PROGRESS REPORT. APE TRACK C

Ambjörn Naeve, Stefan Seipel

Context

1a. Experiment and track name

Experiment 2 - Content archives, student portfolios & 3D environments (APE).

Track C. CVEL experiments (3D communication and visualization environments for learning)

1b. Principal Investigators:

Stefan Seipel, Dept of Information Science, Uppsala University

Ambjörn Naeve, CID / NADA / KTH

1c. SweLL organization:

Coordinator: Donald Broady, Director Uppsala Learning Lab

Evaluation and documentation adviser: Monica Langerth, Uppsala Learning Lab

1d. Staff/faculty involved

Ambjörn Naeve, CID, NADA, KTH

Gustav Taxén, CID, NADA, KTH

Olle Sundblad, CID, NADA, KTH

Han Fei, DIS, UU

Mats Lind, DIS; UU

Activities and progress (overview)

This section gives an overview of the main activities, outcomes and timing during the first six months. For further details, see section 4 and App. 1 (CVEL Work Packages 2000)

At this stage of the project, activities are running according to work schedule.

Table 1: Activities overview in APE, Track C: CVEL

Activity	Outcome/Results	Realized/Timing
Selection of appropriate topics and specification of 3D content and interaction to be created		
A course in interactive graphics programming has been carried out engaging the students in the identification of specific course contents	A 3D experimental teaching program	June
Brainstorming meetings to outline and specify possible visualization experiments which could contribute to an improved understanding of tricky course topics	Proposals and draft specifications for 7 different interactive 3D components for learning are available.	
Implementation of interactive content		
The above-mentioned 3D components are ranked in their priority order and are being specified further..	Implementation of the most significant one (the "Visual Matrix") has already been started up and will soon be demonstrable	Fall
Mathematical archives: Construction of geometrical components and conversion of these files into interactive 3D-graphics viewable by a web browser.	Interactive archive of mathematical components accessible on the web (viewable with the common browsers and an installed JRE). A test-archive is available at: http://www.nada.kth.se/cgi-bin/osu/dirlister2?math	May
Introduction of Graphing Calculator to mathematics teachers.	Future implementation in mathematics courses within the IT and Media programs	Spring 2001
Specification and implementation of information representation landscapes		
A draft specification of an information landscape for the IGP-course has been outlined.	Further refinement will be carried out within the next weeks before implementation into the Active Worlds environment can be performed in the second half of year 2000	Fall
Identification of shortcomings of interaction mechanisms in Active Worlds		

A number of shortcomings of the Active Worlds environment have already been identified which prevent 3D interactive content to be executed as an intrinsic part of the 3D communication environment	Different alternatives to Active Worlds have been investigated, none of which providing sufficient solutions, though. A technical workaround is currently being worked on	Summer
AW does not allow for the most exiting forms of interactions - such as e.g. shared 3D-experience of the same (custom-made) object.	The 3D cyber world DIVE, developed in Kista by SICS (Swedish Institute of Computer Science) will replace AW.	Spring/summer
DIVE system development and extensions (e.g. translation programs, environmental design)	An outline of a teaching environment in which the 3D geometric components works.	Summer/fall
Dissemination and outgoing activities See section 4 (Networked Caves) and section 6 for further details	Contacts have been made with future collaboration possibilities.	Spring/summer

Time frame and current state compared to project and activity plan

So far, the activities are running according to time plan in this project and regularly meetings are held. See section 4 for further details.

Content and current state compared to project plan

1e. Stefan Seipel's report on progress (DIS)

Note: For details in Work Packages, WP; see App. 1

Following activities have been carried out at Uppsala in the first period of the project:
Within the spring period, a course in interactive graphics programming has been carried out engaging the students in the identification of specific course contents, which lend to a 3D experimental teaching program.
Different brainstorming meetings where held to outline and draft specify possible visualization experiments which could contribute to an improved understanding of tricky course topics. As a result of this, proposals and draft specifications for 7 different interactive 3D components for learning are available. They are ranked in their priority order and are being specified further. Implementation of the most significant one (the "Visual Matrix") has already been started up and will soon be demonstrable. These activities are in line with the work description from work-packages WP1 and WP3.

