Hands On Universe - Astronomy Project for Museums
Award DE-FG05-92ER75843
Final Report

I. INTRODUCTION

The goal of the Hands On Universe project is to bring a sense of wonder about the Universe to children and adults in light-polluted and technology-deprived, culturally under-served environments. The beauty and magnificence of the heavens have been a source of wonder to humans from the earliest times. This appeal remains today, but for many people it is never realized. As humans have moved indoors and into urban areas, they have become less and less aware of the heavens. This program was designed introduce teachers, students, and the general community, to image processing and automated astronomy. There were two levels to the program at the Macon Museum of Arts and Sciences: a teacher enhancement/teacher training program and a program for school children which would also serve the general public. A discussed museum exhibit for the general public to be built and prototyped by the Boston Museum of Science never materialized.

The participants in the teacher enhancement/teacher training program used the computers supplied by the Museum of Arts and Sciences and located within our "Hands On Universe Classroom" to request and then work with real image data in the pilot program. One of the teachers, Jamie Akin, used the Museum computers as a supplemental place for her students. Our project coordinator, Milton Ivery, used the computers to run image processing activities and workshops with groups of their students from Boys and Girls Clubs, churches, and the general public. The project allowed museum goers in Macon, Georgia to access telescope in California, taking astronomical images with remote telescopes and Charge Coupled Device ("CCD") detectors sent over telecommunications networks.

The first part of this collaboration consists of the team and the successful telescope, detectors, and networking software of the Lawrence Berkeley Lab's Automated Supernova Search. The Supernova Search regularly takes 500 or so images per clear night. Macon users had access and were able to use some of the time on this system. Participants used image processing software, Win-Vista, developed at University of California, to work with the images on high performance PC's at the Museum. The second part of the collaboration is the Macon Museum of Arts and Sciences and its proven success in attracting and educating under-served populations. With no other science museums or planetariums in a 90 mile radius, the Museum draws school children from throughout the 33 county Middle Georgia area. Its hands-on, interactive

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approach and individually tailored, live tours and programs appeal to Atlanta-area teachers as well. At the time of this project, museum visitation averaged about 75,000 each year, with escorted school groups comprising about 1/3rd of the total. The "Hands On Universe" project is especially attractive, since women and under-represented minorities have been shown to excel in this type of learning, which addresses the needs of Macon's 45% African-American, urban population and the rural population of outlying counties, some of which are 50 to 60% African-American.

With the requested funds from the Department of Energy, we proposed the following:

1. Buy computers for the Macon Museum of Arts and Sciences.
2. Hold one teacher training workshop.
3. Hire a ½ time staff person to run the program for a year.
4. Evaluate the success of this system.

II. OVERVIEW OF SYSTEM

A. The Consortium

An strong component of the proposal was the consortium that was assembled. Carl Pennypacker and the rest of the Lawrence Berkeley Laboratories (LBL) staff, as professional astronomers, grounded the project in state-of-the-art astronomical professional practice and judgment. They also provided easy access to the community of professional astronomers, and, for software development, to LBL lab infrastructure and expertise in this area. The Technical Education Research Center (TERC) is famous for its work in linking participants to real on-going scientific research via computer networking and is one of the recognized world leaders in technology-based curriculum development and assessment. The staff at the Museum of Arts and Sciences had (and still have) great enthusiasm for bringing computers into use in these urban environments and believe that for a marginal increase in the budget and computing power, much higher quality science can be undertaken.

B. Project components

The Hands On Universe project used a Windows version of PC Vista image processing software that will run on 386DX and 486 IBM compatible machines. This software, developed by LBL, was called Win-Vista.

The Museum of Arts and Sciences made a concerted marketing effort to attract organized groups, members, and constituents who make informal museum-going part of their leisure activities. Information was distributed through our

yearly Guide to Program, distributed to the school systems in over 30 mid-state counties, and our bimonthly newsletter. Mr. Ivery spoke to the math and science teachers at each of the public middle and high schools of Bibb County. Even children of staff members were recruited. We will also sought to involve the non-museum going public, particularly the 45% minority population. Brochures were made and they and letters were sent to area churches and community organizations (such as Jack and Jill, scouts, and the Boys and Girls Clubs) that regularly saw young people. In order to attract the most disadvantaged population, all Hands On Universe classes and activities were completely free of charge. For those attending during Museum hours, no Museum admission was required. Classes were held during a variety of times: on Saturdays, after school, and during school holidays.

