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ANNUAL REPORT
October 1, 1995 – September 30, 1996

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This Report is Submitted by

Dennis H. Gill

Program Manager for Science Education

Los Alamos National Laboratory

Mail Stop F671

Los Alamos, New Mexico 87545

505-667-8680

dgill@lanl.gov

**LOS ALAMOS NATIONAL LABORATORY
SCIENCE EDUCATION PROGRAM
ANNUAL PROGRESS REPORT**

October 1, 1995 - September 30, 1996

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EXECUTIVE SUMMARY

Los Alamos National Laboratory has a unique contribution to make to science, mathematics, engineering, and technology education. The mission of the Science Education Program is to apply the scientific and technical resources of the Laboratory to the critical needs in education. Our goals are to:

- improve the quality of science, mathematics, engineering and technology education;
- enhance the technical literacy of the public;
- contribute to systemic change in mathematics and science education; and
- ensure a highly trained, diverse workforce.

With this mission and these goals in mind, Los Alamos conducts a wide variety of science education projects, funded primarily by Department of Energy Office of Defense Programs, with additional funding from DOE Office of Energy Research and from other sources such as National Science Foundation, New Mexico Department of Education, American Chemical Society, and others. Some of the projects are national in scope, others are regional and still others are local (Northern New Mexico). The activities in these projects during FY96 are described in this annual report.

FY96 was a very active year for the Science Education Program of the Los Alamos National Laboratory, in spite of significant budget cuts from FY95 (overall, the budget was down about 29%). Over the course of the year we conducted a total of 30 projects which had 2387 direct participants. The indirect impact of these projects was significantly greater, because many of the direct participants were teachers, each of whom teaches 100 or more students. Also, some of our projects involve working with the schools to help them apply new technologies to the educational process. These latter projects directly involve some participants, but indirectly impact entire schools and districts. Our technology projects make a direct and immediate impact on the educational system and how teaching (and more importantly, learning) is accomplished.

All of the Science Education Projects are done in partnership with other organizations and entities. We partner with the schools, teachers and administrators, with other national laboratories, the New Mexico Department of Education, the U. S. Department of Education, the National Science Foundation, curriculum specialists, universities, and others.

Every science education project we conduct is directly linked with the unique resources of the Laboratory and to the technical programs and core competencies of the Laboratory and the Department of Energy. The projects make extensive use of Laboratory technical personnel for talks, demonstrations and tours. These direct contacts with the active science projects always result in excited and enthusiastic students and teachers.

In all of the post-secondary projects, a Laboratory staff member is assigned as a mentor for each participant. Care is taken in choosing the mentors, and training and information are provided for the mentors. These mentors provide role models for the student and teacher participants.

Diversity is a very important goal for each of the projects. Of all the participants in our projects in FY96, 52.1% were minority and 43.3% were female. The ethnic distribution of the participants was: 33.3% Hispanic, 14.8% Native American, 1.5% African-American, 47.9% Anglo, and 2.2% other. This distribution is very similar to that of the state of New Mexico.

Many of our projects are directed toward systemic change in the educational process. Our teacher enhancement projects spend a significant amount of time on pedagogy, demonstrating by example new methods of teaching science and math (e.g., the Constructivist Method). We also work with the schools and their administrators so that the teachers will have administrative support in the use of these new techniques.

Every project is evaluated internally every year, against its own goals and objectives as well as against the broader criteria of the Science Education Program and the Department of Energy. These evaluations are used to make modifications in the projects' formats and implementation. In addition, we have contracted with the Center for the Study of Evaluation at the UCLA Graduate School of Education to do a formal evaluation of two of our projects. They also have conducted two workshops at Los Alamos for all of our coordinators, helping them to better understand how to do their own evaluations. UCLA is also putting together a library of evaluation tools for the coordinators to use in evaluating projects.

There were significant changes in the overall program in FY96. Several projects were not continued from FY95, and most projects had less funding with which to operate. In many cases this translated to fewer participants. In a few cases two projects were combined for efficiency. Two new projects were started, both university level. The Mentored Collaborative Research with Resident University Teams Project brings teams of faculty and both undergraduate and graduate students to the Laboratory to work on research projects in the Stockpile Stewardship Program. The pilot team this year worked on erbium oxide, a material of interest. The Faculty and Student Teams (FAST) Project brings teams of faculty and undergraduates from both a science or engineering department and a department of education at the same university to the Laboratory to do research internships. One of the goals is to improve communication between the departments so as to improve the education of science teachers.

An Internet Web Site is maintained that describes all of the science education projects and gives contact addresses for those who would like to apply or need more information. Many of the projects post additional material generated during the project, such as summary reports, lesson plans and suggested activities. This Web Site was accessed an average of 580 times per day in FY96.

The Science Education Program at Los Alamos is very valuable to the Laboratory and to DOE. We are very proud of our accomplishments recorded here, and look forward to FY97 with enthusiasm.

LOS ALAMOS NATIONAL LABORATORY
SCIENCE EDUCATION PROGRAM
ANNUAL PROGRESS REPORT

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I. TEACHER/FACULTY ENHANCEMENT

A. National Teacher Enhancement Program (NTEP)

Description of the Program

The National Teacher Enhancement program (NTEP) is a three-year, multi-laboratory effort funded by the National Science Foundation and the Department of Energy to improve elementary school science programs. The Los Alamos National Laboratory targets teachers in northern New Mexico. FY96, the third year of the program, involved 11 teams of elementary school teachers (grades 4-6) in a three-week summer session, four two-day workshops during the school year and an on-going planning and implementation process. The teams included twenty-one teachers from 11 schools. Participants earned a possible six semester hours of graduate credit for the summer institute and two hours for the academic year workshops from the University of New Mexico. The Laboratory expertise in the earth and environmental science provided the tie between the Laboratory initiatives and program content, and allowed for the design of real world problems.

In order to clarify individual needs and applications of the goals, participants revisited and rewrote vision statements describing the ideal elementary science program, evaluated their current status, and brainstormed ways of moving toward that ideal. Participants continued to use the National Center for Improving Science Education (NCISE) Four Step Constructivist method of science teaching via the Science Immersion Scenario model. They were introduced to the Event Based Science (EBS) curriculum model developed by Dr. Russell G. Wright. The EBS model follows the Constructivist method of science teaching and provides science immersion models for the classroom.

The teachers received background information on various topics from lectures, demonstrations, tours and hands-on activities. While studying volcanology, for example, the teachers discussed the nature of certain issues and concerns, inherent problems, and the process of finding possible solutions with Laboratory earth scientists. The teachers were involved in numerous tours, including the Bradbury Museum and the TA-54 Waste Management facility of the Laboratory. For each sub-topic, teams of teachers researched specific questions by using the library, the Study Center, and the Internet.

Goals

The principal goals of this program were to:

1. Increase teachers' general knowledge of science through a science immersion experience.
2. Enhance teachers' skills in teaching science.
3. Provide teachers with hands-on science activities and materials.
4. Expose teachers to specific applications of math and science at national labs.
5. Help teachers encourage students to pursue careers in science.

Implementation

The goals were addressed by the following activities:

1. Increase teachers' general knowledge of science through the science immersion experience:
 - implement with scientists from the Earth and Environmental Science Group (EES-1) and TA-54,
 - formulation of questions for research of selected topic,
 - research topic areas in a variety of ways (community library, Laboratory's Oppenheimer Study Center, the Internet).
2. Enhance teachers' skills in teaching science:
 - through introduction and modeling of research on the Internet,
 - through the NCISE constructivist teaching model,
 - through the Event Based Science curriculum model.
3. Provide teachers with hands-on science activities and materials:
 - volcanology workshop during which teachers examined topographical maps and interpreted geological photographs
 - examined and compared a variety of rocks and minerals.
4. Expose teachers to specific applications and science at national laboratories:
 - through involvement with earth and environmental scientists
 - through tours of Bradbury museum, TA-54 Waste Management site.
5. Provide ways for teachers to encourage students to pursue careers in science:
 - through EBS curriculum model (model component)

Evaluation

The program was evaluated using a variety of indicators, tools and instruments. Evaluation surveys were developed by the National Center for Improving Science Education (NCISE). Evaluation of the effectiveness of the program was accomplished by comparing the entry survey and the exit survey data. A number of items necessary at the entry level, but not at the exit, were not included in the comparison. The entry survey provided a baseline about teachers' attitudes towards teaching science, and their perceptions of their own teaching. The teachers completed pre and post-program surveys. Periodic informal discussions with the participants, teachers and presenters, were used to determine if the program was meeting the stated goals and to allow the teachers to recommend any changes they felt necessary. The results of the pre- and post-program surveys were compared to ascertain whether the program goals and expectations were met.

In evaluating the impact of the program, results indicated growth for the teachers in the following areas:

- using program experiences for explanations and examples in teaching and developing student projects,
- developing new materials and making curriculum changes based on what was learned in the program,
- helping students explore science concepts and achieve deeper understanding of science concepts through laboratory investigations and problem solving,
- being able to assess growth based on ability of students to apply knowledge to new situations,
- providing more student group work on long term projects,
- teaching how to collect and interpret data rather than rely on the use of worksheets and textbooks,
- using manipulatives and equipment,
- using computer technology beyond word processing,
- an increase in their comfort level for science, math, and technology (SMT) knowledge,
- an increase in their comfort in teaching science, math, and technology.

Responses interpreted as a reversal from what we anticipated were:

- in general, teachers seemed to favor comprehensive coverage even if it meant sacrificing in-depth study.
- a slight tendency for teachers to say that students should learn basic scientific terms and formulas before learning underlying concepts and principles.

Anecdotal comments from Participants

- "The curriculum is more student driven. We investigate a topic or process and then students branch off to invent their own experiments/projects for others."
- "My students learned that there are no right or wrong answers and that one does not need to feel dumb about science. One learns by doing, so we did many 'hands-on' activities thanks to NTEP."
- "They (the students) are developing their own scenarios and questions to be answered based on what they already know!"
- "I have tried using more experiments in my class."
- "Doing more experiments. Students build and integrate science/math to everyday situations. Use problem solving with open ended questions. Cooperative learning teaches them to work together and responsibility for their part. Can take a local science issue and make it global."
- "Will use event based unit next year."
- "My students are involved more with problem solving - in science activities and math situations! Also, our students are using more hands-on and manipulatives!"
- "They are more engaged in discovery instead of me just presenting the material. We are ending up at the same place, but we're getting there in a different way. They are more confident in finding what they want to know."
- "The main difference between last and this years' science/math methodologies is the students are required to write more about their classroom activities. Writing about science activities is an extension of language arts writing, where story elements is the focus. But here, writing based on non-fiction is the focus, and generalization supported by facts is the technique."

Follow-on Activities

FY96 constituted the third and final year for the NTEP program. Follow-on activities have been arranged for the fall semester of 1996. Participating teams prepared proposals for implementation of the curriculum developed during the final year. Follow-on awards of varying amounts were awarded to selected teams.

B. Teacher Opportunities to Promote Science (TOPS)

Description of the Program

TOPS (Teacher Opportunities to Promote Science), conducted by Los Alamos National Laboratory (LANL), is a three-year teacher enhancement program aimed at 6th, 7th and 8th grade science, mathematics, and technology teachers from rural northern New Mexico communities with little access to technical resources. TOPS has 25 teachers with predominantly Native American and Hispanic student populations.

During FY96, LANL conducted the second year of the program for a third cohort of teachers.

TOPS ties to LANL's role in the DP mission of increasing advanced computer technology capability for simulation and modeling through improved speed, data collection, spatial dimensions, number of dimensions, and the completeness of physics models. This tie is made by connecting TOPS to LANL core competencies through the selection of themes and immersion experiences designed to expose teachers to cutting edge science and to take advantage of Laboratory facilities, materials, and expertise. TOPS teachers and their students conducted storm tracking experiments for Laboratory scientists during 1995-96 academic year and weather tracking was the topic of the immersion experience during the 1996 summer institute. By participating in this research project, TOPS participants benefited from LANL's core competencies of: (1) complex experimentation and measurements, (2) analysis and assessment, and (3) expertise in modeling, simulation, and high-performance computing, especially in the area of global climate studies. Teachers and their students took weather measurements and collected, organized and analyzed the data. TOPS trains teachers in the use of computer imaging and uses modeling and simulation projects to demonstrate the use of imaging in state-of-the-art research science and applications. TOPS supports the Laboratory's tactical goal to "Make notable improvement in valuing and furthering diversity in Laboratory internal and external interactions." This support is evidenced by TOPS recruiting practices, target audience, and the development of student/parent components and curricular units that reflect the diversity of the target communities. TOPS supports LANL's tactical goal of "corporate citizenship" by developing and strengthening mutually beneficial relationships between the Laboratory and its neighbors.

Goals

The program's goals are broad and systemic in nature, with the intent of:

- increasing teachers' knowledge of science, mathematics, and technology;
- enhancing teachers' skills in teaching science, mathematics, and technology;
- providing participants with hands-on activities and materials to take back to their schools;
- exposing teachers to applications of science, mathematics, and technology at national laboratories;
- helping teachers encourage their students to pursue careers in science, mathematics, and technology; and
- enabling teachers to prepare colleagues for systemic change in science, mathematics, and technology education.

The program focuses on providing teachers with the skills necessary to (1) set up successful science learning experiences in their classrooms, (2) help students make connections between their ideas and the real world, and (3) foster science, math, and technology education in their communities. Another important component of the program is the fostering of improved community relations through public education and awareness of the nature of science and the science process. Through TOPS, educators (including teachers, administrators and parents) and students work with Laboratory staff on-site and off-site to slowly dispel ingrained misconceptions and fears of science.

Implementation

In each three-year program, Los Alamos National Laboratory sponsors 25 teachers who collectively teach, on average, 5000 students. Presently the TOPS cohort has 24 teachers representing 19 schools in 12 districts and consists of: 38% male, 62% female, 13% Hispanic, 4% Native American, and 83% Anglo. The TOPS teachers serve student populations ranging from 20% to 100% minority populations, with an average minority population of about 80%.

TOPS continually integrates Laboratory resources into the program through the storm tracking project. Laboratory personnel introduced teachers to current Laboratory science, trained them in using the analysis, assessment, experimentation, and measurement skills necessary for conducting this original lab research, and mentored them in designing the weather experiments for and with their classes. During the school year they continued as mentors and subject matter experts for the participants and their students. Laboratory personnel, program staff, teachers and students are networked through GEONet to facilitate this relationship. Through the DOE Equipment Gift program teachers have access to computers and weather stations needed to conduct this research.

Over the course of three years, teachers attend summer institutes and follow-up academic-year workshops designed to increase teachers' content knowledge, enhance their teaching skills and provide them with opportunities to reflect on their teaching practices and student learning. Topics range from exploring how students learn math and science concepts to developing lessons integrating math, science, and technology. LANL designs activities which mesh state-of-the art Laboratory resources with science, math and technology content, science process and problem solving skills, classroom management and cooperative learning strategies, and alternative assessment techniques relevant to middle level students. Academic year workshops are conducted to increase exposure to the different resources at LANL. Throughout the program, Laboratory program staff visit the teachers' classrooms to provide on-site follow-up to workshops and institutes, deliver classroom materials and equipment, and provide technical assistance. Teachers, working with parents and administrators from their schools, are encouraged to apply for seed money to design and implement a student-parent science enrichment

program at their schools. In the third year of the program, teachers learn skills which enable them to serve leadership roles in their own districts and to continue their professional communications with colleagues once the program funding ceases. All interactions between participants and LANL staff are designed to model or illustrate how real world science is done. Activities are planned to integrate working with scientists and using the tools, methods, and processes of scientists.

Summer Institute June 17-28, and July 15-19, 1996

The goal of the summer institute was to immerse the participants in the emerging storm tracking project and prepare them for the continuing translation of the project into their classrooms. The presentations, activities, and field trips scheduled for this summer were designed to address topics in three major areas: the science, math, and technology content related to the storm tracking project; the refinement of the storm tracking project itself; and the pedagogical content needed to implement classroom integration of the project.

The content topics were designed to support the TOPS storm tracking project. The teachers participated in a hands-on exploration of the basics of electricity; an inquiry-based investigation of related math applications; and an interactive meteorological presentation on cloud formations. These topics combined to provide the necessary background information for an introduction to the physics of lightning and a field trip to the Langmuir Laboratory for Atmospheric studies at the New Mexico School of Mining and Technology (NM Tech). With their newly expanded knowledge of circuitry and an introductory session on soldering skills, the teachers were able to build lightning detectors to attach to their weather stations (gifted by DOE during the FY95 summer institute). The detectors enhanced their data collection for the storm tracking project with lightning data. This allowed the teachers and their students to refine their weather related experiments to include the phenomena of lightning.

Storm Tracking Project

In conjunction with the TOPS Mentor Program, TOPS participants conducted storm tracking experiments for LANL scientists. The storm tracking project provides a science immersion experience over the three years of the program. The experiments are designed to provide scientists with a broad base of ground level weather data. Scientists use the data to study how storms move across the state. There is a need for more local data in this state with its diverse topography and isolated pockets of population. As weather stations increasingly rely on radar and satellite data, localized weather events are hard to track, especially in areas lacking large population centers or airports. Weather stations located at TOPS schools, in many remote and rural areas, collect and share their local weather data. Currently (including TOPS alumni) there are 100 weather stations located at TOPS sites around New Mexico.

Site Visits

Site visits are made several times a year by the program coordinator and, if possible, a LANL technical staff member. Site visits were made during the fall of 1995 and the winter of 1996. The visits were designed to follow up on the summer institute. The intention of these visits was for the coordinator to observe the participants' school communities and classroom environments, meet their administrators and peer teachers, and provide technical support for the storm tracking project. The visits also provided an opportunity for classroom observations to monitor the integration of science, math and technology topics and curriculum, as well as educational strategies, tactics, and tools for implementation, into the TOPS teachers' classrooms.

Regional Meetings

TOPS regional meetings were implemented for the first time this year. LANL and Sandia National Laboratory participants formed seven New Mexico regions and TOPS mentors (alumni of the TOPS Program, see discussion on page ____ of this report) were assigned to each region. The purpose for these regional meetings was twofold; first, to establish a local support network for TOPS participants that will enhance the networking done at the regular TOPS meetings and will endure beyond actual participation in the TOPS program and second, to encourage the continued involvement of TOPS alumni. The TOPS mentors led several local informal meetings with their regions throughout the school year and took advantage of the academic year workshops and the summer institute to schedule evenings with neighboring regions. TOPS coordinators and LANL technical staff members attended all the regions' formal one-day workshops during the spring of 1996. Regions were responsible for their own agendas with the mentor teachers providing technical support for the storm tracking project. Within these small groups, technical support was available to address individual hardware and software needs and provide guided practice with the technology component of the storm tracking project.

Student-Parent Component

Participants were given the opportunity to write proposals for a student/parent component (SPC) to the TOPS program. All 20 schools participated and were awarded a small stipend to conduct a student-parent component. The SPC projects were designed to provide math, science, and technology related enrichment activities involving students, their parents, other community members, and school staff. Projects were structured around family nights, field trips, club meetings, or activity days and represented a broad range of themes and topics. SPC interim reports are on file with the program coordinator.

Evaluation

A variety of methods and instruments were used to gather evaluation data for the TOPS program during FY96. Data was collected specifically to document performance indicators developed for program goals. The TOPS cohort was given a pre-program survey in the spring of FY95, and a midpoint impact survey in the spring of FY96, based on a NAEP teacher impact survey. The students were also given pre- and mid-point impact surveys based on a NAEP student survey.

The impact study for the students of TOPS teachers was conducted over the 1995-96 school year. Pre-year data was collected within the first month of school, and post-year data within the last month of school. The purpose of the study was to begin to document the impact of the TOPS program on participants students. The study examined changes in students' attitudes and achievement, and explored the relationship between program participation and changes in attitude and achievement. The study was conducted using three types of measures. The first used two science achievement measures, one consisting of multiple-choice achievement items and the other, select-and-fill-in concept maps. The second type assessed students' attitudes toward science and math, and the third quantified teachers' participation in the TOPS program. The study's final report concludes: "The TOPS students scored well above average in comparison to a national norm group... and improved in achievement across the school year (in some cases, quite dramatically). They held positive attitudes toward science and mathematics ; some of these attitudes (about 17%) became more positive across the school year while most stayed about the same. These students did not experience decreases in attitudes, although research literature had let us to anticipate that negative changes might occur (among middle school students). Increased program participation by TOPS science teachers tended to be associated with increased achievement gain in their students' connected understanding of science and in their attitude towards science."

Anecdotal Data –National Impact

- Event-Based Science (EBS) author, Dr. Russell Wright, is using two TOPS participants to pilot his new *Thrill Ride!* curriculum and intends to recruit other participants for future projects. The Event-Based Science model simulates real-life events and experiences to make learning more authentic and memorable. Dr. Wright has also spoken to several groups of teachers about the possibility of publishing the event-based curriculum they developed during the TOPS summer institute. EBS is sponsored by the NSF (National Science Foundation).
- *Math Exemplars* project director, Ross Brewer, after presenting to TOPS teachers during the 1996 summer institute, wrote asking TOPS teachers to submit activities and samples of their students' work to be included in his new science publication, *Science Exemplars*. The Exemplars project is designed to provide teachers with effective

assessment tasks along with guidelines and benchmarks to assess student performance.

– The western center for *Microcosms*, a project directed by Dr. Doug Zook of Boston University, has opened at the Albuquerque Academy in Albuquerque, NM. The intent of the project is to provide experiences that invite students to explore the inner space world of micro-biology through activities that mainstream concepts and themes in biology and earth science. The center is a direct result of Dr. Zook's continued relationship with TOPS teachers and alumni following a Microcosms presentation at a TOPS workshop in the spring of 1994.

Anecdotal Data –School Impact

- A TOPS math teacher reports that his school now offers multiple sections of math electives including: *Math Potpourri, Math and Science in Outer Space, and Science World*. In describing how it feels to teach these classes, he said, “ I can't believe I'm teaching math this way. Too bad more teachers can't do it in their schools.”
- At a site visit in fall of 1996 a principal commented that he would allow any of his teachers to go to any TOPS event. When asked why, he replied that it was because he'd seen such big improvements in the classrooms of TOPS teachers. When asked to be more specific, he explained that the number of referrals of students for behavior problems decreased in those classrooms.
- One TOPS participant credits his involvement in the TOPS program with completely turning around his principal's attitude about technology. He reports that what began with a request for a phone line into his computer classroom that would allow his students to take part in the TOPS storm tracking project, has resulted in an assistant superintendent's decision to put in a whole new computer lab for this rural school. The principal commented that it felt like Christmas when the school received a technology grant on top of the new lab. The teacher reports that last year when he asked for a bus to take students to the river to collect data, it was like pulling teeth. Now the principal says to just let him know when they need a bus for one of their data collection field trips.

Anecdotal Data –Community Impact

- In an interim report on the TOPS student/parent/community component, a teacher wrote, “Briefly, the results have been a beginning in community involvement that would never have happened without TOPS and Los Alamos (National Laboratory) connecting to our community.”

Anecdotal Data –Classroom Impact

The following are excerpts from teachers' reflections in their journals or on specific assignments:

- “Some students from other life science classes are wanting to come to my class.”
- “I feel very good about the job I am doing with this unit. If you ever need a real live classroom teacher to go testify to the powers that be that this really works, I'll be happy to volunteer.”
- “Most of all, I find that my students, who tend to be the ‘Sweathog’ variety, are beginning to ask, ‘What do we get to do today?’
- “This is my first year in which I have not dealt with dozens of behavior problems and I think Interlearn and the TOPS program has something to do with it.”
- “I am happy to report that my students have become more proficient at developing the more difficult questions.”
- “The vast majority of my sixth graders, pass each chapter test with at least an 88%; many students make a perfect test!”
- One science teacher reports that in the past when he taught a unit on space, more than half the class failed to apply Newton's laws of motion. This year, when he taught the unit using strategies, tactics, and tools presented through TOPS, 96% of the students were able to correctly apply the laws.
- “Introducing this (strategy) has increased the level of activity and participation in my class. Students have gained a level of self-confidence that seemed to be lacking. I'd been concerned about this, because this is a group of honors students who had apparently lost interest in the class, or the motivation to do well. This trend seems to be reversing itself now.”
- “The kinesthetic and tactile learners are often neglected in my curriculum of book reading, note taking, and video watching. ...I am much more aware of addressing the needs of all the learning styles now.”

- Another participant reports that using what they've learned in TOPS, "has given me a much more calming and enjoyable way of teaching. It has allowed me to add variety to my teaching style, but most importantly, I have come to experience that it really does feel good not to have to be "in charge"...I don't have to be the 'sage on the stage' but rather 'the guide on the side'."

C. TOPS Mentor/Storm Tracking Project

Description of the Program

The Los Alamos National Laboratory TOPS Mentor Program is a three-year project for master teachers who have been members of previous TOPS cohorts. The program promotes excellence in the teaching of middle-school science and math; interests the students of participating teachers in science, mathematics, advanced technology, and advanced communication; and creates new avenues for teachers and their students to learn and retain new math and science skills, use telecommunications, develop and build scientific equipment, and collaborate with other classes throughout the state. The TOPS Mentor Program includes 15 master middle-school teachers from all areas of New Mexico. These experienced teachers act as mentors and advisors to the new TOPS teachers. This allows for the free exchange of ideas, relieves the feelings of isolation that many experience, and improves expertise on both sides. The program enlists teachers and their students to gather information about the weather and other environmental data, to use those data to study the dynamics of storms, and to contribute the data and results to others studying atmospheric statics and dynamics. Having students participate in experiments of genuine scientific interest creates a motivation to learn science and the underlying mathematics, and to become more proficient in the use of technology and telecommunications. Students and their teachers gather weather data and other environmental data; propose, design, execute, and analyze their own experiments; and design and build their own detectors as needed.

The mentors have arranged themselves and the TOPS teachers into regional groups that meet frequently and provide mutual support. They mentor the TOPS teachers throughout the year, providing support, technical assistance, and curricular assistance. Academic year and summer workshops for the teachers and for highly motivated students provide instruction, training, and assistance with the materials, activities, and information necessary for targeted experiments.

The TOPS Mentor Program is linked to systemic reform efforts in the state. The participants are recruited from TOPS alumni. They are networked to participants in other systemic efforts by the GEONet Bulletin Board System and an 800 number supported by Los Alamos. The storm tracking experiments drive the content of the program, while the weather experiments in collaboration with Laboratory scientists tie the project to the Laboratory's core competencies.

The TOPS Mentor Program helps teachers develop hands-on, investigative activities using environmental data. Through the program, teachers and their students learn how to gather valid data, and develop techniques to deal with and analyze those data. Field techniques require familiarity with the equipment, how it works, and how to fix simple problems. Analysis requires many skills, including classifying, comparing, estimating, planning, developing ideas, testing hypotheses, making models, exploring, and discovering. Teachers and their students learn how to use computers and networks as tools in all those activities. They explore how to find and understand patterns, proportional relationships, and generalization. They have been (and continue to be) exposed to the limits of measurement. Computer networks already make significant amounts of data freely available to the public about environmental factors such as rainfall, insolation, temperature, barometric pressure, and so on. Participants in this program are able to contribute their own data to local, state, and national databases, and to understand how their location fits into the national picture. Participants in our programs learn methods of communication, including the making and use of plots and figures, graphs, tables, models, and charts. Teachers and their students use GEONet to exchange information between schools, and to provide information to other teachers, students, and parents in a compact, coherent, and understandable way.

Goals of the Program

The program's goals are broad and systemic in nature, including:

- develop a discovery-based intercurricular physical science and mathematics program with experienced, master teachers;
- provide training in mentoring science content and process skills for other teachers;
- provide science immersion in research through storm tracking, other weather-related experiments, and data collection; and
- further increase and develop teachers' knowledge of science and mathematics content and expose them to applications of science and mathematics at the Laboratory.

Implementation Strategy

TOPS Mentor events are often planned to coincide with TOPS events, in order to foster the mentor-teacher relationship. Teachers attend summer institutes and shorter follow-up workshops during the academic year. These are designed to increase the teacher's knowledge of content and encourage them to develop their leadership and mentoring skills. This year, teachers learned about electricity and magnetism, electronics and detector design, experiment design, statistics, lightning and other violent atmospheric phenomena, and climatology from Laboratory technical staff. They were exposed to the use of these topics in Laboratory research. All these interactions were designed to continue to expose mentors to the techniques of real-world

science, and to encourage individual communication between teachers and scientists. Activities were planned to integrate working with scientists, and using the tools, techniques, methods, and processes of scientists.

Mentors distilled basic concepts from these topics and interpreted them for the classroom. They developed techniques to include this content in classrooms, and modeled the constructivist approach and the Socratic method as they led TOPS teachers through explorations of these topics. They also piloted and helped develop a technique of using simple electric circuits to teach fractions. Throughout, they trained and supported their TOPS colleagues in the successful use of the Davis weather stations and GEONet.