With regard to WP5, a draft specification of an information landscape for the above mentioned course has been outlined. Further refinement will be carried out within the next weeks before implementation into the Active Worlds environment can be performed in the second half of year 2000.

With regard to WP6, a number of shortcomings of the Active Worlds environment have already been identified which prevent 3D interactive content to be executed as an intrinsic part of the 3D communication environment. To tackle this problem, different alternatives

to Active Worlds have been investigated, none of which providing sufficient solutions, though. A technical workaround is currently being worked on.

1f. Ambjörn Naeve's report on progress (CID/NADA)

Mathematical Archives

I have been using Mathematica to construct a multitude of geometrical components - 3D curves and surfaces - with interesting mathematical and graphical content. Moreover, I have found a way to convert these Mathematica files into interactive, web browser-viewable 3D-graphics, using a freely available Java applet called LiveGraphics3D created by Martin Kraus
(http://wwwvis.informatik.uni-stuttgart.de/~kraus/LiveGraphics3D)
Some of the geometrical shapes that I have created are discussed in the basic mathematics courses at the university level (such as quadric surfaces), whereas some are more interesting from a shape-research point of view - with special applications within the fields of CAD (Computer Aided Design) and computer graphics. I have also managed to transform Mathematica animations in the same way, and have created an animation with special applications to the field of optics and solar energy (Point Focus). The common theme of these geometrical components is that they should be of strong interest to some segment of the scientific and/or educational community - thereby serving as "ambassadors" for the somewhat neglected field of geometry.

In collaboration with Olle Sundblad at CID I have started to explore different ways to archive mathematical components of different kinds - including the ones described above. Olle has created a powerful tcl/tk-program called dirlister, which creates opportunities for different ways of interacting with such an archive. Our test-archive is presently available at http://www.nada.kth.se/cgi-bin/osu/dirlister2?math

This archive can be updated dynamically (by using e.g. ftp, Fetch or Anarchie) and the components are viewable under both Netscape and Explorer - provided the JRE (Java Runtime Environment) is properly installed. Presently there is no text on the html pages, but soon we will be putting in textual descriptions as well. We are presently working out the best way to handle the mathematical formulas, which presents a well-known problem - traditionally solved by painful workarounds like screen dumps in the form of gif-images.

Graphing Calculator

We are also exploring how to handle components created by using a program called Graphing Calculator - created by Ron Avitzur at PacificTech. He is based in Stanford, and he has close connections to Terry Winograd's research group at the computer science department at Stanford University. In my opinion, the Graphing Calculator is the best program available today for the visual display of mathematical formulas. It offers truly novel ways to interact with the components of a mathematics archive, where frozen animations (in the form of e.g. Quicktime movies) can be downloaded and brought back to life by dumping the corresponding files in the Graphing Calculator window. The mathematical parameters can then be changed and explored and a new film can be recorded an uploaded to the archive. This constitutes a very exiting graphical way of conducting mathematical discussions between the teachers and the students as well as between the students themselves. I have started to introduce this technique to two of the mathematics teachers (Henrik Shaghoulian and Gunnar Johnsson) who are teaching within the IT respectively the Media program, and we are planning to introduce this technique in

the mathematics courses that will be given on the IT and Media program during the spring term of next year

Dive

During the spring I have started to collaborate with Gustav Taxén at CID in order to make my geometric components available in an avatar-based 3D environment. The original plan was to use Active Worlds as the underlying 3D world for the construction of a site where these components could be exhibited, discussed and explained by interacting avatars. However, although Active Worlds is widely available - and runs on many different platforms - we have found that it does not allow for the most exiting forms of interactions - such as e.g. shared 3D-experience of the same (custom-made) object. With AW we would have to settle for the traditional web as a mediator between the avatars and the 3d-experience, which defeats the main purpose of shared 3d-experience.

