

Final Report

Contract Number: NAG13-24

Contract Title: Building an Integrated Environment for Multimedia

Organization: University of Southwestern Louisiana

Project Director: Dr. Theodore Williams

Multimedia courseware on the solar system and earth science suitable for use in elementary, middle, and high schools was developed under this grant. The courseware runs on Silicon Graphics, Incorporated (SGI) workstations and personal computers (PCs). There is also a version of the courseware accessible via the World Wide Web. Accompanying multimedia database systems were also developed to enhance the multimedia courseware. The database systems accompanying the PC software are based on the relational model, while the database systems accompanying the SGI software are based on the object-oriented model.

Although project participants varied mainly due to student graduation, the project team normally consisted of two undergraduate students and one or two graduate students in addition to the project director. The undergraduate students did much of the multimedia courseware development and some research in ways to more effectively present courseware. The graduate students completed much of the multimedia database system development, some of the multimedia courseware development, and some research in multimedia database systems.

Early on in the project, area high school principals and counselors were polled to determine the hardware platforms currently available at their schools. They were also asked about the amount and types of courseware used at their schools. It was learned that there were both Macs and PCs at the schools with possibly more PCs than Macs. It was also learned that the schools varied widely as to the amount of hardware and software present at the various locations. The schools indicated a desire for science based courseware.

Because of the desire for science courseware and the fact that NASA was funding the project, we decided to develop courseware on the planets of our solar system as our first application. We also decided to develop the courseware on the SGI workstations in our facility. These machines have impressive graphics capabilities, and they come with multimedia presentation software which allows the creation and manipulation of 3-D objects in addition to allowing the integration of text, graphics, sound, movies, and animation. Although these machines were too expensive to expect that they would be present in schools in large quantities, using them allowed us to easily develop visually appealing courseware. Price trends also indicated that prices for SGI machines with current capabilities would continue to drop over the next several years. This trend has proven to be true as SGI has introduced lower cost machines. Developing on the SGIs

allowed us to explore the capabilities of the machines for multimedia courseware development and to have packages ready when the machines became affordable enough to be purchased by some schools. We also decided to develop the courseware on the PC platform.

We got most of the source material for the Solar System Courseware from various places on the World Wide Web. We got images and text from various NASA sites such as JPL and Goddard Space Flight Center. We got video from Johnson Space Center's video archive. The initial courseware allowed a user to navigate within the documents in sequential order or, by using hyperlinks, to jump around to desired portions of the document. The courseware included such interesting features as narration of picture captions, scrollable text windows, pop-up windows with sound effects, and zoomable pictures.

We then tested the courseware with groups of high school students who visited our facility on some Saturday mornings. The students indicated that they enjoyed using the courseware much more than they would have enjoyed reading a book. They seemed impressed with the graphics and special effects of the courseware. The students also pointed out problems with the software.

In addition to the courseware, we developed a multimedia database system. Because there was no database management system on the SGI workstations, we developed the database using Oracle, a relational database management system, on a networked workstation at another location on campus. The database system allowed us to query the database for images, text, audio, movies, and animations which satisfied desired characteristics and have the media displayed in the appropriate format.

One of the major goals of this project was to investigate the use of an object-oriented database management system (OODBMS) in the development of a multimedia database system. We decided to use ObjectStore, a leading OODBMS, to develop an object-oriented version of the Oracle database system. We purchased ObjectStore for the SGIs from another source of funding. We now had a localized database management system. This gave us more control than we had with the remote system.

In developing the object-oriented, multimedia database system, we developed a set of media classes which could be later reused with other database systems developed for domains besides the solar system. We developed classes for text, images, audio, movies, and animation. Objects could then be created for each of these classes with capabilities and behaviors defined in the classes. For example, a text object could display itself and a movie object could play itself and return the number of frames contained in the movie. An image could give related objects. Audio narration objects could give the name of the narrator.

