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Science education by way of the 'ultimate electronic field trip'

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ABSTRACT

Regional education institutions, scientific research organizations, government agencies and business/industry partners join hands to create a collaborative networking infrastructure around California's Monterey Bay Sanctuary. Their goal: the nurturing and support of life-long learning through the implementation of collaborative electronic field trips and classroom activities by student groups, educators and scientific research communities in various ecosystems. Initial trips and activities are designed around three exemplars: the Virtual Canyon Project, the San Lorenzo Valley River Watershed Project and the Virtual Telescope Project.

Main conference themes: flexible learning
Educational areas: secondary education
Study topics: science/engineering, life sciences/medicine
Secondary keywords: curriculum development, future developments, innovation, teleteaching, telecommunications

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INTRODUCTION

Various regions across the United States currently face critical and related issues:

- Their ability to respond to the call for systemic educational reform through restructuring to make their public schools and universities more effective.
- To optimize through collaboration across industry and education sectors, both private and public, the opportunities arising from the abrupt changes in a national and regional economic base resulting from the end of the Cold War and massive military base closures.
- Their need to capacity build scientists, technicians, as well as a skilled workforce for the changing needs of an information based society.

More specifically the greater Monterey Bay region—located on the natural resource rich, central coast of California—faces all of these critical issues. Yet, boasting a number of worldclass research, educational and high technology organizations the region is on the verge of a renaissance in research, education and development. With the closure of Fort Ord, the largest military installation on the United States Department of Defence Base Realignment and Closure list, and its reuse for a major new university with research centres, new relationships and alliances are evolving and gaining momentum for cooperative efforts among K-12 school districts, community colleges, universities, business and industry and the scientific research community.

The collaboration

Reflecting these new relationships a regional consortium, the Monterey Bay Futures Network, was created to provide a mechanism to facilitate joint action across industry sectors, both public and private, and across the geographic range of the Monterey Bay economic region. Action Teams were formed to focus on strategies for promoting linkages between and development of the region's agriculture, tourism, environmental and education sectors. One such action team is the Initiative for Information Infrastructure and Linkage Applications (I^3LA). It is under the auspices of I^3LA that scientific research organizations, educational institutions, government agencies, libraries, museums and business/industry partners formed an education collaborative, the Monterey Bay Regional Education Futures Consortium (MBReEF).

In the Spring of 1994 the consortium successfully collaborated in visioning and securing a suite of industry, state and federal grants for connectivity and access, planning, curriculum development and equipment acquisition which would begin developing a collaborative educational networking infrastructure around the Monterey Bay Marine Sanctuary and which will, over time, build a

sustainable base as well as serving as a national model for the application of science education through telecommunications technology (Fig. 1). Consistent with the goals of the National Information Infrastructure [1] these efforts are building synergy between technology and education researchers, developers and implementers to design and implement a flexible educational networking infrastructure, test selfsustaining strategies and explore networking benefits.

The technology

The new high performance data communications and networking services which were selected to allow high levels of interconnectivity and interactivity between regional and ultimately national and international constituents for MBReEF are Frame Relay and Integrated Service Digital Network (ISDN) technologies provided by Pacific Bell, a Pacific Telesis Company, as part of the California Research and Education Network (CalREN). In 1994 Pacific Bell established CalREN as a trust to fund innovative applications development for use of high speed network services [2]. Their goal is for the network and its evolving uses to contribute to improving California's economic and social climate in targeted areas of the state. Under a competitive process 26 CalREN Education Grants were awarded in 1994. Testbed sites utilizing Frame Relay are on lanes which operate at speeds up to 1.544 million bits per second. It is best used for applications such as computer assisted design, animation and is also being used for videoconferencing at a number of project testbed sites. ISDN operates at speeds up to 144 kilobits per second and is suited to a wide range of uses. These include access to the Internet, images and stored video, electronic democracy, desktop videoconferencing and telecommuting.

With access to such communications technologies this broadbased project is working over time towards the following:

- improved quality and effectiveness of instruction and learning in the areas of regional/global marine, astronomical and environmental studies;
- the use of data communications to increase access to informational, instructional and technological resources (voice, video and data);
- models for integrating the most cost effective of telecommunications networking into the school environmental science curriculum;
- a migration model to allow schools and/or agencies to move from one service tier to the next as their needs and applications change;
- improvement of learning resources management;
- definitions of the role of voice, video and data communications in teacher training;

a model for product and service dissemination, collaboration between diverse agencies and military base closure reuse blending with education.

