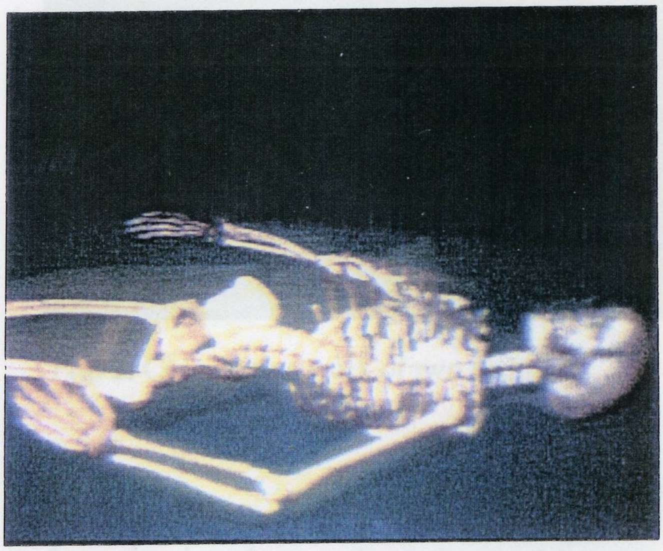

Fig. 6 The virtual patient with semi-transparent skin

Fig. 7 Surgery planning scenarion

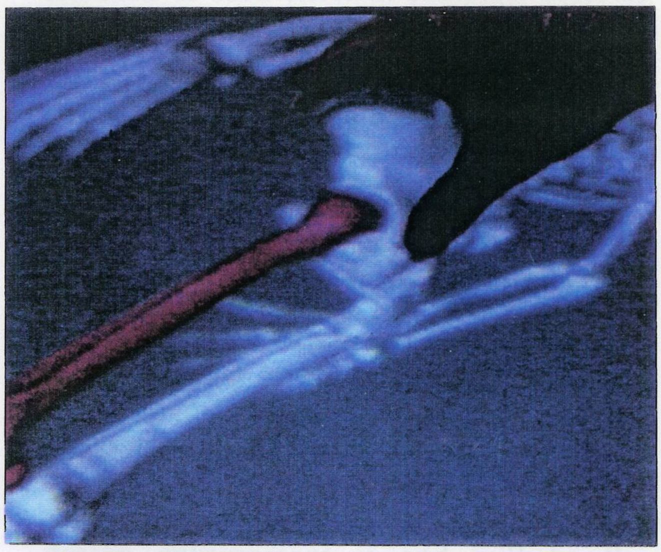

Fig. 8 Removing a bone