Jurassic Classroom

MCI WorldCom Foundation
Carnegie Museum of Natural History

Project Interim Report
April 26, 1999

1 Summary

The Jurassic Classroom project aims to engage and educate internet visitors to the Carnegie Museum of Natural History's dinosaur collection using leading-edge technologies in robotic manipulation and streaming video. The technological star of this project is *Chips* (below), the robot tour guide that has been giving tours to museum visitors in Dinosaur Hall, full time, for a record-breaking ten months. The Jurassic Classroom brings Dinosaur Hall to internet visitors using Chips as their tour guide in real *and* virtual museum worlds.

The real Chips will respond to internet visitors' requests to examine several exhibits more closely. Its on-board camera will provide live, streaming video through the internet. Five other cameras throughout the museum will provide even more live footage, with pan and tilt controls on each camera that are also controlled by web visitors.

Chips will also serve as the internet visitor's host as they explore a virtual museum with six exhibit halls, each relating a scientific discipline to paleontology. Problem-driven curricula, which we distribute to schools, will challenge students with questions that they can answer by exploring the virtual museum.

***Chips** giving live tours of the CMNH dinosaur collection*

This project has been active since September, 1998, and considerable progress has been made in making the Jurassic Classroom dream a reality. Section 2, Curriculum, describes the curriculum materials that have been designed and are now being produced. This month is an exciting time, for the first phase of the curriculum is being completed and prepared for live testing.

Section 3, Web Site, describes the site design, which hinges on an innovative approach that we call *Virtual Museum*, in which an entire museum sitemap is dedicated to the various disciplines that contribute to Paleontology. The logical divisions of the *Virtual Museum* correspond to discrete portions of the curriculum.

Section 4, Hardware and Software Development, describes the final hardware architecture and control system that has been designed for *Jurassic Classroom* through a contract with Mobot, Inc, a Pittsburgh-based robotics company.

Finally, Section 5 identifies several key milestones on the road to project completion.

2 Curriculum

The Jurassic Classroom is using the structure of a virtual museum. The halls or galleries within the virtual museum will demonstrate that paleontology relies on knowledge from a number of scientific disciplines. Each hall will cover key concepts and highlight a particular member of the paleontology staff to provide a personal connection to the theme. The halls are: *Hall of Dinosaurs*, *Hall of Geology, Hall of Ecology, Hall of Evolution, Hall of Biology* and *Hall of Discovery*.

For each hall, the curriculum materials include an on-line activity, a classroom activity, a teacher track that includes educational objectives, vocabulary, background information, procedures, and potential challenges, and an evaluation rubric. For example, the online activity for the Hall of Ecology involves creating a Dinosaur Zoo.

Students will select an environment and add animals and plants. They will need to decide on the kinds and numbers of dinosaurs and other animals and plants that would be able to live successfully in that environment based on the time period, requirements of the animals, interactions of the animals and plants, and other variables. The classroom activity has student teams make models of their zoos, paying attention to scale. The evaluation rubric will help teachers assess student achievement based on the inclusion of specific components in their work.

Our goal is to create a product that actively involves students in the use of technology to explore scientifically accurate information, experience the real-life work of scientists, and use the processes of scientific inquiry to learn about dinosaurs and the Earth's past. Our objectives include the following:

<u>For the Curriculum, the lessons will</u>:
support core curriculum content in science in grades three through six. integrate with the course of study in geology, paleontology, dinosaurs, prehistoric life, and other similar earth science areas, as well as address science as inquiry;. be interactive;. align with science standards, including the National Science Education Standards, the proposed Pennsylvania standards, and those of Ohio and West Virginia.

<u>For the Students the lessons will</u>:
encourage creativity, support student choice and interests, and offer opportunities for cooperative learning.

For the Teachers the lessons will:

provide teacher's activities and background information and identify potential challenges; have clear educational objectives with measurable outcomes and include assessment strategies.