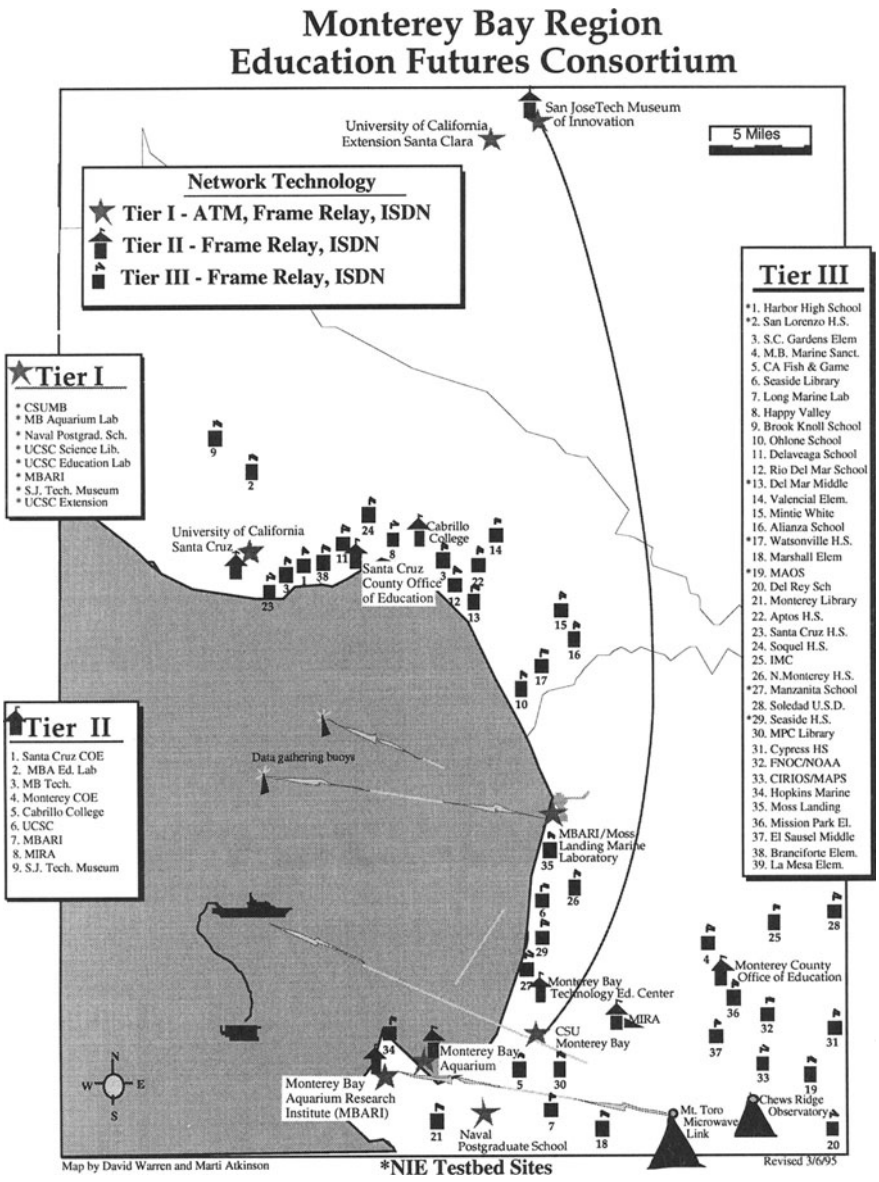

Fig. 1 Map of testbed sites on the central coast of California: Greater Monterey Bay Region

The construct

Just imagine ...

