Multimedia for a "Hands-On" Oceanography Course

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The purpose of this project is to continue to develop software for a series of "hands-on" multimedia lab modules intended for a lower division oceanography course with a "Quantitative Science" component. The emphasis is on individual and group discovery, observation and analysis of the most current geophysical and geographical data, and the communication and revision of ideas through both group discussions and writing. Some of the tools being developed for this project provide access to data that has been previously accessible only to graduate students specializing in a field related to that data. The development includes a student laboratory manual, a CD-ROM, and an instructor's manual. The home page (http://oceanography.geol.ucsb.edu) contains availability information. The focus of the software and supporting lab manual is to guide students through the process of making observations and writing a technical paper that describes their results and interpretations. This process takes place over a period of four weeks. The datasets available are (1) global elevation; (2) global volcano distribution; (3) global earthquakes; and (4) images and movies of areas of geological interest, such as movies of seafloor dives in Alvin. Students access these data by simply pointing and clicking. Extensive support is provided to help students visualize the features they are studying. A profile game has been created to help them learn to use the software tools to determine the shape and physical properties of structures they observe in the elevation database. This game is being modified, as it was too difficult for many students during tests. Supporting student writing is a key component of this project; many students do not know how to write in a technical style. The profile game is being enhanced to produce sample descriptions of the (randomly generated) feature the student is studying. A database of sample writing is being implemented also. Some students have difficulty determining how earthquake data, topography data, and volcano locations are combined to determine the type of plate boundary. Several "discovery" problems, focusing on small regions, are being created to help them develop this skill. The current writing software supports random anonymous peer review. Students send their writing to review, review others' writing, and revise and modify their own writing. Students are highly motivated by having access to their scores. Many of the homework assignments are entered into the computer and graded immediately. All grades are entered into a central database, where they are accessible to all TAs, the professor, and the student (his/her grades only). Testing has been done on a number of small groups (Spring 1994), two class sections (Fall 1994), and the entire class (Winter 1995). Most of the students in the Spring and Fall tests praised the "hands-on" aspects and freedom to explore. Some were over-challenged by the open-ended nature of the work. The Winter 1995 test implemented the automatically graded homework entry for the first time. Students were critical of initial bugs in the homework entry software and the difficulty of the profile game. However, most students worked at the homework until they got 100%, and their written papers were quite good. During review sessions, students were noticeably more proficient at answering questions about earth processes. Evaluation is being done using both written student feedback and in televised focus groups.

New Geology Laboratories: Interactive Data Acquisition, Analysis, and Multimedia Modules of Geologic Phenomena, Part II

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This project brings an individualized approach to science in large introductory courses for non-science and science majors through participatory geoscience laboratories. Use of the multimedia products developed to date show that this new approach produces excitement and increased comprehension. Field and laboratory data acquisition, statistical analysis, and computer modeling of complex systems, are elements throughout. The laboratories develop skills such as field and laboratory data gathering, graphical analysis, statistics of data, mathematical representation of results, map representation of information, computer modeling, synthesis and simulation of complex phenomena, and the interaction of science and society. The topics of the laboratories in this project include earthquakes, mass wasting, topography, surface water chemistry, and earth resources and materials. The end products of the development will be a CD-ROM and a paper laboratory manual. The multimedia components in SuperCard can be used for instruction. These modules contain extensive visual material of geologic phenomena, interactive computer models of significant physical principles, video and audio segments of geologic processes and simulation models of complex geologic problems.

Development of a Dynamic Digital Map Template for Desktop Computer Users to Insert Digital Maps and Data to Generate High-Quality Color Maps for Digital Publication

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Part of the problem in field-related geologic research is the inability of workers to publish high-quality color geologic maps quickly, inexpensively, and in a format that is widely usable without additional software, or software that requires extensive training to use. This is especially true of maps with large geographically tied databases. This project is creating a Dynamic Digital Map (DDM) Template into which users of SuperCard can insert their digital maps to generate their own high-quality color geologic maps for publication in computer format. This template has similar, but more generalized capabilities, to those described by Condit (1995, *GSA Today*, v. 4, p. 86) in his description of DDM.SVF. The Template includes all essential objects (windows, cards, menus, data fields and text buttons) with associated script that link these objects to the maps, data fields and text files. Data that can be inserted include maps, digital images, chemical, paleomagnetic and structural data and text files. The initial development platform is the Macintosh computer; the pending development of a DOS version of SuperCard may allow conversion of

projects to a DOS Windows format. Concomitant with development of the Template, the project is developing a tutorial manual to include: (1) a brief introduction to the use of SuperCard as it pertains to making Dynamic Digital Maps; (2) an overview on the structure of the template program; (3) a step-by-step description of how to load the Template into SuperCard, and insert maps, images and data and text; (4) how to copy and attach script that links objects pasted into the Template; (5) how to most efficiently duplicate and rename essential objects of different classes to facilitate the user's own map DDM generation; (6) how to modify given objects (e.g., windows, data fields) to conform with slightly different user needs; and (7) how to turn the user's SuperCard DDM into a stand-alone program for distribution in a form which can be run independently of SuperCard by any end-user. The over-riding consideration guiding the creation of the Template and tutorial is to make it as efficient as possible for the user to make DDMs. Initial distribution of review versions of the Template and tutorial will be by Internet (FTP); an early version of the tutorial can be obtained by anonymous FTP from 128.119.45.20 in the directory ccondit. Final publication should be on CD-ROM. It is hoped this type of publication will be of interest to professionals and students alike.

Educational Earthquake Visualization

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Despite the important role that earthquakes and seismology play in the Earth Sciences, there has been up until now no good way to visualize the process by which an earthquake generates waves that propagate throughout the Earth. These seismic waves are important because they cause destruction in many parts of the world, are used to determine the location and size of the earthquakes, and are the means by which geologists have mapped out the interior of the Earth. Without a way to visualize the process of seismic waves spreading throughout the Earth after an earthquake, it has been very hard to explain this phenomenon and for students to understand it. The difficulty lies in the fact that the production of such an animation requires advanced geophysical algorithms, high-speed computational capabilities, and a strong dedication to use these research capabilities for an educational purpose.

This project meets this need by producing a computer-graphics color animation that accurately represents the propagation of seismic waves from an earthquake, and is available to educators in both VHS-video and computer formats. The project is based on a prototype of such a video-animation recently made by the PI. The production of a realistic visualization of earthquake wave propagation through the Earth is computationally intensive. The prototype took five months of computation on a Sun Sparcstation 10/41. The animation not only gives viewers an intuitive feel for the internal structure and layering of our planet, but also teaches the principle of wave physics applied to the Earth, showing waves reflecting, refracting, and diffracting along the different layers within our planet. The computer animation is narrated, presenting an educational discussion of earthquakes, their destructive capabilities, their relation to plate tectonics, and their role in mapping the details of the interior of the Earth.

Computer-Aided Learning Modules for General Education Geology Courses

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This project takes advantage of recent developments in multimedia computer technology to create an integrated set of computer-aided learning (CAL) modules to teach fundamental concepts of geology in general education courses. The software consists of graphics-intensive, interactive multimedia modules that include animation, video, sound, and hypertext linking across topics. Module topics include global geology, plate tectonics, geologic time, Earth interior, Earth materials, global cycles, human influences, and evolution of the Earth. Questions throughout the material provide immediate feedback to the students and guide their progress. Quizzes after each section assess concept attainment and provide automated scoring for assessment of student progress and effectiveness of the instructional media. The new modules build on the success of an award-winning pilot module developed by the PI, and are guided by student evaluations collected throughout the development and assessment phases. The initial target audience is students in two large general education courses for non-science majors (>60% freshmen-sophomores, ~10% education majors) taught by the PI (History of Life) and the Co-PI (Planet Earth). The modules have broad applicability to any introductory geology general education course, and will be published, widely advertised, and disseminated nationally to universities, colleges, junior colleges, and high schools. Extensive use of the modules in the preparation of elementary and secondary teachers is planned.