The Museum offers classes and workshops for different age groups throughout the year. We developed a course called *Hands On Universe* for interested adults and teenagers, modeled on the teacher workshops and using the HOU curriculum materials, making them available to the general public. The Mark Smith Planetarium was used during some course sessions to provide the general connection to astronomy and to demonstrate the techniques via the large projection, while the laboratory sessions will provide the participants with the actual "hand-on" experience.

C. Curriculum Components

The Hands On Universe Program works on a four tier model:

1. System competency
2. Grass roots astronomy
3. Real time student discovery
4. Philosophical development

1. SYSTEM COMPETENCY

In this stage, students learn to use the software. To create the challenge to learn the tools necessary, students are asked questions about the Moon. For example,

- a. Here is a picture of a portion of the Moon. Can you reproduce it exactly on your computer screen?
- b. What is the height and width of a specific crater?
- c. Find the largest crater on the Moon.
- d. Find the oldest crater on the Moon.
- e. How many craters are on the Moon?

The length of this stage depends on the previous knowledge of the group. Skills that the students will need to know (either initially or through working with the program) are:

- a. Software skills, such as understanding of file structure
- b. How to use the Win vista software options
- c. Image processing concepts and capabilities
- d. Scaling, both linear and logarithmic
- e. Order of magnitude
- f. Estimation and dealing with large numbers
- g. Dimensions
- h. Rudimentary astronomy -- dealing with space and time

Although the lessons progress from simple to more complex, Hands On Universe does not really teach these skills. For example, although some of the lessons require the use of logarithmic scales, which hopefully will motivate a student to learn logarithms, and show him why they are necessary, the program is not designed to show what a logarithm is.

2. GRASS ROOTS ASTRONOMY

This stage uses astronomy as a tool to further enhance Win vista competency and increase the use of science process skills. Possible lesson subjects include:

- a. work on other lunar features
 - b. finding supernovae
 - c. finding distances to supernovae
 - d. finding distances to other objects (such as star clusters)
 - e. find supernova rate
 - f. using Voyager image data
 - g. surface features on Mars
 - h. monitor changes in Mars' polar caps
 - i. rediscovering Kepler's laws
 - j. size of solar flares
 - k. sunspots
 - l. rotation rate of the sun
 - m. planetary nebulae
 - n. size and age of the Universe
- and many others.

3. REAL TIME STUDENT DISCOVERY

At this stage, students can request images to be taken through the project telescope. Possibilities include:

- a. monitoring for supernovae in other galaxies
- b. monitoring for variable stars
- c. using Cepheid variables to get distances
- d. study of QSO's (quasars)
- e. study of solar features

- f. determining distances to comets and asteroids
- g. finding the heights of lunar features
- h. monitoring a patch of sky to look for long term changes

4. PHILOSOPHICAL DEVELOPMENT

The final lesson included time for everyone to sit back and discuss the implications of their discoveries. We wanted students to leave with an understanding of the scientific method, what science is, what scientists do, and what science cannot explain.

III. Results

A. Buy computers for the Macon Museum of Arts and Sciences.

A room on the Museum floor that had been used by the Museum Guild was converted into use for the Hands On Universe project. During this time (from late 1992 until the official end of the project at the Museum in 1996), the Museum guild office was moved into a stairwell! Ten 486 IBM compatible computers were purchased, along with a color printer and a tape backup system. The room was fitted to include air conditioning, enough electrical outlets, an isolated telephone line, and tables and chairs.

B. Hold one teacher training workshop.

Carole Helper (Director of Physical Sciences) attended the first HOU workshop in Orono, Maine, along with two Bibb County high school teachers, Linda Howell and Jamie Akin. This grant did not pay for the trip. It did, however, pay for Carole Helper to travel from Maine to Boston and Nancy Anderson (Executive Director) to travel from Macon to Boston to discuss with Boston Museum of Science personnel how to adapt Hands On Universe to the unique environment of a museum. The Museum of Science worked for several years on an exhibit component based on HOU image processing for use by the general public.