We have therefore decided to use the 3D cyber world DIVE, developed in Kista by SICS (Swedish Institute of Computer Science). Gustav has created a translator program that transforms my geometric components into the format required by Dive, and we are presently working to construct an outline of a teaching environment where avatars can gather and share their experience of interesting 3D geometric shapes. In the center there will be a sort of conference room with an oval table and a virtual OH-projector. This room will be shaped like a hexagon and it will be surrounded by six different rooms of the same shape. These rooms will function as exhibition rooms, and each of them will house a different family of geometric components. In the central conference room the theory can be presented and then the avatars can walk out into the surrounding exhibition rooms and study the shapes in practice. And since Dive is equipped with sound, the avatars will be able to discuss their experiences in the good old traditional way.

Newtworked Caves

Prof. Yngve Sundblad has put Ambjörn Naeve in contact with Prof. Ralph Schroeder, Inst för teknik och samhälle, CTH (Chalmers Tekniska Högskola), who is planning a project for connecting the virtual reality caves at KTH in Stockholm and CTH in Gothenburg. The plan is to study the cognitive effects of various activities in this kind of networked cave environment. Having been introduced to our archive of geometric components and the Dive geometry teaching project, he has decided to choose geometry teaching as the central activity to be studied in this networked cave setting. This fits well with the fact that SICS is presently working on adapting Dive so that it will be able to run in the cave environment. Hence we will be able to bring out geometric learning environment into the networked cave setting. This project 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. Moreover, it also would provide a good opportunity to get Gothenburg involved in the activities of the Swedish Learning Lab.

Evaluation

1g. Evaluation plan overview

Table 2: Evaluation focus and activity plan

Focus and general objectives	Activity	Supportive technology	Data collection	Data analysis/ method	Timing
To explore whether the use of 3D tools enhance students ability to understand complex spatial and dynamic relationships in different disciplines	Implementation of various 3D features in courses in mathematic and Interactive Graphical Programming	Interactive 3D environment for communication and visual representation of content 3D representation on interactive web sites	?? Usability test Interviews/focus groups Observations	??	Spring 2001
To explore whether a shared experience (by sharing and interacting with the same 3D object) enhance students' ability to develop deeper understanding of complex systems.	The use of an interactive 3D community (such as Active World or Dive) to interact with each other and the same objects simultaneously.	Interactive 3D environment for communication and visual representation of content	?? Observations Usability test Interviews/focus groups	??	Spring 2001

1h. Travel

Ambjörn Naeve's report on travel

During the period of March 9 to March 29 I spent 10 days in Stanford visiting the Stanford Learning Lab and 1 week in Arizona visiting professor David Hestenes.

During my visit to Stanford I met Tamara Munzner, who is a PhD student under Terry Winograd and a close friend of Ron Avitzur (the creator of the Graphing Calculator). Tamara was very impressed with the interactive geometric work that I showed her and expressed a strong wish to collaborate with us. She has been engaged in advanced geometric modeling work for several years, and she is presently working with a prototype called Hyperbolic-Cube (H3) which is a graph display tool that can display 3d-graphs and zoom in on various parts. This tool would greatly enhance the presentational power of Conzilla, the conceptual exploration and presentation prototype that we are developing at CID.

Stanford

Unfortunately, Ron Avitzur was away during my visit, but through Tamara I am presently in contact with him via e-mail. During April and May he has been sending me pre-release test prototypes of the Graphing Calculator which I am trying out for evaluation and feedback. There has been substantial improvements made during this time, and I'm really impressed with the development pace that Ron and his crew at Pacific Tech manages to keep up. It's worth while to check them out at http://www.PacificT.com

While at Stanford I also met with Brad Osgood who is a mathematician closely associated with the Stanford Learning Lab. He is a strong advocate of reforming the mathematical curriculum and is presently working in the department of Electrical Engineering, where he has created novel techniques of illustrating electromagnetic phenomena. He was not familiar with the Graphing Calculator, but when I demonstrated its workings he immediately saw the value of using it in mathematics education. According to Brad there is an increasing awareness among the engineering faculties at Stanford that “some radical changes have to be performed in mathematics education - regarding both what we teach and how we teach it”. Since the same awareness seems to be growing at KTH there should be room for many forms of collaborative efforts in the future.