In addition to the media classes, solar system classes such as "planets", "moons", and "stars" were developed. These classes in combination with the media classes allowed us to display solar system multimedia data. For example, we could play movies related to

the sun, or retrieve an object representing the planet Mars and display its related images. By exploiting the object-oriented concepts of encapsulation and inheritance we were able to develop a set of reusable classes. This multimedia database system was then integrated with the SGI courseware.

We developed a version of the multimedia courseware for the PC. We also developed an accompanying multimedia database system for the courseware using the Microsoft Access relational database management system. The PC system is similar to the SGI system although the authoring paradigms were very different. The authoring paradigm for the SGI system was page-based in that you defined the contents of each page and navigation was based on specific links. An icon-based paradigm with flowcharts was used in the PC version. Navigation was based on the value of system and custom variables. The other major difference between the SGI and PC systems is that the SGI system uses an OODBMS and the PC uses a very widely used relational DBMS. Even so, to the user, the look of both systems is very similar.

We created CDs for the PC version of the courseware. The initial CD contains the courseware presentation. An optional set of diskettes contains the multimedia database system. The multimedia database system allows teachers to add new text, graphics, audio, movies, and animation to the multimedia database. The new media are stored in specified directories on the hard disk. Student queries are run against both the original material on the CD and the new material on the hard disk.

The original CDs were developed to be viewed at 800X600 screen resolution. Because we did not want students to be unable to use the courseware because they were working with older machines, we also developed CDs with a resolution of 640X480 which can be viewed on older displays. This package has the same capabilities as the 800X600 package except that the graphics are not as good.

We also developed a version of the courseware for the World Wide Web. This version allows a greater number of students to access the courseware than is possible with the SGI version of the system or even with the CDs developed for the PC version of the system. No DBMS was connected to the Web version of the system.

The earth's environment is a very important area of concern for NASA as evidenced by programs such as NASA's "Mission to Planet Earth". For this reason, our second subject area was earth science. As with the solar system, we developed SGI/OODBMS, PC/relational DBMS, and Web courseware packages for earth science. This courseware focuses on areas including global warming, the ozone layer, earthquakes, rivers and lakes, oceans, wetlands, polar ice, and volcanoes. As with the solar system, much of the media content for the earth science packages was obtained from the Web.

The final set of software developed for this project follows:

- I. Solar System
 1. SGI multimedia courseware

2. Object-oriented multimedia database system
3. 800X600 PC multimedia courseware
4. 640X480 PC multimedia courseware
5. Relational multimedia database system
6. Web multimedia courseware

II. Earth Science

1. SGI multimedia courseware
2. Object-oriented multimedia database system
3. 800X600 PC multimedia courseware
4. 640X480 PC multimedia courseware
5. Relational multimedia database system
6. Web multimedia courseware

In addition, we investigated the creation of Mac versions of both the solar system and earth science courseware. Because of storage problems on our Mac system, we decided not to make Mac CDs.

This project allowed us to evaluate the differences between relational DBMSs and OODBMSs in the development of multimedia database systems. We published a paper describing the project in the Proceedings of the 1994 IEEE 37th Midwest Symposium on Circuits and Systems.

In conclusion, this was a very rich project. It allowed us to explore various aspects of multimedia data including multimedia courseware packages on workstations and PCs, multimedia courseware on the Web, and multimedia database systems. We looked at the trade-offs between using relational and object-oriented technology to develop databases. The project was a good opportunity for undergraduate students to get exposure to software development such as they will experience upon graduating from college. They were also exposed to limited research tasks. Hopefully, it will encourage some of them to attend graduate school. The graduate students were able to gain research and development experience while developing a practical product. CDs containing the courseware developed under this project are currently being distributed to a set of schools.

Response Form

Please return this sheet with your response. For your convenience, use the return label at the bottom of this page.

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☒ *Materials from this Contract / Grant are enclosed for your review.*

☐ *Materials from this Contract / Grant were submitted to the following:*

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☐ *Materials from the Contract / Grant were never published.*

☒ **Other Response** Copies of the enclosed materials were also

sent to Mr. Charles K. Hayes

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