We have enlisted the assistance of James Botti, Ph. D. for the development of the curriculum. Botti's resume is attached. A former science teacher and school administrator, Dr. Botti is a consultant to NASA's Classroom of the Future (COTF) at Wheeling Jesuit University, Wheeling, West Virginia. For COTF he helped develop the web-based learning modules for the project "Exploring the Environment." He currently is working on online graduate-level courses for teachers and is involved in teacher training for various COTF programs.

Phase I of the curriculum development includes activities for two halls, Ecology and Geology. These are serving as prototypes for the remaining lessons to ensure that the elements included in the curriculum for students and teachers are appropriate and that the format used is successful in meeting the content objectives at the grade levels chosen.

The Phase I curriculum will be tested in classrooms of teachers and students who are experienced and comfortable in using technology. We chose to do our initial testing with experienced users to expedite the testing in the short time we have and to focus the feedback. The classroom testing of these activities throughout May and early June will involve observation of teachers and students using the materials, as well as interviews with the users. Some of the questions we will be looking to answer include: What features keep the students engaged? What challenges did the teachers encounter? What opportunities did the technology enable for improving learning? How did the social interactions encourage support learning?

Based on the evaluations, revisions will be made to these lessons, and the information gained will be used to further inform the development of the activities for the remaining three halls. Phase II, incorporating curriculum for every hall, will be complete and ready for testing by September 1999. During the rest of 1999, testing of the curriculum will be combined with teacher training. By 2000, summative evaluations of the curriculum's efficacy will begin, and a final report on the curriculum will be produced in April 2000.