Arizona

In Arizona I was working for a week with my friend David Hestenes, who is a professor of physics at the department of Physics and Astronomy at Arizona State University. As mentioned above, we are part of a team that are giving an advanced course in Geometric Algebra at the computer graphics conference Siggraph2000 which will be held in New Orleans between July 23 and July 28. David Hestenes is an internationally renowned authority on GA (or Clifford Algebra as it is also called) and he has spent the last 40 years advocating its use as the basic mathematical tool in exploring physical reality.

See http://modelingnts.la.asu.edu/GC_R&D.html for further details on this great project.

While in Arizona, I also met Alyn Rockwood who is the organizer of our GA course at Siggraph2000. Alyn Rockwood is a computer scientist specializing in computer graphics. He has been a collaborator of David Hestenes for many years and is presently heading the computer graphics research at the scientific laboratory of the Mitshubishi corporation in Boston. Alyn Rockwood is closely involved with the Siggraph organization, and he was so impressed with my geometric work that he wants to organize a Siggraph workshop on interactive geometry at KTH in Stockholm. He also gave me a standing invitation to come to Boston and present my work to the people at the Mitsubishi scientific lab.

Conferences

Stefan Seipel's report from LEARNTEC

The European Conference on Learning Technology LEARNTEC, 8.2.-11.2. 2000, in Karlsruhe. The visit gave a good overview of the European state-of-the-art in WEB based training and education. It showed, that activities such as performed in the CVEL project are clearly ahead of what is currently being researched and experimented on. Surprisingly, none of the speeches given could demonstrate interactive 3D learning scenarios. Most

common are HTML based learning scenarios and stand-alone multimedia products, which do not provide networked interaction capabilities.
At this conference contacts were established to Dr. Heino Steentoft, who is director of the Technology Transfer Center of the Kiel University in Germany. They have been starting up a project using virtual 3D environments to simulate chemical laboratory settings. The challenges they met are equal to those we find in the CVEL project. As a result of their market analysis of available development tools, they decided to use ViScape for development of their interactive 3D environments.

Ambjörn Naeve's talks at the upcoming SIGGRAPH-2001

Ambjörn Naeve will get a chance to present this work at the prestigious conference on computer graphics called Siggraph2000 which will be held in New Orleans in July. He is attending the conference as part of an international team headed by Prof. David Hestenes that is giving a 1 day course on Geometric Algebra (http://www.siggraph.org/s2000/conference/courses/crs31.html). In this context Ambjörn Naeve will give a lecture entitled Projective Geometric Computing, where he will make use of the dynamic geometry program PDB (Projective Drawing Board) developed by Harald Winroth and myself as a part of Harald's doctoral dissertation at CVAP last year.

Within the GA course Ambjörn Naeve will also give a lecture on the Garden of Knowledge as an example of an interactive mathematical learning environment. Here he is planning to present the GoK prototype that has been developed at CID, and he will give a short presentation of the ongoing work on the Dive geometry exhibition that was described above. The three programs (PDB, GoK, and Dive) will also be entered into the Siggraph Creative Applications Laboratory, where they will be available during the entire conference for demos on request by intrerested people, and for general conference attendants to try out. This presents a great opportunity to generate interest and make strategic contacts for future development projects

Talks/presentations

Ambjörn Naeve: Talks and presentations, see same section 6 in APE Track A.

Workshops

• March 7-8

Place: Kämpasten, Sigtuna.

Purpose: Presentation of the Swedish Learning Lab

Participants Track C: Ambjörn Naeve, Stefan Seipel

• May 9-10.

Place: Uppsala Learning Lab.

Purpose:. Presentation and discussion of SweLL Evaluation Research Framework and Research focus

Participants Track C: Stefan Seipel

• May 25.

Place: Uppsala Learning Lab.

Purpose:. Presentation and talk during the official inauguration of ULL

Participants Track C: Ambjörn Naeve, Stefan Seipel

Appendix

Appendix 1: Activity Plan for Experiment 2, APE (Track A-C). January 31, 2000.

Appendix 2: Curriculum for the courses under development in Track C.

Appendix 3: