CyberMath

CyberMath is a prototype of a shared 3D mathematical ILE developed by Ambjörn Naeve and Gustav Taxén[1]. The following two paragraphs are quoted from the CyberMath web site: http://www.nada.kth.se/~gustavt/cybermath/.

It is well known that the current state of mathematics education is problematic in many countries. The Interactive Learning Environments group at CID is developing an avatar-based shared virtual environment called CyberMath, aimed at improving this situation through the presentation of mathematics in a new and exciting way. CyberMath is suitable for exploring and teaching mathematics in situations where both the teacher and the students are co-present and physically separated. The environment is built on top of DIVE, a toolkit for building interactive shared distributed virtual environments that support multiple simultaneous participants.

In the CyberMath environment, people (represented by avatars) can gather and share their experience of mathematical objects. When a person points to an object with the mouse, a red beam running from his avatar to the object appears in the 3D environment, similar to a laser pointer. Objects can easily be manipulated (rotated and translated) using the mouse. Since live audio is distributed as well, a person can point, act and talk - much as he/she would do in real reality - as if the mathematical objects were hanging there in front of him/her. Hence, mathematics teachers are provided with a tool that integrates the best of both the virtual and the real world: virtual (mathematical) objects can be manipulated and discussed in a realistic way.

As mentioned earlier, CyberMath was presented (as a part of the Garden of Knowledge project) at the Siggraph 2000 conference in New Orleans . It was also presented at the CILT-2000 conference on new learning technology in Washington DC that was held in October 2000. Moreover, CyberMath has been accepted for independent presentation in the Educators program at Siggraph 2001 (Los Angeles, August 2001). As mentioned earlier, it has also been accepted for presentation at the ICDE-2001 world conference on open learning and distance education (Düsseldorf, April 2001).

On Oct. 5, 2000, we performed our first real distributed lecture in CyberMath, operating between Stockholm and Uppsala[2]. The teacher (Ambjörn Naeve) was physically located in Stockholm, and a group of 12 students were physically located in Uppsala. A tele-presence module was set up in parallel with the CyberMath system, which allowed teacher and students to have eye-contact during their interaction in cyberspace. This module was designed and operated by Claus Knudsen of the Media group at NADA as a part of the Communicative Spaces project within the Swedish Learning Lab.

CyberMath has recently been adapted to the VR-cube environment that is available at KTH (http://www.pdc.kth.se/projects/vr-cube/). There are still some minor problems to straighten out, but in principle it works great. We are planning a series of user

[1] A doctoral student at CID specializing in computer graphics and 3D systems programming.
[2] See pp. 47-50 below for an assessment of this experimental lecture.

studies to evaluate the differences of embedded VR versus desktop VR in this educational setting. CyberMath will also be used within a project called SHAPE (funded by the European Union) in which CID takes part (http://cid.nada.kth.se/sv/forskning/eu-projekt.html).

In the Wallenberg Young Scholars Program for the creation of the Virtual Museum of the Nobel e-Museum (www.nobel.se) there is a strong emphasis on the connection between young people's interest in a website and its ability to support advanced forms of animation and interaction. For the same reasons, we believe that CyberMath in a networked cave environment holds the potential to provide a high-tech front end which is interesting enough to create public interest and contribute to a more positive attitude towards mathematics - especially among young people. It could also provide a useful platform for developing various forms of interactive problem solving games - where the present violence-orientation of the gaming industry could be shifted towards an emphasis on cooperative problem solving skills, leading to future knowledge games that are designed to stimulate the learning interest of the gamers.

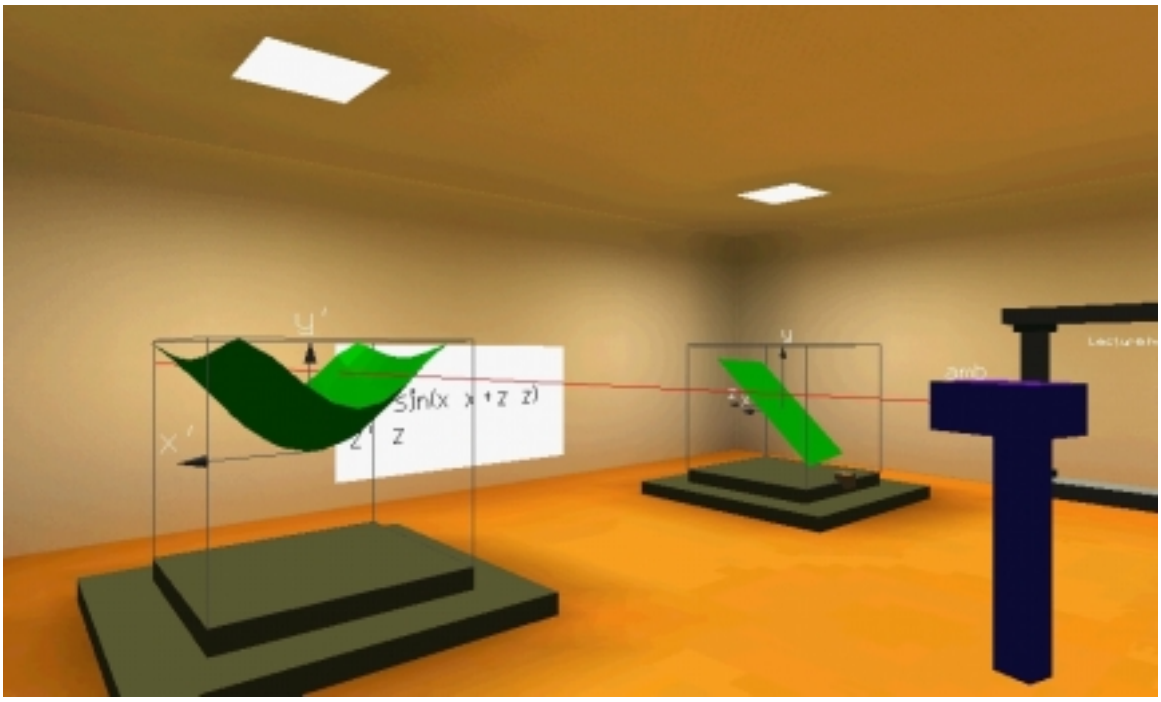

Fig. 1: The Transformation room: An avatar pointing to the image of the green plane under the mapping described on the wall.