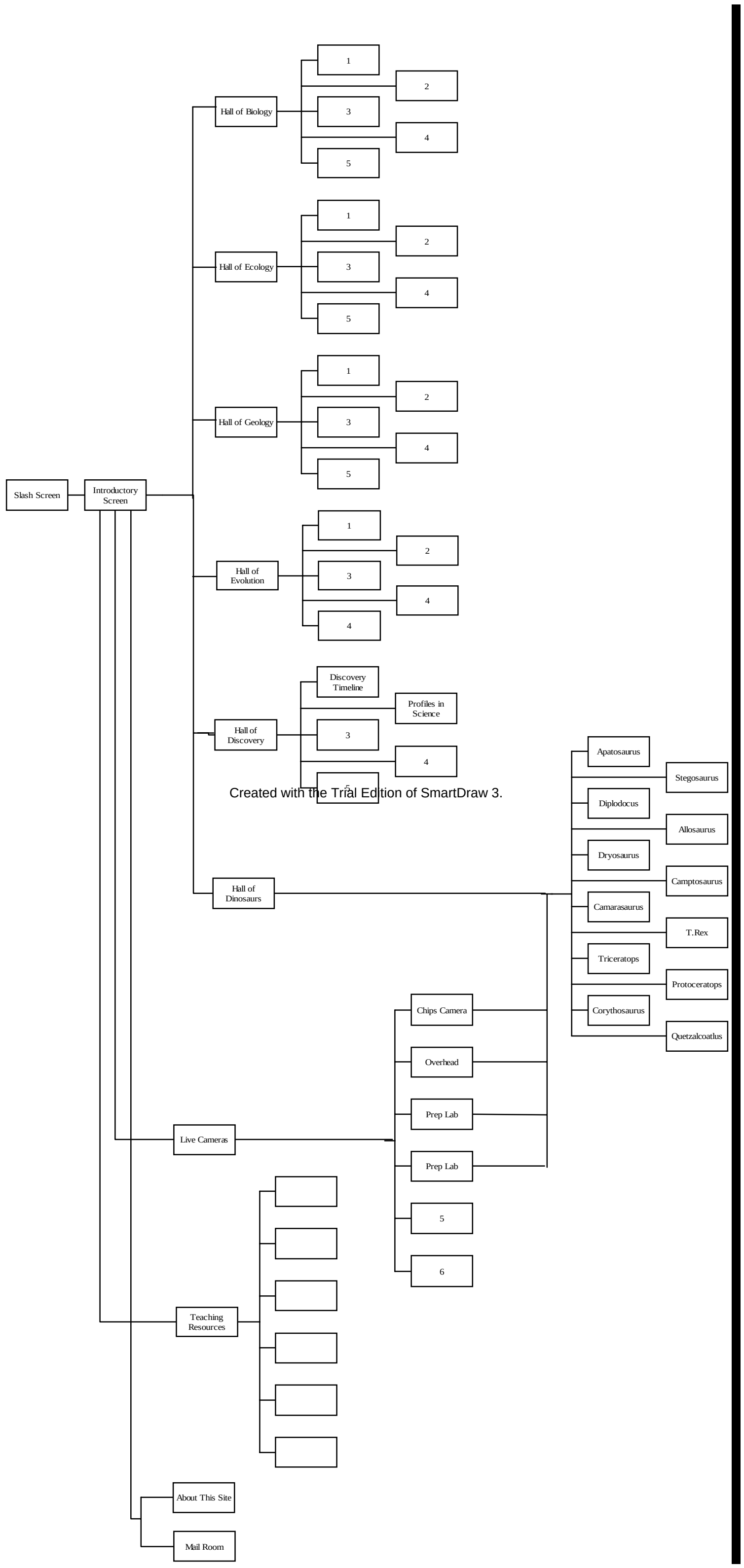
3 Web Site

The Jurassic Classroom Web site introduces visitors to the fascinating world of paleontology. Through text, still image "slide shows," interactive activities and streaming video, it will present the various aspects of paleontological work at the museum, and will introduce key concepts in the study of past life.

Like the curriculum, the site will be structured around the metaphor of a "virtual museum." Within this museum, "halls" and "exhibits" will serve as conceptual wayfinders, providing an intuitive path for discovery of key concepts in the study of dinosaurs. We will not attempt to create a three dimensional, rendered version of the museum, but rather use the familiar concept of the museum to aid visitors in finding the information they are seeking through the site structure.

The museum's "halls" will demonstrate that paleontology relies on knowledge of a number of scientific disciplines and that knowledge from such disparate scientific fields as geology and botany can be useful to the paleontologist. Through this site we hope to spark interest in a number of fields of science and encourage students to explore the vast worlds of natural history on their own. Each "hall" within the site will also highlight a particular member of the paleontology staff, providing a personal connection with some of the site's major themes and focusing attention on the scientific work that takes place at the Carnegie Museum of Natural History.

The Jurassic Classroom: *Web Site*



As shown on the website map, the Halls are adjacent to a group of live cameras and a teaching resource area. The live cameras, described in section 4, provide the museum visitor with a window into real-time images of the dinosaurs in Dinosaur Hall, a technician cleaning fossils and insects in the Entomology Department. The screen shot above shows the typical information page. Note that easy shortcut links near the top enable the user to go directly to a search page or to the live camera feeds.

The *Jurassic Classroom* site will feature six "exhibit halls."

Hall of Dinosaurs
The "Hall of Dinosaurs" will present the individual specimens on display in Dinosaur Hall. Concepts presented within each animal's description will link to other "halls" in the site.

Hall of Geology
Our knowledge of dinosaurs and all past life on Earth comes from fossils—the traces of past life preserved in the Earth. An understanding of key concepts in Earth Science is crucial to the study of paleontology. This hall will introduce key themes in Earth science.

Hall of Ecology
Dinosaurs did not live in isolation in the 160 million years of the Mesozoic era; rather, they coexisted with a great variety of plants and animals in environments very different from those that exist today. The "Hall of Ecology" will show how dinosaurs shared their world with a variety of fascinating plants and animals.

Hall of Evolution
Understanding the place of dinosaurs in the story of life requires a knowledge of their relationships to each other and to the animals that came before and after them. This hall discusses major concepts in the study of evolution.

Hall of Biology
The time of the dinosaurs exists as a unique period in the history of life on Earth because the dinosaurs, as we commonly think of them, were endowed with physical characteristics uniquely adapted to life in the Mesozoic era. "The Hall of Biology" explores the range of dinosaur shapes, colors, and anatomical features.

Hall of Discovery
The study of dinosaurs has a long and colorful history and discoveries made in the discipline of paleontology have had a crucial role in shaping modern scientific thought. Today, scientists at the Carnegie Museum of Natural History and elsewhere continue to expand our understanding of these fascinating creatures. Exhibits in the "Hall of Discovery" provide a window into the world of paleontology at CMNH.