In the summer of 1993, a teacher workshop was held in Macon. The teachers were housed at nearby Wesleyan College. Approximately 40 teachers and facilitators attended. Some of the expenses were picked up by LBL. For instance, all the teacher stipends were covered by LBL, except for the three teachers attending from Middle Georgia. And all of the air travel costs were also borne by LBL, with one exception: We agreed to pay for one person (Larry Schindler) from the Museum of Science in Boston to visit Macon during the teacher workshop to be held there.

An additional workshop, using some of the Macon computers, was held in Bradenton, Florida in October 1993 by Museum staff Carole Helper and Jim Greenhouse during the conference of the Southeastern Planetarium Association. Conference attendees were planetarians, some from museums, some from high schools or elementary schools, and some from colleges or universities.

C. Hire a ½ time staff person to run the program for a year.

Milton Ivery, a high school mathematics teacher, was hired as Project Coordinator. He began a strong recruitment drive, targeting schools, civic organizations, and churches. Some groups came for only a session or two. On special days, such as Astronomy Day, or exhibit receptions, he would be on hand to assist walk-in patrons. He developed a curriculum, for ages ten and up, based on TERC materials, of 10 -12 two hour sessions. Individuals as well as groups signed up for his sessions. He also helped students of teachers Linda Howell and Jamie Akin who required extra time or wanted to pursue additional projects. At the end of each set of sessions, an awards ceremony was held and certificates of completion were handed out.

D. Evaluate the success of this system.

The term of the DOE grant was from 9-1-92 until 8-31-93. Once we had the money, we were able to buy the necessary computers and modify a room into a dedicated Hands On Universe classroom. We hired a project coordinator, Milton Ivery, and in 1993 began classes in image processing using Win-Vista. At the end of the grant period, the project was still going strong. We had just completed a teacher training workshop in Macon, Mr. Ivery was teaching 3 classes each week, and we had become a resource for local teachers involved in the project. At the end of 1994, however, the project drew to a close. Museum remodeling required the demolition of the dedicated Hands On Universe room. A new "computer lab" was to be constructed in another part of the building, but the old room was slated to destroyed in Phase I and the new lab was to be built during Phase III. Mr. Ivery was let go, the equipment was packed up into boxes, and the Hands On Universe project went into hiatus. It never recovered. The Museum had been using an 800 number provided by LBL to phone their computer over the network to request and download images. LBL discontinued their 800 service, asking that patrons select their own internet service provider (ISP). At that time, there was no ISP in Macon, except for a local college willing to provide text-only service at 2400 baud, and long distance charges to the nearest in Atlanta was cost-prohibitive.

Students participating in the Hands On Universe project in Macon ranged from grade 6 – adult. Some were walk-in, or attended only one or two sessions as part of a church or organization, but many met for ten or twelve two hour sessions. Since students were not required to attend, and the classes are free, the drop-out

rate were nearly 50%, but the students that remained were very enthusiastic. Students went through the lessons much more slowly than the lessons provided by TERC would suggest. Many had never used a computer before, and time had to be spent teaching them clicking, double clicking and dragging the mouse, moving items about, and minimizing and maximizing screens. Once they developed some ease with the computer, image processing could begin. However, some lacked math skills (such as use of the Pythagorean Theorem) needed to complete tasks. Mr. Ivery's skill as a math teacher became invaluable. "Moon Match," lesson number one in the TERC curriculum, was reached by some groups only on session 6. Students go through the lessons more slowly than I would like (Moon Match is lesson #6, for example). Most students did not go beyond stage 1 (system competency) and onto stage 2 (grassroots astronomy). Few of them achieved a stage where they could request images from the telescope in California and analyze the results. In spite of the slow progress, the students seemed very happy with the classes. Students and their parents gave speeches after the last class, during the awards ceremony, saying how much they enjoyed the curriculum, and how their math grades and enjoyment of math had improved. Those students who had never before used a computer were very proud of their newly acquired skills. Achievements in science were a bit harder to judge. Lessons about the moon, sun, Jupiter, and supernovae taught them about these objects, but it was unclear if they left understanding the scientific method or if their attitudes toward science had changed. In the spring of 1994, the classes took pre- and post-tests to evaluate exactly that. The tests were submitted to LBL for evaluation, along with the tests of others from around the country.