> "Instead of visitors having to rely just on books in stores and libraries, imagine that anyone visiting a museum could return electronically any time he or she wished, from anywhere in the world. Further, imagine that the return visit would not only allow displays to be viewed again, but that the visitor could move 'behind' the display to explore its content in any level of depth desired. Then imagine that this same visitor could collect in-depth reference material and pose focused questions to experts in the field for clarification—anywhere these experts might be on the planet. And then imagine that, for fast-moving fields of study, the reference material not only provides a historical context for the subject, but provides access to new research results as soon as they are disseminated. Such virtual museums and ultimate field trips could meet the needs of novice and expert alike. They would provide a forum for discourse among experts, as well as discovery by neophytes. They would be open to all, anytime, anyplace, 24-hours a day, 365 days a year—all from the privacy of one's home or at school." [3]

Development of the **Ultimate Electronic Field Trip** can serve as a model for 'real time' or 'just-in-time' curriculum delivery and addresses some of the questions being generated about the quality of on-line and on-demand curriculum [4] as they relate to pedagogical issues. It also serves as a model of collaboration for delivering new discoveries and fundamental advances as well as basic knowledge in the field of science and applications in telecommunications by students and practitioners. The consortium currently supports 49 agencies including testbeds at 27 K-12 public schools and five public libraries across a three-county area (Fig. 1). Respective field trip teams of practitioners and students are joining with science research and business/industry communities to create, test and pilot innovative approaches to environmental science and astronomy which will serve as proving grounds for the role of communications technologies in closing the gap between learning and teaching and work world applications and interactions. Given the notion of life long learning the philosophical premise of the entire effort is one in which students/clients ask their own questions, pose and solve their own problems. Where student/clients and educators both function as facilitators and constructors of their learning and where volition is the moving force rather than motivation.

The consortium was careful to establish parameters for the project in order to focus participant efforts as well as take advantage of the rich natural and human resources indigenous to the Monterey Bay region. Hence efforts are

currently underway in the areas of regional and global environmental studies and astronomy. Three overarching and interacting elements are essential to our work within this framework:

- high-speed data communications access (ISDN and Frame Relay) and computer technologies are made available to K-14 school sites, institutions of higher education, scientific research communities and libraries by business and industry partners;
- given such access, educators, scientists, engineers and technicians work collaboratively to sort and identify relevant electronic data sources based on real world applications and work world interactions;
- this information, both asynchronous and real time, becomes available via a Regional Environmental Electronic Library (REEL) to the student/client groups involved at the testbeds (Fig. 2).

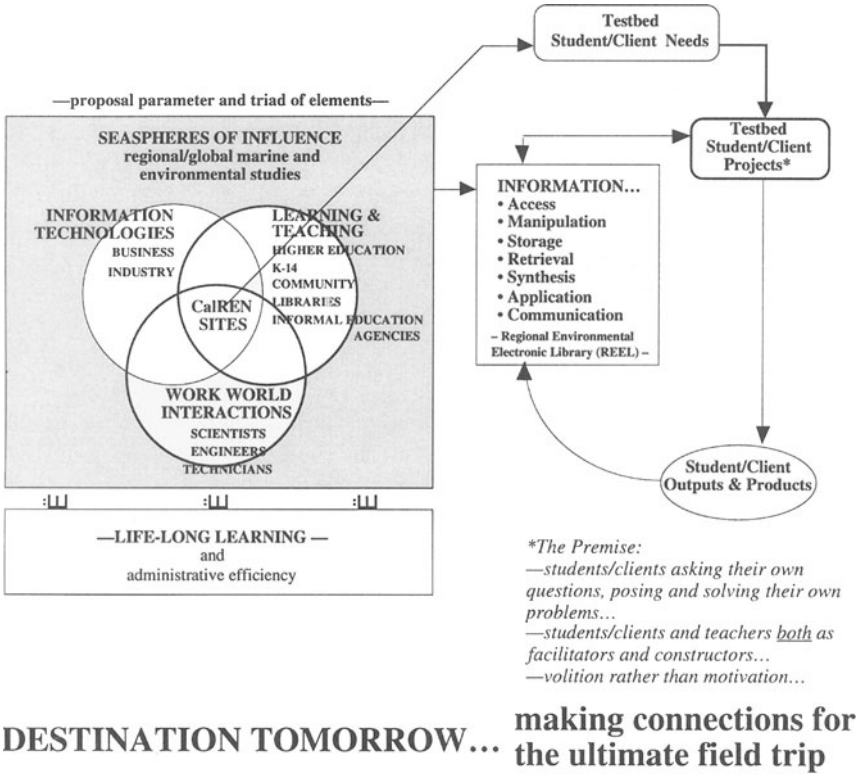

Fig. 2 Regional Environmental Electronic Library (REEL)

It is here that the ultimate field trips begin. With funding from the National Science Foundation and the continued support of Pacific Telesis teams of scientists, educators and students are now designing electronic field trips for themselves and for others. For the purposes of planning and implementing pilots current field trips are designed around three exemplars: the Virtual Canyon Project with the world renowned Monterey Bay Aquarium and Monterey Bay Aquarium Research Institute (MBARI), the San Lorenzo Valley River Watershed Project with the United States Department of Fisheries and the Monterey Bay National Marine Sanctuary and the Virtual Telescope Project with the Monterey Institute for Research in Astronomy (MIRA).