Each of these halls will explore its topic through a number of hands-on exhibits. The topics comprising the Hall of Discovery are:

1. **100 Years of Discovery**
   This section of the site describes "100 years of Discovery" at CMNH, presenting in a timeline format major events in the history of CMNH paleontology. The site may serve as a "temporary online" exhibition during the "Dino-Mite Summer" at CMNH.

2. **If the Head Fits. . .**
   The misplaced head of Apatosaurus serves as an illustration of the scientific process and highlights the work of CMNH paleontologist Dave Berman. Apatosaurus stood with the head of another dinosaur (Camarasaurus) for many years, and many popular conceptions of dinosaurs were based on its image. Reanalysis of the original evidence led to a different conclusion than that which had been accepted for many years.

4. **World of Discovery**
   Certain areas of the world have seen great amounts of paleontological activity at different times. Fieldwork at Vernal, Utah, saw its greatest discoveries in the early part of the century. Recent discoveries in China have focused attention on that part of the world. An interactive map with hotspots on a number of locations will trigger pop-up windows that include images and descriptions of the types of discoveries made in those areas.

5. **Streaming video of collection manager Betty Hill discussing the history of the CMNH collection.**

6. **Field Notes**
   The image of the dirt-covered scientist chipping away at the earth forms the basis of a common conception of paleontologists at work. The public is fascinated with this aspect of paleontology, yet there is little real understanding of the fieldwork process. This section will present an interactive slideshow of images from Dave Berman's fieldwork in New Mexico.

7. **Profiles in Science**
   This section will highlight the people behind the science at CMNH. Curators, preparators, illustrators, and collection managers will each be presented, and have the opportunity to talk about their work.

8. **Reconstructing Past Lives**
   Though fieldwork is, perhaps, the most glamorous aspect of the paleontologist's work, the most significant work actually takes place in the laboratory. This section describes the process of "re-creating" an animal from the evidence left behind. It may feature the work of Mark Klingler and Zhexi Luo, whose recent reconstructions have recently received much attention.

4 Hardware and Software Development

Mobot, Inc. has worked with CMNH to design, author and install the hardware and software required for the video streaming and live camera pan/tilt control system. To date, the overall system architecture is complete and all required hardware components have been procured. Software to enable video streaming has been installed, customized and tested. Software-based pan/tilt control of the cameras has also been completed. We have written control code enabling any web page to contain controls for each of six cameras, some of which have already been installed at CMNH. Within the next 2 months, all of the hardware and software components of Jurassic Classroom will be complete. This includes an ongoing design effort into educator access control and queuing, since the physical pan/tilt cameras and robot host will be a limited resource in high demand situations.

Basic Hardware Architecture
As shown in the attached diagram, the hardware makes use of 3 computers, each with two Osprey100 video capture cards. Thus, each computer can capture from 2 cameras. Each computer runs RealProducer Plus which encodes the raw video image. One server computer also runs the RealServer Plus program which streams the encoded data (it can stream video that is encoded on all three computers). Using a Java applet designed by us, the museum's web server simply links to the RealServer machine in order to make the video and controls accessible in the web.

The six cameras will be placed as follows:

Dinosaur Hall:

1 static camera on Chips, the robot, to broadcast robots-eye view of the world.
1 pan/tilt camera mounted above the entrance to give a good overview of the hall and some nice close-ups of dinosaur heads.

Dinosaur Hall Workshop:

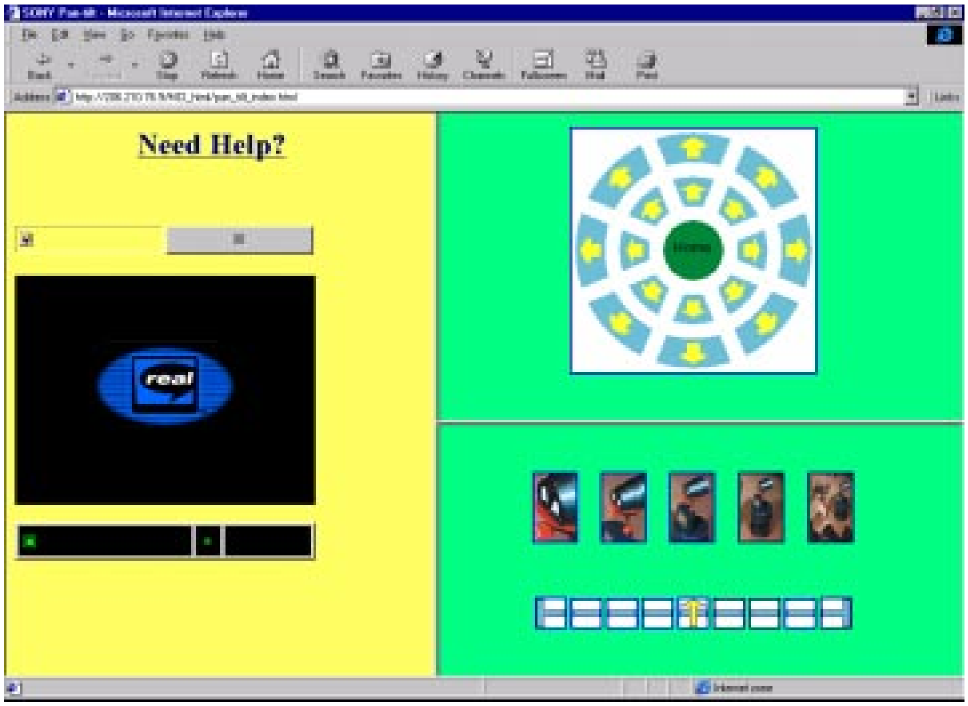
1 pan/tilt camera mounted high on the wall so viewers can watch the technicians clean and prep bones.
1 static camera which feeds from the technician's microscope so users can experience that point of view.

The Entomology Display:

1 pan/tilt camera hanging from the ceiling to give an overview and to look towards the windows into the bug prep-room.
1 pan/tilt camera placed to look at live bee hive and live*dermestia* beetle display.

User Interface Architecture:

On the web page, a link for each camera will be provided. If a link to a pan/tilt controlled camera is followed, a control page will be presented. This page gives the user graphical control of the camera's motion (pan and tilt) and zoom level. A normal web-surfing user who wants to control the camera will be given the controls for a 2 minute period on a first come first serve basis (this is to avoid multiple people all trying to move the camera in different directions).



There will also be an *exclusive access* mode for educators. After making prior reservations with the museum a teacher would have a reserved period to use the cameras. To do this they would simply connect to a special page which would ask for a username and password. From there they would then be able to use any of the cameras without waiting for other users to finish.

This mode would also provide educators with the option to control the robot during hours when the museum is not open. The educator could have the robot go to specific exhibits in Dinosaur Hall while watching a live video broadcast of what the robot is currently looking at. Control of the robot will be "goal-oriented." The educator could tell the robot to go to a specific station ("go look at the T.Rex head"), and the robot will go there. Thus, there is no danger of an educator getting the robot lost or otherwise confused.

5 Project Timeline

Major milestones to project completion

April 99

Prototype of curriculum for Geology and Discovery halls ready for class testing
Multiple video streams demonstration

May 99

Access scheduler administration software complete
Access integration and testing complete
Final museum installation of computer and video hardware
Classroom testing of curriculum phase I begins

June 99

Phase I testing is complete, teacher and student evaluations are complete

Sept 99

Prototype of Phase II curriculum ready for classroom testing
Phase II testing begins

Nov 99

Final curriculum project released on Nov. 30, 1999
Teacher training and summative evaluation of curriculum begins, ongoing

Apr 00

Summative evaluation report complete

James A. Botti, Ph.D.
12519 Ridge Road
North Huntingdon, PA 15642
(412)863-9356

Present Title

Instructional Design Contractor; Exploring the Environment Project, NASA Classroom of the Future, Center for Educational Technologies; Wheeling Jesuit College; 1994-99

Professional Experience

Faculty - Pennsylvania Governor's School for Teaching; Millersville University of Pennsylvania; 1991 & 92

Faculty - Teach for America Institute.; University of Southern California, Los Angeles, CA; 1990

Adjunct Faculty - Duquesne University; Graduate School of Education, Pittsburgh, PA; 1988-91

Science Department Chairman - East Allegheny Schools; 1987-94

Faculty - California University of PA, Dept. of Educational Studies, California, PA; 1986-87

Biology Teacher & Computer Teacher - East Allegheny Schools; 1978-86

Student Teacher Supervisor - Penn State University; 1976-77

Biology Teacher - East Allegheny High School: 1964-76

Presentations

"Earth Systems Science: Professional Development and Student Engagement"; Botti, J.A. & Myers, R.; Presented at the National Science Teachers Association national convention, Boston. National Science Teachers Association; Boston; '98

"Problem-Based Learning on the WWW: A Course Design that Works"; Myers, R.J., Davis, H.B., Botti, J.A., & Pucell, S.L.; A workshop presented at NECC, San Diego, CA; '98

"Recreating Instruction to Support Educational Reform"; Botti, J.A., A workshop presented to graduate students, California University of Pennsylvania; '98

"Technology Training for Teachers Who Work with At-Risk Kids"; Botti, J.A., A workshop conducted for the West Virginia Department of Education; '98

"Great START for the 21st Century", Training of Facilitators for EdVentures in Simulations workshop for the Challenger Center for Space Science Education; Pasadena, CA; '97

"MTPE Teacher Inservice: Earth System Science"; Botti, J.A. & Myers, R.; Presented at the National Science Teachers Association national convention, New Orleans. National Science Teachers Association; New Orleans; '97

"A Technology-Rich, Inquiry-Based Earth Science Curriculum" Myers, R., & Botti, J.A.; Presented at the National Science Teachers Association national convention, New Orleans; '97

"Problem Based Learning" Member of a Forum Panel at the 52nd Annual ASCD Conference, Baltimore, MD; '97

"Inquiry-Based Methods in the Science Classroom" "Problem Based Learning," Myers, R., & Botti, J.A.; Presented at the Florida Educator's Educational Conference (FETC), Orlando, FL; '97

Publications

"Exploring the Environment, Problem-Based Learning in Action"; Myers, R.J., & Botti, J.A.; Presented at the annual meeting of the American Educational Research Association meeting, San Diego, CA; '98

"Developing Strategies for Online Collaboration and Community Building."; Myers, R., Davis, H., Shay, E., & Botti, J.A.; Presented at ISTE's Sixth International Conference on Telecommunication and Multimedia in Education (Tel*Ed '97), Austin TX.

"Great START to the 21st Century. EDventures in Simulation"; Botti, J., Myers, R.J. and Sturm, N; Challenger Center for Space Science Education, '97

"A Web-Based Earth Systems Science Graduate Course for Middle School Teachers", Myers, R.J., Shay, E.L., Davis, H.B., & Botti, J.A.; Published in the *Proceedings - International Geoscience and Remote Sensing Symposium*; Volume I; Singapore, '97

"Design, Development, and Implementation of an Inquiry-Based, Technology-Rich, Science Curriculum" Myers, R.J., Botti, J.A., & Pompea, S.; Published in the *Proceedings - Association for Educational Research Annual Meeting*, Chicago, IL, '97

“Simulating Through Technology” *The Heart of Teaching*; A publication of Performance Learning Systems, Inc.; Number 52, September; ‘96

“A Model for Environmental Earth Science Module Design” Botti, J.A., Gonsalez, K.D., & Myers, R.J.; Published in the*Proceedings - International Geoscience and Remote Sensing Symposium*; Volume I; Lincoln, Nebraska, ‘96

"Exploring the Environment: A Problem Based Approach to Learning About Global Change” Botti, J.A., & Myers, R.J.; Published in the*Proceedings - International Geoscience and Remote Sensing Symposium*; Volume I; Florence, Italy, ‘95