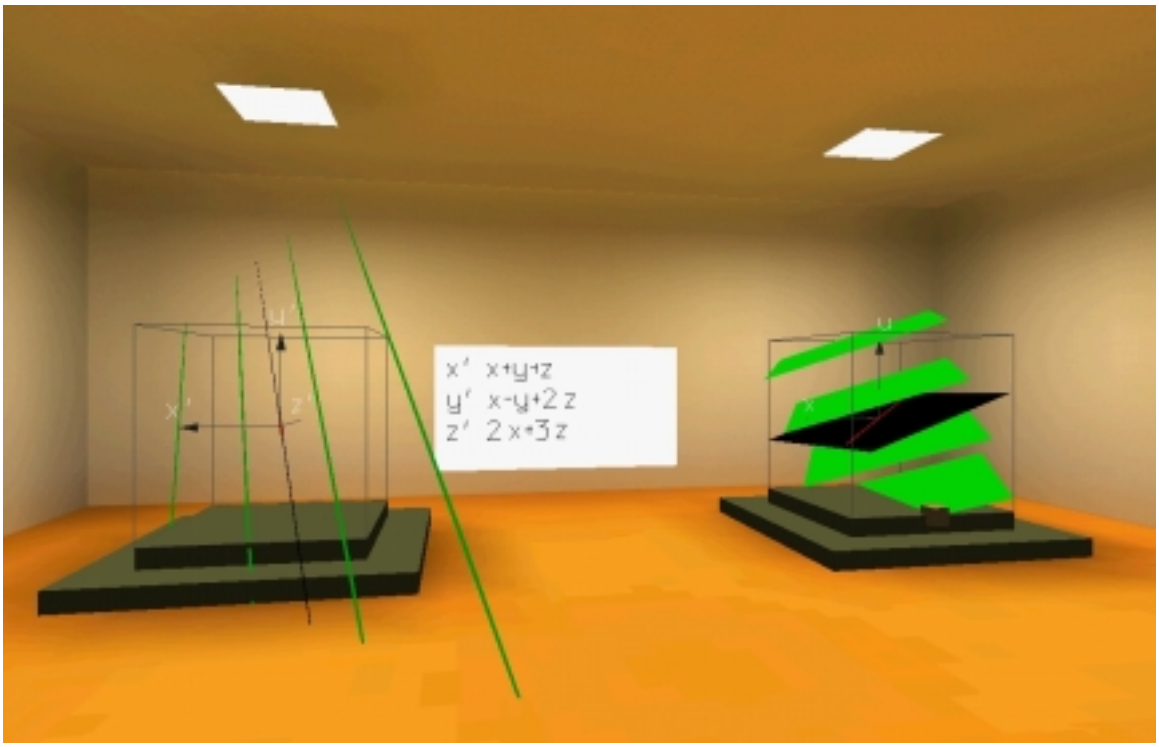

Fig. 2: The Transformation room: Determining the kernel of the linear mapping $R^3 \rightarrow R^3$ on the wall. (Note: The equality signs are missing due to font problems)

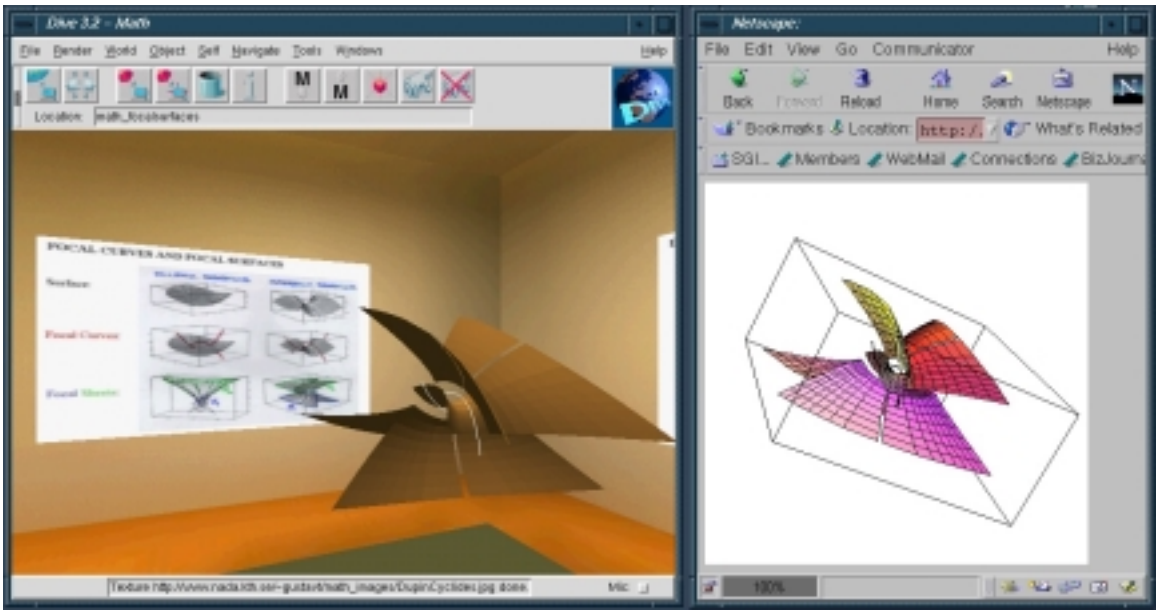

Fig. 3: Importing a Mathematica object (and connecting to the web archive)

Left-clicking on a a mathematical object in the CybeMath environment, brings up a web browser and connects to a web archive where the corresponding object is stored as a component with graphics, formulas and explanations of various kinds. The object can then be manipulated (= rotated and scaled) directly in the browser using LiveGraphics3D.

It is a basic design decision to keep the CyberMath environment “formula-free” in order to avoid the neurotic reactions that mathematical formulas tend to trigger in many people at the first encounter. Since the geometric forms created by the formulas are experienced by most people as structurally interesting and aesthetically pleasing, these forms can serve as an incitement to overcome the “formula-neurosis” and penetrate the formidable language barrier that hides the magic and the beauty of mathematical formulas from public view.