A Next Step in Distance Delivery

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Abstract

Alfred Tech, Jamestown Community College, Brookhaven Lab and Corning have recently been funded by the NSF to pursue a unique arrangement to create an accessible, self-perpetuating, 'real-world' capstone experience for students in isolated, rural two-year colleges. The four institutions are developing lead teams composed of student and faculty collaborators via summer internships at Brookhaven. The teams work on problems selected by staff members at both Corning and Brookhaven that span the gamut of the sciences and engineering technology, and which take advantage of capabilities unique to Brookhaven or Corning: e.g. scientific visualization facilities, advanced scientific instruments, cutting edge material science and world-class staffs.

Following internship, the lead teams are responsible for transporting key pieces of these projects back to their home campus, and involve other faculty and students. This program, which represents a next step in distance education, creates an extended learning community that emphasizes campus-based, real-time interactions between participants at different sites. The earliest projects involve construction of scientific visualization facilities at the two campuses, and mastery of selected measurement techniques resident at BNL. Later projects will focus on problems for which a combination of measurement capabilities and visualization technology are uniquely helpful.

The incorporation of immersive stereographic visualization techniques, in particular, makes possible the delivery of learning experiences not now in the domain of distance education. Virtual laboratory experiences such as the remote control of instrumentation, navigation through apparatus, and computer-aided fabrication and analysis are introduced in a realistic, attention grabbing way despite the span of miles. Thus the work environment and teaming concepts introduced during the summer at Brookhaven are largely continued at the home campuses.

Background

It is widely recognized that there are systemic deficiencies in technician education.[1-4] Industry complains that new technician graduates often arrive with little understanding of the technical culture of the modern workplace, or how to effectively communicate and interact therein.

One reason for this arises from the chronic difficulty technical colleges have reliably obtaining and maintaining state-of-the-art instrumentation and the concomitant expertise that underlies all superlative technical training. Another reason stems from an absence of sustained collaboration between industry and educational institutions focused on obtaining desired educational outcomes. These problems are particularly acute in isolated, rural areas.

A project recently funded by the National Science Foundation's Advanced Technology Education program addresses the needs of this vital yet historically neglected segment of the science and technology education community. Specifically, it has put in place an informal consortium between two, predominantly two-year upstate New York colleges (Alfred State College and Jamestown Community College), an upstate New York Fortune 500 company (Corning Incorporated) and a renowned scientific research institution (Brookhaven National Laboratory). These organizations are collaborating in the implementation of a two-year demonstration project leading to a capstone experience for students in science and engineering. The effort combines state-of-the-art materials science, and innovative display and measurement technologies

The project, which represents a next step in distance education is creating an extended learning community which emphasizes campus-based, real-time interactions between participants at different sites. It includes construction of scientific visualization facilities at the two campuses, and mastery of selected measurement and analysis techniques resident at Brookhaven, drawing on applications from several scientific disciplines, for which visualization technology is uniquely helpful. The project emphasizes the themes of technical experiences of students and faculty in a real world setting, faculty development, and integration of technology in education.

Objectives of the Project

This activity has six principal goals.

- To provide science and engineering technology students the opportunity to participate in `real-world', team-based projects, which are both interdisciplinary and inter-organizational.

- To update and re-invigorate two-year college science and technology faculty in the target campuses by providing professional development and applied research opportunities for faculty at Brookhaven National Laboratory.

- To create a dynamic, on-going and cross-cultural relationship between these colleges, local industry and a world-class national lab so that research and development opportunities and experiences can extend beyond the life of this project.

- To create facilities on the two campuses which permit more general involvement of the campus communities in project activities.

- To develop these new, collaborative experiences among different departments, disciplines and organizations into a capstone curriculum experience, providing future students with an opportunity to draw on all their developing skills and knowledge, including general education as well as major-specific competencies.

- To expose participating students to a range of experience, both technical and non-technical, not available at their home institutions.