These trips are utilizing selected datasets, voice and video originating at participating science research agencies, museums and/or aquaria as well as staff members and scientists themselves. In addition selected real-time video and data will ultimately be provided from the bottom of the Monterey Bay Canyon via the MBARI's undersea Remotely Operated Vehicle (ROV) from the San Lorenzo Valley watershed field sites and from the heavens via MIRA's telescopes. As each field trip is completed and made available via the REEL, other student/client participants will be able to take these trips and they in turn will create yet another level of electronic field trips for yet another group of peers based upon their experience, questions and interactions. The process, outcomes and ultimate curriculum products of each field trip created and taken become new input for the REEL: new trips, utilizing existing and new, successive inputs are then created and embarked upon in such a way that the entire information system is recursive and ever changing.

The overall goal for the exemplars is to use a network linking testbed classrooms with video images and data from research institutes, libraries, museums and aquarium to promote interactive learning through the virtual field trip experience. Participating science research agencies, museums and aquaria can field questions and guide general discussions generated by the field trips in a problem solving environment;. Scientists and organization staff can provide up-to-date information and answers to general questions, a forum for sharing of lessons, instructional strategies, classroom management ideas, as well as the creation of discussion groups on topics identified by the users through the monitored electronic bulletin board. Testbed classrooms will also be provided with CD-ROM disks of images, video clips and text relative to each specific exemplar, as well as live link teleconferencing on scheduled occasions. It is the intent of the participants to include those elements which research suggests is needed for the successful use of telecomputing in science instruction. These include: hands-on project oriented activities which require student collaboration, problem solving and data collection and analysis, investigations into real world

problems, peer communications of efforts, the involvement of scientists with student investigators over the network [5].

With the ultimate field trip construct in place the ISDN and Frame Relay connections provided by CalREN will be used to establish implementation models and prototypes, explore the role of electronic networks in education, support research and development for large scale, cost effective implementation of education networking—including training, curriculum reform, school organization, instructional strategies and tools and learning resource management. The work currently being carried out includes:

- installation of ISDN and Frame Relay connections at selected testbeds;
- development of a curriculum planning and implementation model;
- development of collaborative curriculum packages or electronic field trips;
- development of training models for electronic networking;
- accessing resources of the Monterey Bay Futures Network's Asynchronous Transfer Mode (ATM) site capabilities and the University of California, Santa Cruz (UCSC) Regional Environmental Electronic Library (REEL);
- development of training models utilizing videoconferencing technologies.

The contributions: liberating the learner

It is the intent of MBReEF and this particular project to develop unique migration models on two fronts: technological and geographical. The technological migration model can provide a process by which schools and/or agencies can move from one communications service tier to the next as their needs and applications change—ISDN to Frame Relay to ATM or others as the technologies become available and cost effective. The geographic migration model will allow for the implementation of the exemplars to move pro-actively from a development and pilot phase in the Greater Monterey Bay Region (phase 1) to inland access, resource management and utilization phases in the California Central Valley (phase 2), to national access (phase 3) and ultimately to global access (phase 4). Such an outreach model will strengthen and support the vision of random access to the virtual museum and the ultimate field trip via the electronic highway—the vision inherent in the NII's first two requirements calling for affordable access for all Americans as well as accessibility in a variety of learning environments. This model however global in its vision still maintains the integrity of thinking locally in order to think globally and minimizes distractions from the real benefits we also receive by connecting with people and resources in our very communities [6].

Still utilizing the three exemplars now under development older students can furthermore assist their younger counterparts in field work and technology tool usage; and then continuing on the grander scale Greater Monterey Bay Region

students can network with students in multiple submarine environments, watersheds and celestial heavens—sharing their experiences and their resources—or better yet, make the experiences available virtually to those who do not have access to the oceans, the mountains, the museums, the aquaria or observatories. Utilizing communications technologies the Virtual Canyon, River Watershed and Virtual Telescope projects create a grander synthesis of communities monitoring, studying, comparing and revitalizing their home planet, their universe. This is liberating the learner in its finest sense.