Two teachers co-authored the paper "Distributed Computing Network for Science and Math Education in Rural New Mexico", and represented the TOPS Mentors at the Association for the Advancement of Computing in Education (AACE) TEL-ED/TEL-MEDIA World Conference on Educational Multimedia and Hypermedia and Educational Telecommunications in Boston.

Evaluation

Formative evaluations for each planned activity are conducted using surveys, journals, and discussion. Participants fill out evaluation forms on each presenter. At the end of the summer session, TOPS teachers were asked about the effectiveness of the mentors, and the mentors had a response session with program coordinators and technical staff. The mentors also intensely evaluated the progress of the program and its goals. This session showed the mentors continue to incorporate many levels of information and content into their lesson plans, including topics of high interest to their students. They are becoming leaders in education in New Mexico by discussing strategies and techniques with other teachers, not only those in the TOPS program. Some are presenting information and techniques more formally at other workshops.

D. Teacher Research Associates (TRAC) and Nonproliferation and International Security — Teacher Enhancement Program (NIS-TEP)

Description of the Program

The Department of Energy's eighth Teacher Research Associates Program (TRAC) at Los Alamos National Laboratory provided outstanding middle and high school science, mathematics, and technology teachers with professional scientific research experience through eight-week summer appointments under the mentorship of Laboratory scientists. Eleven teachers – selected from a competitive pool of applicants primarily from the three-state region of New Mexico, Colorado, and Arizona – participated in this summer's program from June 17, 1996 to August 9, 1996. Of the eleven participants, there

were four from New Mexico, two from Colorado, three from Arizona, and one each from Japan and Massachusetts.

Coordinated in parallel with TRAC is the Nonproliferation and International Security Teacher Enhancement Program (NIS-TEP), in which six teachers participated during FY96. While both TRAC and NIS-TEP place teachers in research positions, the programs differ in that NIS-TEP participants conduct research on nonproliferation and international security issues under the mentorship of scientists with Nonproliferation and International Security Division and program offices at the Laboratory. Summer 1996 was the third year that NIS-TEP was conducted at Los Alamos National Laboratory; two teachers participated in the program in Summer 1994, and five teachers participated in Summer 1995.

The primary focus of both TRAC and NIS-TEP is research: 80% of participants' time is devoted to hands-on scientific research, and 20% is devoted to supplemental activities focused on the use of research as a classroom teaching and learning tool. Teachers are required to complete a technical summary of their research, instructional materials to transfer the experience to their classrooms, and a final oral presentation. Teachers may earn three or six hours of graduate or continuing education credit through the University of New Mexico. All FY96 participants received a computer through the Equipment Gift program to enable them to network throughout the academic year with fellow participants and mentors.

Goals

The goals of TRAC and NIS-TEP are to:

- Increase teachers' awareness and knowledge of current research efforts in science, math and technology,
- increase teachers' understanding of the scientific research process,
- promote transfer of teachers' research experience to the classroom, and
- enable outstanding science, mathematics, and technology teachers to renew and revitalize themselves professionally.

Implementation

Mentors – The scientists who serve as mentors are vital to the quality of the program as they devote a significant amount of time and effort to guiding and advising their teacher mentors. A one-hour luncheon meeting was held one month prior to the teachers' arrival to provide mentors with general information about the program and specific information on being a mentor.

Research Experience – Teachers devoted 80% of their time to research and were incorporated into teams of Laboratory researchers across the Laboratory. Research projects in which teachers

participated included, but were not limited to, the following: Use of Neural Networks to Detect Proliferant Activity; Fission Product Tagging; LOBSTER X-Ray Astronomy Satellite; ALEXIS Satellite Operations and Management Techniques; Data Acquisition for Treat Verification Research; and Experimental Study of the Auroral Arc Generator Mechanism.

Supplementary Education Activities – The remaining 20% of teachers' time was spent on supplementary educational activities, including science education workshops, tours of Laboratory research facilities, a visit to the Bradbury Science Museum, and a video presentation workshop. Also, teachers spent time each week working independently and in small groups on their educational transfer plans.

Technical Summary – Each participant was required to complete a written technical summary of the research s/he conducted while at the Laboratory. Participants shared drafts of their summaries with their mentors for feedback before finalizing their papers.

Educational Transfer Plan – Each participant was required to develop an educational transfer plan delineating a strategy for sharing their research experiences with their students and colleagues during the 1996-97 academic year. All educational transfer plans and technical summaries were compiled into a booklet and given to each teacher following completion of the program.

Final Oral Presentation – Evaluation feedback from FY94 indicated that teachers spent inordinate amounts of time preparing for a final poster display of their research, thus reducing the time available to conduct research. As a result, this summer's cohort of teachers was required to prepare oral presentations instead of poster displays. Each participant presented a 5-8 minute summary of his or her research and educational transfer plan, and the presentations were videotaped. A mini-workshop was held in advance to prepare teachers for the videotaping. Each teacher was given a copy of the video for use with students and colleagues to promote understanding of scientific research at a DOE laboratory and to help recruit future participants.

Resource Leveraging – All of the Laboratory mentors devoted significant amounts of time and scientific expertise while mentoring their teachers for eight weeks during the summer. This teacher-mentor relationship has, in many cases, extended to the teachers' classrooms during the current 1996-97 academic year. In addition to mentors, teachers frequently worked with technicians, post-doctoral students, graduate students, and other Laboratory scientists.

Other resources leveraged during FY96 were: (1) the Laboratory's Equipment Gift Program provided each participant with a computer to use in the classroom as a communications networking tool; (2) the Science Education and Outreach Group entered into a partnership with the Southwest Educational Development Laboratory (SEDL), which

provided curricul m development support to help participants design educational transfer strategies; (3) staff from the University of New Mexico and Northern New Mexico Community College provided teacher workshops and educational support; (4) participants' schools and districts supplied financial and in-kind contributions, ranging from \$250 to \$6,150 per participant, to help implement the educational transfer plans during the 1996-97 academic year.

Recruitment – Regional applicants were recruited jointly using two methods: (1) letters were sent to principals and department chairpersons in school districts throughout New Mexico, Arizona and southern Colorado asking them to distribute applications to interested teachers; and (2) the Associated Western Universities (AWU) sent its national TRAC applications from New Mexico, Colorado, and Arizona to Los Alamos National Laboratory after the DOE decided not to conduct a national TRAC program. TRAC and NIS-TEP are open to middle and high school teachers employed full time in public or private schools in the U. S. or in U. S. schools abroad. Candidates' teaching assignments should be in mathematics, science or technology at grades 7 or higher. A Bachelors degree is required, preferably in science or mathematics. U. S. Citizenship or PRA status is required.

Selection – The Science Education and Outreach Group Program Coordinator matched teacher applicants with research proposal(s) and sent the applications to the sponsoring mentors. Each mentor then reviewed her or his allotted applicants and made a final selection. Mentors were encouraged to call applicants to discuss the project and the applicants' qualifications prior to making a final decision. Selection was based on the applicant's educational background, teaching and other professional qualifications, references, and the compatibility of the candidate's research interests with the research needs of the host Laboratory group. Each selected teacher was notified by the Program Coordinator by phone, and an offer letter was sent asking the candidate to officially accept the position in writing.

Evaluation

The following evaluation tools provided formative and summative information regarding the design, delivery, and outcomes of the program: (1) pre- and post-program surveys; (2) an exit evaluation for participants and mentors; (3) observations during on-site visits; and (4) informal discussions with teacher participants and mentors throughout the program.

Participants contribute to creating better public understanding of the research and technology base of the Laboratory and DOE and to improving student preparation for work in science-related fields. Based on quantitative and qualitative results from FY96 pre- and post-program surveys, each of the following increased: (1) teachers' knowledge of and familiarity with current scientific research; (2) their degree of confidence in interacting with students and colleagues on scientific topics; and (3) their level of enthusiasm for teaching and/or

the field of science. As one teacher stated in a final journal assignment: "I know I'll go back to Denver with a rekindled flame for why I started teaching in the first place."

E. Teacher Environmental Assessment and Monitoring (TEAM)

Description of the Program

The Teacher Environmental Assessment and Monitoring (TEAM) Program is designed for science, math, computer, or technology teachers currently teaching high school students in grades 9-12. Through hands-on activities, field-based research experiences, and using STELLA® computer modeling software, participants develop a systems thinking approach to environmental assessment. The program consists of one three-week summer institute, followed by two two-day academic year workshops as well as two school site visits by the program coordinator. During the summer institute LANL environmental scientists and computer modeling specialists worked with participants, guiding them through the assessment and modeling of complex environmental systems. In the course of a typical fiscal year, two cohorts of teachers participate in the TEAM program: the first, (Cohort 1, below), having had its summer institute in the previous fiscal year but having continued on with its follow-up activities in October-April of the FY 96 fiscal year; the second, (Cohort 2, below), having completed the summer institute in June of the FY 96 fiscal year.

Goals

The goal of the TEAM program is to provide teachers and students with skills and tools to help them illustrate the complexities and interrelationships between and among the factors in complex systems. This is done by taking participants through the process of developing a systems thinking approach to environmental problem-solving. The TEAM program has the following objectives:

- Enhance participants' content knowledge of specific content areas;
- Increase participants' understanding of systems thinking;
- Increase participants' understanding of the use of computer models to better understand complex systems;
- Increase participants' understanding of the process of scientific inquiry, particularly data analysis and interpretation;
- Increase participants' ability to effectively use educational technology as an instructional tool.

Implementation

The TEAM program consists of one three-week summer institute, followed by two two-day academic year workshops as well as two school site visits by the program coordinator, and an end-of-program student culminating event. In FY 96 the program culminated with a Student Research Summit.

Cohort 1:

School Site Visits - All schools were visited twice during the 1996 fiscal year. The purpose of these visits were to: (1) meet with the school administration and cultivate support for the program; (2) meet with colleagues of participants who have become involved in the implementation of the instructional program developed at the TEAM summer institute; (3) provide feedback on implementation plans and implementation; (4) facilitate telecommunications hardware connections; (5) provide on-site 'training' in electronic networking, and; (6) answer additional questions.

Follow-up Workshops - Two academic-year follow-up workshops were held for the first cohort. These workshops were designed to: (1) review and enhance both content and process skills covered at the summer institute; (2) introduce new content, and; (3) promote continued networking and resource sharing among participants and with the Laboratory.

Student Research Summit - The 1996 TEAM Student Research Summit was held in April. TEAM participants from 1994-95 and 1995-96 were invited to participate in the Summit. Student teams of three students each were invited to submit student research papers to be presented. Over forty-five students and fifteen teachers participated in the two-day Summit held in Los Alamos. Students delivered oral presentations and poster sessions of their work. In addition, Laboratory researchers talked about their research at Los Alamos and students were able to tour Laboratory research sites.

Cohort 2:

The 1995-96 TEAM program summer institute was held from June 10-28, 1996. The program was for science, math, computer or technology teachers currently teaching high school students in grades 9-12, who are interested in learning about a systems thinking approach to math, science, and technology instruction. This year's program was designed to provide teachers experienced in facilitating student water quality field investigations with additional skills and tools to help them understand and illustrate the complexities and interrelationships between and among the factors which impact the water quality of a riparian system.

Key components of the 1996 institute included: (1) an overview of computer modeling and simulation by several scientists at the Advanced Computer Laboratory; (2) learning how to use STELLA® systems modeling/systems dynamics computer software to develop a model of a local river system; (3) an overview of the surface, groundwater, and other related water systems in Pueblo/Bayo Canyons by Laboratory scientists; (4) the creation of a model of Pueblo/Bayo Canyons based upon information gathered in the field; (5) learning to create models for student manipulation for instructional

purposes; and (6) development of a plan to transfer summer institute experiences to the classroom.

Scientists and technicians from Los Alamos presented various portions of the summer institute, bringing scientific content and expertise, relevant hands-on experiences, and coaching on how to apply an interdisciplinary approach to solve problems to the summer institute. Scientists and technicians also served as role models, tying their "real world" science at the Laboratory – environmental assessment and high-performance computer modeling – with participants' own experiences through contact with Laboratory scientists. Participants gained a deeper understanding of the process of science.

Participants were exposed to Laboratory research in the areas of environmental monitoring/restoration, environmental management, GIS information systems, and high-performance computer modeling and simulation at the Laboratory's Advanced Computer Laboratory (ACL).

Participants

Nine teams of teachers and administrators were in the first cohort, for a total first-year cohort of 23 teachers and 10 administrators. Of the 9 teams, 3 were from New Mexico, 3 were from western Texas, 1 was from Colorado, 1 was from Russia, and 1 was from Mexico. Of the sixteen teachers in the second cohort, 1 is from Colorado, 6 are from New Mexico, 5 are from western Texas, and 2 are from Mexico (Juarez). Student populations represented by teachers in the second cohort are well in line with state and regional student demographics: 4 teach at schools where the majority of the student population is Native American and 9 teach at schools where the majority of the student population is Hispanic.

Two teachers from the first cohort were selected by a competitive process to act as "Master Teachers" for the second cohort. Responsibilities of a Master Teacher include participating as presenters and developers of the 1996 TEAM program summer institute and providing support throughout the academic year in various capacities.

Evaluation – First Cohort

Ongoing evaluations of the program included observations at follow-up workshops and school site visits, evaluation of student Summit presentations and teacher end-of program portfolios. Overall, impact data indicated that the participants benefited from participating in the TEAM program. Fifteen TEAM teachers succeeded in forming student teams and bringing them to the end-of-program Summit. One additional teacher was recruited mid-program and attended the Summit. For many students attendance at the Summit was their first trip outside of their small, rural home towns; several teachers commented that the Summit experience was invaluable for their students in increasing their confidence and interest in math and

science. Student presentations at the Summit revealed an increase in understanding in subject area content related to water quality assessment, an increased understanding of the science research process, and an increase in oral presentation skills. Two scientists associated with the program throughout the year and who spoke at the Summit told the students and teachers assembled that their participation in TEAM was one of the most gratifying and rewarding experiences of their Laboratory careers.

Evaluation – Second Cohort

As stated above, the second cohort has completed only the three-week summer institute of this year's program; the two follow-up workshops and site visits by Laboratory education staff and scientists will be completed over the course of the 1997 fiscal year. Pre/post-institute data indicates that the TEAM program summer institute met its designated objectives. By the end of the summer institute all participants could create a working computer model of a given actual system, something none of them could do prior to attending the TEAM summer institute.

In addition, teacher-participant responses to the 1996 TEAM summer institute were very favorable: all participants (n=14) either "Strongly Agreed" (12) or "Agreed" (2) with the statement "I would recommend the TEAM program to a friend/colleague" (average=4.9 out of a possible 5). Anecdotal evidence confirms participants' positive experience with the 1996 TEAM program summer institute: "There was lots of evidence of prior planning at this institute. The experience was tremendous."

II. CURRICULUM IMPROVEMENT

A. Risks, Rewards and Responsibilities

Description of the Program

This project had its beginnings in the summer of 1995 with a collaboration between the Santa Fe Public Schools, EnterLearn Technologies, and Los Alamos. The initial effort focused on developing a curriculum that would allow radiation to be introduced early in the high school physics academic year. This initial objective was embraced because radiation is a topic usually included at the end of standard physics text books. This means that the probability of the topic being covered in the standard school year is low.

The original concept was tested in physics and physical science classes in the Santa Fe Public Schools at both Capital High School and Santa Fe High School. The results were mixed. For advanced placement physics student (those intent on taking the advanced placement exams offered by the Scholastic Testing Service) including the radiation material early impacted on their preparation for the exam. In short, they were somewhat penalized by the approach with regard to external factors. In contrast, students taking conceptual physics or not preparing for the advanced placement exams benefited from the material in that it provided an overview of most of the physics course. Finally, physical science students were not prepared for the amount of new material included in the first construct of the course.

NEWNet

Concurrent with the testing in Santa Fe, the requirements of the Neighborhood Environmental Watch Network (NEWNet) program became clearer. NEWNet is a program that grew out of Three Mile Island and the nuclear weapons testing program. NEWNet has three major components.

The first component is an environmental monitoring platform. This platform is a stand-alone system that monitors standard environmental or weather data such as temperature and wind direction, but also measures local radiation levels. Radiation monitoring is done with a pressurized ion chamber and provided readings in micro-Roentgens per hour. This approach was chosen to ensure compatibility with measurements used by the health physics profession. Micro-R per hours converts directly to micro-rem per hour. Rem stands for Roentgen equivalent man, the unit used for exposure standards.

Data from the sensor platform are uplinked by NOAA satellite back to Los Alamos for integration into the second component of the NEWNet system. This component is a real-time data base of the collected data. These data are essentially immediately available to the public via the Internet. To explore these data, visit the NEWNet homepage at

The final component of the NEWNet system is the Environmental Teller Machine (ETM). The ETM provided access to NEWNet data and other related educational material through a kiosk. Such kiosks could be located in the vicinity of a local NEWNet platform or other public places such as museums.

As the year progressed, the value of NEWNet to the movement of hazardous nuclear waste became more and more apparent. Specifically, the NEWNet system has potential for environmental monitoring along waste movement routes and in the vicinity of storage sites. The immediate availability of the data, in turn, provides reassurance to the affected populations. Further, as NEWNet becomes nationally deployed in significant numbers, the opportunity will exist for studies requiring a distributed sensor system.

A Change in Purpose

The NEWNet program requires an educational component in order for people to use the available data and understand its implications. This need allowed for two choices: prepare and provide instruction for adult audiences in the community or provide supplemental materials for incorporation into secondary and post-secondary classes.

A choice was made to initially target secondary schools. This direction was chosen because trying to reach the adult population directly has not been found effective. Second, the issue of teaching radiation was considered, and this aspect became the pivotal point for the new curriculum.

From the experience in the Santa Fe Public Schools, it was obvious that another radiation curriculum was not the issue. Los Alamos and many other institutions and organizations have produced materials for teaching about radiation in the past. For example, the American Nuclear Society has many curricula materials available. So does General Atomics and the Colorado School of Mines as well as previous efforts by Los Alamos in SWOOPE (Students Watching Over Our Planet Earth). So the question arose, "What's wrong with what's out there? Why do we need another curriculum and, if we do, what needs to be done differently?"

In exploring this quandary, we concluded that the element lacking from instruction about radiation is the "So what?" question. Radiation curricula deal with the types of radiation, half-lives, decay, and those topics needed to tell people what it is. But these curricula do little to tell people what radiation can do in a context of its risks and benefits in everyday life. Going further, it seemed, through empirical observation, that the skills needed to evaluate risks and benefits are generally not directly taught in schools. The implication is that if people, in general, are to make intelligent decisions regarding radiation and related topics, they need a framework for conducting the evaluation.

From this perspective the concept of Risks, Rewards, and Responsibilities emerged. The curriculum allows for developing a methodology for decision making regarding subjects of immediate concern to teenagers and emerging adults without directly dealing with highly sensitive subjects. Instead, radiation is used as a vehicle for exploring the methodology. This approach capitalizes on the multitude of resources and curricula already developed concerning radiation while adding the "So what?" component.

The Beta Version

From this analysis of need, this year was spent developing the subject curriculum to a beta version level. A curriculum kit was assembled with many components and offered to teachers free if they agreed to participate in testing the kit. Participate meant using the kit and completing formative and summative evaluations during the 1996-97 school year. The availability of the kit was publicized via the Internet as well as locally, resulting in approximately 170 kits being posted by the end of September.

The curriculum itself contained a black and white copy of the curriculum (ultimately it is intended to be published in color - the current standard in educational materials) and the following:

A DOE nuclear waste series of 8 books (4 student, 4 teacher) that can be either reference or class material. Subsequent to distribution, we received a request for 150 copies of the student volumes.

The recent Los Alamos National Laboratory *publication Los Alamos Science* dealing with radiation.

The League of Women Voters *NUCLEAR WASTE PRIMER, A Handbook for Citizens*.

A pamphlet on Radiation and Our Environment published by the Atomic Energy Control Board of Canada.

A video tape on the Neighborhood Environmental Watch Network (NEWNet).

A video tape about radiation produced by the Atomic Energy Control Board of Canada.

A video tape produced by Achievement Television about science as a career, ethics in science, and the advent of nuclear weapons (this was aired on PBS).

A video tape about Yucca Mountain produced by Los Alamos.

And finally, a book by General Electric Nuclear Energy titled *Nuclear Power Quick Reference*.

Part of the curriculum allows students to conduct a survey or do other things. Further, teachers probably will want to share ideas and get help. For this purpose, we set up two list servers - one for teachers and one for students. By signing up to the list, participants are able to send messages to the entire list. We are also trying to get the participation of scientists to monitor the lists and respond to questions when appropriate. The lists will be moderated to the extent that the student list will be watched for immature comments.

A web site has been created for the project. On the site will be other interesting materials, links to other resources, and the color version of the curriculum. Students at Los Alamos High School are participating in the development of the site and, as other schools move through the year, their contributions to the site will be encouraged.

The Curriculum Itself

The curriculum explores the premise that we take risks to receive rewards but incur certain individual and societal responsibilities. This premise obviously is applicable to issues such as drinking, smoking, driving, and teenage sex. But the issue explored is radiation and things such as the storage of low level radioactive waste. It is emphasized that we cannot be responsible citizens if we deal with tough issues by emotional response. In making up our minds on issues, we are responsible for seeking out authoritative information and passing judgment about the veracity of the information. The three week curriculum, without supporting materials, is as follows:

- Week One

Primary Focus: Physics Concepts Fundamental to Radiation
Key Learning Objectives:

- Examine the differences between thinking and feeling in decision making.
- Realize that many people have different perceptions and ideas regarding how nuclear radiation affects life on Earth.
- Understand how the mechanics of solids, electricity and magnetism, electro-magnetic waves, and modern physics relate to nuclear radiation.
- Comprehend behavior of objects in everyday life contrasted with that of particles and waves in the nuclear environment.

- Week Two

Primary Focus this Week: The Nucleus and Radioactivity
Key Learning Objectives:

- Understand composition of atoms and nuclei; visualize mass and volume relationships. Comprehend the strong nuclear force, the nature of isotopes, and the key elementary particles.
- Learn the process of decay, including alpha, beta, and gamma emissions, and apply the concept of half-life.

- Explore x-ray and neutron radiation and how they may be artificially produced through energy transfer.
- Gain a working knowledge of normal distributions, uncertainty, probability, and risk.
- Week Three
 Primary Focus this Week: Nuclear Reactions & Protection
 Key Learning Objectives
 - Understand the process of fission, controlled and uncontrolled chain reactions, and operation of nuclear devices.
 - Explore the science of fusion, and examine prospects for future energy sources.
 - Gain familiarity with nuclear regulatory and safety requirements, and understand the equipment and procedures used to prevent nuclear accidents.
 - Be able to use meteorological and radiation database to analyze trends and draw inferences regarding radiation levels.

Connections to the National Science Education Standards

Risks, Rewards and Responsibilities is organized to emphasize the recently published National Science Education Standards.

References to the standards document are noted in the curriculum document. Particular attention was given to the following portions of the published standards:

- National Science Education Standards, Chapter 2 - Principles and Definitions, page 19-24
- National Science Education Standards, Chapter 3 - Science Teaching Standards, page 32-51
- National Science Education Standards, Chapter 5 - Assessment in Science Education, page 77-100
- National Science Education Standards, Chapter 6 - Science Content Standards, page 106 - 113, and 173 - 181, and 190 - 204
- National Science Education Standards, Chapter 7 - Science Education Program Standards, page 210 - 222

The curriculum is rich with content and experiences that provide excitement for students as they explore their understanding of the natural world. Specific content links across curriculum are traceable throughout the lesson plans and we encourage teachers to add enriching details and topics as appropriate for their students. By focusing on individual student viewpoints and their use of scientific knowledge and processes we empower intelligent public discourse and debate about matters of scientific and technological concern.

Activities for FY97

Beta copies of the curriculum are in circulation requiring support and monitoring as well as formative and summative evaluation. As results





are gathered, they must be compiled and analyzed and the curriculum revised. A true first edition is targeted for Fall, 1997.

A shortcoming of the curriculum to date is a shortage of well defined and described NEWNet activities. Development of these activities will provide for better integration with the NEWNet system. Additionally, interest in the NEWNet system and a need for instructional materials for an adult population has emerged. The curriculum needs revision and adaptation for an adult population.

Finally, continued development of a user base for the curriculum is essential, especially in areas affected in the short term by nuclear waste movements and storage.

B. AIMS Fluid Instabilities Curriculum Development

Description of the Program

Fluid instabilities have enormous influence on everyday phenomena, like weather and kitchen physics, yet the subject is rarely studied in grades K-12. We are developing a series of fascinating, inexpensive classroom lessons to educate students and teachers about the "Rayleigh-Taylor Instability" (RTI) that underlies many of these effects. The lessons are based on the fact that pouring water by tilting and inverting a water-filled glass occurs because of RTI at the water's surface. By inhibiting RTI, one may incredibly keep water in an inverted glass. Activities based on this simple demonstration teach students about RTI, and deepen their understanding about fluid density, pressure, and surface tension. These science activities lead naturally to lessons about engineering, like the design of bottle openings and relative strength of wet papers. Such lessons are also in preparation.

Progress this year includes: writing another chapter for the proposed book, *Spills and Ripples* (to be published by AIMS Education Foundation in Fresno CA), sketching several additional chapters, and writing the first draft of an article for The Physics Teacher Journal.

Spills and Ripples is a collaborative project with AIMS (Activities Integrating Math and Science), intended for grades 5-9. The Physics Teacher is a source of lessons for teachers at high schools, junior colleges and undergraduate schools. Also, these activities were demonstrated (i.e., field-tested) in local classrooms.

IV. STUDENT SUPPORT

A. Summer Experience for the Economically Disadvantaged (SEED)

Description of the Program

Project SEED, sponsored by DOE and the American Chemical Society (ACS), is an innovative career development program designed for economically disadvantaged high school students. During the past 25 years, Project SEED has enabled more than 3000 talented high school students across the country to spend the summer participating in research internships. SEED students spend eight to ten weeks during the summer in an academic, industrial, or governmental research laboratory working under the supervision of a researcher or research assistant. The intent of the program is not to create scientists. Rather, it attempts to overcome some of the obstacles - social, institutional, attitudinal, and educational - which have traditionally excluded the economically disadvantaged from preparation for and entrance into professional careers.

The Los Alamos summer experience is designed to involve students in meaningful research four days a week, supplemented on the fifth day with educational activities that include tours of selected Laboratory facilities, career counseling for post-secondary training, and oral and written communications skills development. Students are required to prepare a technical summary, give presentations to their sponsoring groups, and design and display a poster session.

Goals

- to increase the students' knowledge, skills and abilities in appropriate content areas;
- to increase the students' research process skills;
- to develop the students' abilities to make sound educational decisions connected to career and professional goals.

Implementation

Participants – Thirteen schools in Northern New Mexico were targeted for recruitment based on the fact that participants have to be able to commute daily to their work site. Site visits, mailings to school counselors and principals, and announcements in local media were utilized in attempts to seek student applicants.

Students were selected to participate in Project SEED based upon grade point average, standardized test scores (if available), and teacher recommendations. All students must have completed the 11th grade, live within commuting distance of LANL, and come from an economically disadvantaged family. Preference is given to students whose families have annual incomes that are below the federal poverty

guidelines, and who may be encouraged by their work in science to make better use of their capabilities.

In 1996, 10 students were selected for the program, with 4 students entering SEED II and 6 students beginning in SEED I. One student in SEED I left the program in late July to take another job. The remaining students all successfully completed the summer program. Participants selected for the program in FY96 were primarily under-represented minorities with 70 % of the students being of Hispanic origin, and 30% of Native-American origin. By gender, the participants were 60% male and 40% female.

In cooperation with the local ACS chapter, funding was made available for special recognition opportunities. Through this initiative, 4 students were selected to present posters at the ACS national convention held in Orlando, Florida in late August.

Research Experience – Students participating in Project SEED are selected to work alongside a mentor in a research area at LANL. Students spend 80% of their time with a mentor, and 20% of their time participating in problem solving and critical thinking activities, college planning, career counseling, and technical communications. In addition, students participated in site tours to learn about basic research at the Laboratory, and presented a paper and poster on their research. Students earned a small summer stipend for their work, but it is the mentor relationship between the student and the researcher that is the key factor in helping the students establish higher goals for themselves and in expanding their horizons.

The program coordinator recruits students and mentors, and matches the candidates to the research topic by analyzing student transcripts for evidence of content background. Student interests and teacher recommendations are also important in identifying capable and motivated students. By identifying students and projects on a scale of introductory to advanced, the program coordinator matches the appropriate levels of student abilities and interests to the scope of the research experience. The mentor works with LANL staff to select the student, to identify the scope of the project, and to link the project to learning objectives. The program coordinator solicits research proposals from mentors, screens the projects, schedules all training and Laboratory tours, conducts the orientation session, facilitates the course work, and monitors the program through site visits and mentor and student feedback.

Educational and Career Guidance - The students attend a career class at the University of New Mexico at Los Alamos where they receive concurrent high school or college credit. Topics include decision-making strategies, critical thinking and problem solving activities, financial planning, time management, career interests and the educational requirements accompanying these career choices. To supplement the curriculum, ACS provides materials on Careers in Chemistry.

ACS offers to assist Project SEED participants with scholarship/grant information and has encouraged students to contact them on any issue of financial concern. In the post-program questionnaire, mentors are asked to recommend students for assistance. Each student also receives a directory of scholarships specifically available for minorities. The students are informed of the various types of scholarships and grants and are instructed on how to complete the general financial aid form.

The students had several instructional sessions designed to improve their oral communication skills. Many of the students have not previously presented a scientific talk and are provided an opportunity to present their research experience in front of their peers and sponsoring groups. Videotaping their presentations and reviewing the tape with the students individually provides the students with essential constructive feedback to enhance their oral communications skills. Students are required to prepare a technical summary (8-9 pages) of their research, and to submit outlines and rough drafts to the program coordinator. The students are also required to design and display a poster session illustrating their summer experience.

In order to increase the participants' exposure to Laboratory research, various tours and presenters are utilized. Each Wednesday afternoon is devoted to visiting different Laboratory sites in order to interact with scientists and have opportunities to hear about different ongoing research.

Supplementary Activities – Tours of selected Laboratory research facilities were particularly popular. Representative tours were selected that gave the students an overview of the different kinds of research conducted at Los Alamos.

The Project SEED students attended the following tours:

- Human Genome Project in the Life Sciences Division
- Thin Rock Section production and analysis at the EES-1 Facility
- The ALEXIS Project at the NIS-2 Facility
- The Bradbury Science Museum at Los Alamos National Laboratory
- Cancer Research at the Life Sciences Division
- Medium energy particle physics at the Los Alamos Meson Physics Facility (LAMPF)
- Neutron diffraction at the Manuel Lujan Neutron Scattering Center (MLNSC)
- Telemedicine and Supercomputer research at the CIC facility

At each location, Laboratory staff provided briefings and, since the group was small, the presentations were geared to individual students and their personal interests. The tours helped to broaden the students'

awareness of the varieties of research in place at Los Alamos National Laboratory.

Evaluation

Evaluation materials include pre- and post-surveys of the program, site visits and observations by the program coordinator, a study of the students' career plans, and mentor feedback. Students indicated that Project SEED helped them to increase their interests in science, in pursuing a science major, and in pursuing a scientific career. After the program, 100% indicated that their work with real scientists made a difference in their understanding of the research process.

LANL program staff assessed students' knowledge and understanding by using interviews, video and poster sessions evaluation, and written reports. This was used primarily to identify academic strengths and areas for improvement for each student. Student feedback is also used to assess program effectiveness.

During the summer the students' work was assessed regularly. They all made final presentations to their peers on their projects. Students' reports were reviewed with the students and suggestions and comments were provided. Both the poster session and the written report were evaluated by LANL staff from the Science Education Outreach Group, and the results were used in part to determine which students would be selected to go to the ACS convention in Orlando.

Each participant of Project SEED was responsible for preparing a final poster and a technical report based on their research experience. Students were required to prepare a technical summary (8-9 pages) of their research, and submitted outlines and rough drafts to the program coordinator. The students were also required to design and display a poster for a final session illustrating their summer experience.

Highlights

When asked what they had gained from their summer experience in Project SEED, the participating students responded in a variety of ways, some of which are listed below:

"I gained a great deal. I learned to work well in a laboratory setting. I also learned quite a bit about science and what scientists do. It was a great experience."

"Working with a mentor helped me to understand my capabilities, that I can do the same things that scientists do."

"I learned that in order to become involved in a working environment, you must use your communication skills."

"I feel that I have gained a great work experience, as well as a great learning and educational experience."

"Being given the opportunity to present my work to scientists and chemical company representatives gave me confidence in myself and in the work that I completed in the eight weeks that I participated in the summer program."

"At first, I felt like I would not be able to present my work as well as others. I found out that I was able to do just fine, and I completed my work responsibly. I realized that people from small communities such as myself can definitely compete with people from larger communities."

"Since this SEED experience is over for me, I hope to build on the knowledge that I have learned, along with the possible internships and collaborations with scientists. Not only this, but I have learned to talk to people and let them know all the benefits that can come from working in a program like Project SEED."

B. Summer of Applied Geophysical Experience (SAGE)

Program Description

In Fiscal Year 1996 the Summer of Applied Geophysical Experience (SAGE) brought 31 undergraduate students, graduate students, and a high-school science teacher to New Mexico for a month-long, "core" program of classroom instruction and field study in geophysical exploration. Students attending SAGE 1996 represented 26 institutions from the U. S., New Zealand, and Mexico (Table 1). The core program included collection of geophysical data; computer processing and interpretation; and written and oral presentations by all participants. Geophysical techniques which students used in their field activities included seismic reflection and refraction, DC resistivity, ground-penetrating radar, gravity, magnetotellurics, and transient electromagnetics. Despite bad weather for part of the field activities in late June and early July, students collected more than enough data to allow them to process and interpret their own data. Field work focused on two main projects, (1) a study of the Española basin of the Rio Grande rift, including of subsurface sedimentary units and faults, and (2) imaging of buried "paleochannels" (old stream drainages, now buried) at an environmental site at Los Alamos. The later problem is of considerable interest to the Environmental Restoration project, which is investigating the channels as potential pathways for contaminant migration. SAGE was able to provide the project with information regarding the feasibility of using geophysical techniques to locate and follow the channels. Many geophysics students are interested in environmental applications of geophysics, since many prospective jobs are in this field. The exercise was well evaluated by the SAGE 1996 students.

For the second year in a row, SAGE coordinated with the TRAC program to include a high school science teacher, this year from William Smith High School in Aurora, Colorado. The teacher/student was part of SAGE for four weeks, then continued geophysical research at Los Alamos National Laboratory. One objective of the teacher was

to develop curricula which enhance teaching of earth sciences at the pre-college level.

In addition to the core program, SAGE held two week-long workshops for selected students from SAGE 1995. The first of these, at the University of Texas at El Paso, focused on processing of seismic data. The workshop reinforced the "core" SAGE experience and allowed students additional time to learn data processing and interpretation. The second workshop was held at San Diego State University, and emphasized processing of electrical and gravity data. Several students attended both workshops. Besides the workshops in the year following the core SAGE program, several students are continuing to work with SAGE data for their Master's degrees.

As in previous years, support both in dollars and in kind from Industrial Affiliates is of key importance for the successful execution of the course. Among the help that was furnished to SAGE 1996 was loan of field computers by Marathon Oil Company and Landmark, of GPS (Global Positioning System) equipment by Leica, and help with field work by representatives of Kennecott Exploration Co., Zephyr Geophysical, and Zonge Engineering. Dr. Matt Mikulich and Dr. Marvin Bloomquist, Chief Geophysicists respectively for Chevron and Mobil, visited SAGE 1996 and interacted with students. Direct contact with scientists from industry is invaluable to students planning careers in geophysics.

The National Science Foundation provided funding for undergraduate students in SAGE through the Research Experience for Undergraduates (REU) Program. NSF has provided this funding each year of the SAGE program.

Finally, SAGE published a technical paper in the 1995 New Mexico Geological Society guidebook on results of seismic and gravity studies of the Española basin.

Information about SAGE, including photographs, published results, and a list of Industrial Sponsors, is newly available on the World Wide Web at <http://geontl.lanl.gov/SAGE/SAGE.htm> or through the Los Alamos National Laboratory homepage.

2 Figures - SAGE

Figure

Students at SAGE 1996 employ global-positioning equipment to establish survey coordinates for measurements of the Earth's gravity field.

Students at SAGE 1996 employ ground-penetrating-radar technique to search for paleochannels at environmental site.

TABLE 1. Institutions Represented in SAGE 1996

University of California—Riverside	Mt. Holyoke College
University of New Mexico	San Diego State
University	California Institute of
University of Wisconsin—River Falls	
Technology	
University of the Pacific—Stockton	North Carolina State
William Smith High School—Aurora, Colorado	Augustana College
Miami University of Ohio	University of Toledo
Ohio University	CICESE
Victoria University (New Zealand)	Boise State University
University of Wisconsin	Virginia Tech
University of Texas—Dallas	Purdue University
Colorado State University—Fullerton	University of Alabama
University of Arizona	University of
California—Los Angeles	
LaFayette College	Autonomous University
of Mexico	

C. Critical Issues Forum

Description of the Program

The Critical Issues Forum 1996 focused on students' abilities to develop and examine concerns of New Mexicans about issues surrounding the topic of the disposition of nuclear materials. This topic was chosen to actively engage students and teachers in an interdisciplinary area of study. Scientists at Los Alamos National Laboratory were able to interact with schools throughout the State through a Laboratory maintained electronic bulletin board.

The Critical Issues Forum targeted high school teachers and students throughout New Mexico. Built around an issue dealing with nuclear materials, participating students and teachers examined every facet of this complex subject using a number of resources, including Laboratory personnel. The teams researched the political, economic, social, and scientific facets of this critical issue using various dissemination products including official documents, press releases and fact sheets, poster session materials, a Powerpoint presentation and a documentary video.

Goals

- To provide opportunities to develop and apply critical thinking and problem solving skills on a complex problem of global significance.
- To promote cooperative learning through successful teamwork.
- To develop the connections between scientific concepts and everyday life.