Faculty and students selected from the participating colleges in consultation with the identified administrative support personnel will participate in summer internships at Brookhaven National Laboratory (BNL) developing relationships with existing BNL staff and BNL applied research projects. These faculty and students will then return to their home campuses to become leaders in courses designed to continue the research experiences they have begun. (Each school has existing courses that are being modified to meet this need.) The students will continue to work on the research projects they started at BNL. They collaborate with other students at their home institution in a course available to second year associate degree students in a variety of science and engineering disciplines. Thus the benefit extends to all technical students at the participating schools.

Relationships between the faculty and staff at the colleges and the staff at BNL and Corning are maintained after the summer internships via the colleges' updated distance learning infrastructure.

Infrastructure

An early activity is the construction of campus "scientific visualization theaters." These facilities permit a group of observers to collaboratively look at a stereographic image of an object that has been defined by either computer stimulation or by data about a real object collected by instrumentation at BNL. The scientific visualization theaters can be used to study applications as diverse as biochemistry (such as protein) studies, physical structures of all kinds, architectural engineering technology problems, product and machine design problems, CAD/CAM machine tool paths, etc., as well as computer technology issues latent in the design and use of the theaters themselves.

The centerpiece of visualization at Brookhaven is its novel stereoscopic viewing system. The stereo effect is achieved in a conference room setting by projecting two polarized images on a specially designed ten-foot screen (treated to retain light polarization), then viewed through polarized glasses. The viewing algorithm makes the image of the object appear to float into the center of the room. The 1280x1024 pixel resolution and high-intensity projection combine to produce exceptional image quality. [5]

This system was designed for ease of replication and high-speed network interaction. As part of this project, both the Alfred and Jamestown campuses are constructing a less-expensive version of this visualization theatre. Using them, they are able to carry on the work begun at BNL in the summer back at their own campuses, involving larger numbers of students, while still interacting with Brookhaven staff.

This is only possible if the network bandwidth and quality of service among the participants are sufficient. All participants happen to use a common internet service provider, NYSERNet, which improves the prospect for high-quality communications. Studies were performed to verify that the connections were sufficiently robust to sustain this kind of activity as initially envisioned. As the project proceeds and the applications become more involved, network behavior will have to be periodically re-evaluated to assure continued sufficiency.

Applications

The first summer of the project was designated ‘year zero,’ because it took place before the NSF funding was in place. Hence, only an abbreviated session was possible, in essence a ‘proof of principle’ effort. Even with this single-team, one-week session, it was possible to demonstrate the value of this experience to the students and their ability to perform at the high level required by the work. The major application in this session was visualization of simulations of sub-atomic particle tracks through an accelerator.

That work is continuing in the second summer, and the first full year of the project. Particle accelerators are the workhorses of experimental high-energy and nuclear physics. A world-class accelerator costs hundreds of millions of dollars to construct, and the experimental collaborations can also have similarly expensive detectors, used by hundreds of collaborators around the world. The design has to be correct before being committed to construction, and simulations help ensure the veracity of the design. Thus, there is one team which is physics oriented, working on visualization techniques for particle orbit and electromagnetic field calculations.

A second team has a chemistry orientation. Its chief tool is micro-tomography, the technique of irradiating a sample to determine, with great precision, its internal structure. Specific applications here include characterizations of environmental hazards in soils, medical imaging for malignant tumors and osteoporosis, geologic investigations, and study of meteorites.

Numerous industrial applications also present themselves. For example, Corning Incorporated, a local, Fortune 500 company, is one of the world’s leading manufacturers of environmental products such as the catalytic converter and the diesel particulate trap. The combination of micro-tomography and stereographic, 3D visualization is of particular, practical interest to them as a way to understand more fully the details of how these porous, reactive surfaces change and degrade during use.

The task of the third team is mastering the computer technology itself. That includes replication of the imaging system, network studies, and implementation of infrastructure improvements over time.