Other contributions which this project can make toward carrying out fullscale, selfsustaining implementation of educational networking are evident in the human network which has been brought together to plan and implement the proposal and, ultimately, to implement the project. The Monterey Bay renaissance in research, education and development was initiated by the closure of Fort Ord. Plans for the closing and reuse of this base centre on the establishment of a multi-institutional Center for Science, Technology and Education by University of California at Santa Cruz (UCSC) in 1995, the creation of a teaching university at the new California State University Monterey Bay (CSUMB) in Fall 1995, the establishment of the REEL, the creation of the high-speed CalREN ATM backbone, the continuation of the Monterey Bay Technology Education Center (MBTEC) which was established in 1993 by the Monterey Peninsula Unified School District as an outgrowth of its participation in the state funded California Model Technology Schools Project and the expansion of the federally funded Eisenhower Science Education program in Santa Cruz County, Science Connections.

Yet another contribution of this project lies in the impact of education applications utilizing communications technologies on underserved communities in general. Testbed sites selection was based upon submission of justification narratives addressing project criteria and standards for participation. Selected sites include specific target populations which can be designated as underserved beneficiaries based on ethnicity and socio-economic status and which are reflective of the state of California and general national demographic trends. The migrant workforce supporting the region's agribusiness creates a large limited English proficient and non-English speaking learning community. The use of readily available high speed communications technology for immediate and continuous access to resources to meet cultural and linguistic needs as well as to enhance instruction and curriculum is imperative. Studying the natural resources afforded by the Monterey Bay region is one clear way to make learning relevant to the world in which we live for these particular communities of learners.

The role of business and industry

The diversity of support team participants involved in the efforts at hand provides broad areas of expertise. Essential to establishing the infrastructure and building successful testbeds is leveraging the active participation of the industry technology leaders [7]. With organizations such as Apple Computer, Hewlett-Packard, Sun Microsystems, Pacific Bell and BDM International a wide spectrum of technology providers and implementers can be brought to bear. BDM International, a global information technology company, has taken the lead in the implementation of school district automation in the United States.

CONCLUSION

The education community across the United States faces a critical period of time in which it must respond to a call for systemic educational reform through restructuring to make its public schools and universities more effective. In doing so it can begin to address its need to capacity build scientists, technicians as well as a skilled workforce for the changing needs of an information based society [8]. In this collaboration across industry and education sectors both private and public becomes imperative. It is within this context that I^3LA and MBReEF have moved forward in the implementation of a broadbased project establishing an educational networking infrastructure around the Monterey Bay Sanctuary which will, over time, build a sustainable base as well as serving as a global model for the application of science education through telecommunications technology. It will liberate the learner by way of the 'Ultimate Electronic Field Trip'.

REFERENCES

1. National Coordinating Committee on Technology in Education and Training (NCC-TET) (1994) *The National Information Infrastructure: Requirements for Education and Training.* Executive Summary—Machine-readable data file.

2. Pacific Bell (1994) *ISDN: A User's Guide to Services, Applications & Resources in California.* San Ramon, CA.

3. Thornburg, D. (1994) *Virtual Museum.* Machine-readable data file. Thornburg Professional Development Center. San Carlos, CA.

4. Salvador, R. (1995) *Emerging Technologies: What's new in Curriculum Delivery?* Electronic Learning, **14** (5) p. 18.

5. Lenk, C. (1992) *The Network Science experience: Learning from three major projects.* In Tinker, R. and Kapisovsky, P. (eds.), Prospects for Educational Telecomputing: Selected Readings. Technical Education Research Center (TERC), Cambridge, MA.

6. D'Ignazio, F. (1995) *Information Dirt Roads, Bike Paths, and Hiking Trails.* The Computing Teacher, Journal of the International Society for Technology in Education **22** (6) pp. 46-48.

7. Newman, D., Bernstein, L. L., and Reese, P. A. (1992) *Local Infrastructures for School Networking: Current Models and Prospects.* Tech. Rep. No. 22. New York: Bank Street College of Education, Center for Education Technology.

8. Miller, Jon. (1990) *Who is Scientifically Literate?* Paper presented to the Science Forum, American Association for the Advancement of Science. Los Angeles, CA