There are a number of other applications that can be addressed, given enough resources. Mechanical CADCAM, climate studies, and investigations of the human genome and proteome are amenable to such projects. One of the more fascinating areas arises in the problem of displaying information that is inherently of higher than three dimensions. Examples arise in physics, economics, and practically anywhere else complex phenomena are modeled. A number of new approaches have been deployed recently to decompose images into meaningful 3D constituents and these can be explored by one or more teams.

Each of these applications represents an interdisciplinary scientific/engineering activity suitable for a capstone experience. Engaging in these efforts as part of a technical group provides the student with real-world analytic experience as well as lessons in the values of a teamwork approach. A gallery of images representing these areas and more appears in http://www.itd.bnl.gov/visualization/.

Progress and Observations

There are several unique aspects of this project. First and foremost, it focuses on two-year technical students who are an under-served segment of research laboratories' traditional educational outreach programs. It gives students from mainstream rural schools opportunities for research careers while it familiarizes them with modern equipment and techniques in research. Its aim is to enrich this vital, yet historically neglected segment of the science and technology education spectrum. Secondly, it involves faculty and students working and learning together. Third, it goes beyond current education paradigms to a networked based collaborative approach that enables "hands on" at a distance. Fourth, it guarantees an echo effect which will involve a myriad of students at each home school as well as the local high school students who will be introduced to the technology and to the exciting world of research.

The project is cost effective. A small number of students and faculty become the teachers and leaders of a larger group of students when they return to their home institution. The project will result in systemic changes within each institution. It has a distinct multidisciplinary aspect, particularly in its latter phase. It provides a hands-on experience with actual teams of engineers and scientists rather than a contrived simulation

In essence, this project is the attempt to use distance learning technology and faculty and student summer seminar laboratory internships to create a climate on the campuses which transcends traditional instruction in the disciplines and causes faculty and students in second year interdisciplinary courses to engage in active interdisciplinary applied research in a wider research community.

Even though the project is far from over, it has already demonstrated several important results. One is that distance education can be augmented by newer technology to broaden its applicability to experiences previously only available in a traditional laboratory setting. Second, it is clear that many students from technology schools and community colleges can contribute effectively in apprenticeships reserved largely for students from prestigious research universities.

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Jerry Fong

Dr. Fong is an Associate Professor of Chemistry and Coordinator of Chemical Technology at SUNY Alfred State. He has had extensive teaching experience including major responsibilities for courses in chemical instrumentation, analytical chemistry and organic chemistry. Prior to teaching at Alfred, Dr. Fong was a research scientist for 12 years at Corning Incorporated, and served as their corporate K-12 Education coordinator. He holds 5 patents, has authored a variety of scientific articles, and has completed coursework for a teaching degree in secondary science education (at Elmira College.) He is the leader of the Upstate New York Operation Chemistry ACS Outreach team and holds a B. Sc (with honors) from the College of Chemistry, University of California at Berkeley, and both an M.Sc. and Ph. D from the University of Michigan at Ann Arbor, in Physical Chemistry.

Arnold Peskin

Arnold Peskin is a Senior Scientist and past Head of the Information Technology Division at Brookhaven National Laboratory. He is also the Deputy Head of Brookhaven's Center for Data Intensive Computing. His primary research interests are scientific data visualization and collaborative computing environments. Mr. Peskin is a Senior Member of the IEEE, and a Fellow of the Accreditation Board for Engineering and Technology. He was a founding Board Member and member of the Executive Committee of NYSERNet, Inc. He has also been an adjunct faculty member at Columbia University and SUNY at Stony Brook.

Marie Plumb

Marie Plumb is the Professor of Physics at Jamestown Community College. She has had extensive teaching experience, having taught at every level, including at a university. She has taught both math and physics. She has two Master's, Degrees and is currently working on a Ph.D. She has been co-PI or PI on several grants, which have focused on introducing these new teaching techniques into the classroom. Marie has also been involved with community outreach and innovative early learning programs that have been used as models for programs developed by a local industry and by colleagues at other community colleges.