- To increase understanding of the science process.
- To increase public understanding of the issues relating to the future of the nuclear world.

This program leverages LANL's scientific capabilities and resources by integrating our core competency in nuclear materials management, stockpile support, and stockpile stewardship with education. The Critical Issues Forum contributes to systemic improvement in science, mathematics, engineering and technology education by:

- Enlisting participation and support at the district, school and classroom levels
- Increasing communication within and between schools
- Developing partnerships between Laboratory and education community
- Providing resources and technical support to schools and districts
- Providing electronic communications technology as one method of distributing educational materials to the public
- Providing access to Laboratory personnel

The Forum enhances scientific and technical literacy by:

- Preparing teachers and students to utilize technology appropriate to the research topic
- Enhancing students' use and understanding of science research methods and technology
- Providing enrichment opportunities for students and teachers in research, workshops, and curriculum development

Implementation Strategy

Workshops – The Forum is designed to match Laboratory expertise with the needs of New Mexico high schools to provide a unique educational opportunity. It was evident that the schools offered standard courses in English, Mathematics, Science, etc., but it did not appear as though the schools provided an opportunity to apply multiple disciplines to a singular topic of current national interest. Program staff met with teachers and students and decided that the best way to provide such an opportunity would be to select such a topic, provide instruction for students and teachers in process and content, and supply resources that required teams of students to sharpen their critical thinking and problem solving skills on a real world problem of global concern.

Site Visits – Each participating school is visited twice during the academic year. This provides an opportunity for program staff to interact with students, teachers, and administrators in their school setting. This also helps to ensure that students have access to computers and other necessary resources, are provided with time to

pursue the critical issue and that any on-site problems relating to the program can be addressed.

GEONet – To insure parity among participants, GEONet, an electronic bulletin board, was provided and this capability became a central location for interaction and collaboration. Through the bulletin board, participants could access each other, Laboratory program coordinators, Laboratory scientists, and university staff as resources. GEONet also provides participants with electronic mail accounts with Internet access. As skills in telecommunications grow for participants, users can extend their scope of contact to include organizations and resources throughout the world.

Benchmarks – Teams are required to demonstrate their learning and understanding throughout the year in ways that combine content information, critical thinking, problem solving skills and telecommunications.

Products – Each team produced dissemination products based on their work on the topic. In FY96, The teachers from each team worked on the development of curricular materials incorporating issues of nuclear materials disposition. Teams created a final official document that contained various recommendations with respect to solving “the problem”, press releases and fact sheets, poster session materials, a Powerpoint presentation and a documentary video.

Evaluation

The evaluation included a review of GEONet use, student surveys, teacher surveys, observations by program coordinators, and an analysis of student products such as the recommendation packets and presentation materials, to determine the extent to which the students developed their critical thinking skills and their abilities to work cooperatively in teams. Teacher and student surveys indicate that the Forum was successful in meeting its overall goals. The students enjoyed interacting with each other within their schools, as well as meeting students from other schools. Teachers generally agreed that the students learned a lot about the topic, as well as how to work in groups and how to prepare presentations.

The Critical Issues Forum Program was evaluated internally by Laboratory coordinators and also externally by the UCLA National Center for Research on Evaluation, Standards and Student Testing, Center for the Study of Evaluation.

Students and teachers showed significant positive increases in the following areas:

- understanding of nuclear materials;
- understanding of telecommunications;

- content understanding in the disposition of nuclear materials and the monitoring of excess nuclear materials;
- use of technology for research purposes;
- how to research a critical issue;
- ability to use the computer to communicate and share information with others;
- ability to research a complex issue in-depth;
- use of concept mapping;
- understanding of content by using a problem-based approach to learning science; and
- small group work.

Program Highlights

Students - "Before this project, I'll admit, I didn't know much about the disposition of nuclear materials. But now, I feel more comfortable in the subject, and I feel like I learned a lot."

"I've learned to ask more questions and consider all sides of an issue. I also see the Internet as an effective learning tool for the classroom."

"I feel I have achieved a lot of growth through this program. I have learned a lot about nuclear materials. I also liked the opportunity to meet and work with other students and teachers, which has helped my personal growth."

Teachers - "I learned more about Socratic teaching than ever before and a great deal about developing discovery based activities. I now feel comfortable teaching and discussing all issues related to radioactivity, nuclear power, nuclear weapons and storage."

"Most beneficial has been the opportunity to work with other teachers from across the state. These people have brought new ideas into the workshop that I can use and modify to enhance my teaching. The networking will allow us to continue to share ideas."

"I plan to use nuclear materials issues-based lessons in math units on exponents, logarithms, metric conversions, solution of equations in 1 or 2 variables. I plan to continue to maintain collaborative contact with CIF peers and mentors via GEONet BBS."

"I have gained appreciation for the part that group activities can contribute to the learning process. I would like to try to implement more group related activities in my lesson planning."

"My knowledge of nuclear disposition has greatly improved. I know feel comfortable enough to bring this matter up both with my students and my peers."

able to see the computers that they had been working on in both the Laboratory Data Communication Center machine room and in the Advanced Computing Laboratory. Talk topics included: In Vitro Models of Cancer, Snake Awareness Program, TRANSIMS Prototype Animation System, Video Teleconferencing, BEAM Robotics, Global Positioning System, the impact of computing technologies on our society, Talking with Your Computer, Information Resource Management, Security at LANL, Scientific Challenges for Very Large Scale Simulation, Supernova, and the Web. Approximately 100 LANL people were involved with the activities in one way or another, 50 of them were escorts.

Several times during the year, Challenge coordinators attended conferences and workshops to promote the Challenge and encourage participation by others.

Data from evaluations and interviews has shown a great need for teacher instruction and this summer, two two-week Summer Teacher Training Sessions were held, one at Eastern New Mexico University in Portales and the other at New Mexico State University in Las Cruces. A total of 47 teachers participated and received three units of graduate credit from those institutions. They were instructed in C++, Unix, the Internet/WWW, HTML, NESP, and other topics. Although they were intense days of instruction, the teachers learned a lot and said that they would recommend the sessions to others. (See the graph of the teachers' pre-test and post-test scores.) The teachers were very enthusiastic with comments like "The STTS should be a requirement for Challenge teachers (some of the best training in my career)", "Sponsoring the team will be easier with experience from this session", and "Excellent – I would like to come again!"

The Challenge has had a positive impact on students, teachers, schools, and communities. LANL's participation has had a positive effect on participants' perception of the institution.

The unrelenting growth of the Challenge has strained the sponsors ability to support the Challenge. In the past, without any prerequisites to participation, many students would begin the program but not follow through. We feel that the students learn and gain from the Challenge however long they participate, but since the expensive portion of the Challenge is the beginning, the state committee decided to try to control the number of participants and encourage strong commitment to the program by instituting a limit of four teams per high school. The sponsors hope this growth restriction will enable them to continue offering the program to students who are committed to active participation.

Large schools will be allowed to ask for a waiver from the state committee. During the registration period for the '96-'97 Challenge, no schools requested a waiver. In the past schools have entered as many as 17 teams and those that have done that have not been able to keep

the interest going for that many students. Last year the school that entered 17 teams did not have a single team finish the entire year.

Preliminary numbers for the '96-'97 year show that the rule did reduce the number of students registering (maybe too much). Now we will monitor the attrition carefully to see if more students can complete the entire year. We have had positive comments from past teachers about the new rule. It gives them leverage to cull students who would only go for the two days "out of school." One teacher has said that he will still have a Challenge class, but only 20 students from the class will participate this year, the others in the class will be learning from those 20 and be able to participate next year, sort of like the junior varsity.

LANL and the Challenge look forward to their contributions to the future participants and the world in which they will live.

(3 Figures from Challenge)

The partnership between HBCUs and DOE national laboratories is another valuable use of government facilities and resources. Also, it is a way in which the laboratories contribute to the improvement of quality and diversification of the future workforce in science and engineering

Participants can choose from many disciplines throughout the national laboratories structure. They have the opportunity to conduct basic and applied research using state-of-the-art instrumentation, advanced computers, both proven and experimental technology, and facilities and resources not available at their local campuses. National and world renown scientist direct projects and mentor students giving them a career experience advantage in the future job market. Some projects are done by HBCU teams with Laboratory scientists as collaborators. The technology and experiments developed sometime become a part of the core curriculum of the HBCU local campus.

Implementation Of Program

During FY96, the HBCU Program at LANL realized one of its goals, to bring fourteen students to another commencement point in their careers. Eleven students spent 15 months at LANL working with mentors on research projects and attending classes. Their accomplishments are summarized below:

- 3 UGS received Bachelors of Science degrees
- 4 GRAs received Masters of Science degrees
- 3 GRAs returned to Graduate school
- 1 UGS is continuing under-graduate studies

Another 3 GRAs spent 7 months (summer + 1 semester) at LANL doing similar work. Two of them accepted full-time-regular employment with other agencies or institutions, and one returned to graduate school to complete his doctorate degree. For the summer 1996 there were two returning students and one new student.

The student interns came from Southern University, Grambling University, Texas Southern University, Prairie View A&M University, North Carolina A&T State University, and Fort Valley State College,.

Mentors, Workplans, and Student Career Goals

Another HBCU Program goal reached during FY96 was to build a stronger relation between the HBCU Program Office, the mentor, and the student. A visit was made to the worksite of each intern. We (HBCU acting coordinator, the mentor, and the student) discussed the workplan, the career goals, and the research or assigned project along with any publications or progress reports submitted to the host group. We also discussed the over-all HBCU Program and how they believe it could be improved. These interactions were very positive and informative. This must be repeated with each set of new students and new mentors as well as keeping in touch with those who participate year after year.

One weak area was the workplans. They were not very descriptive nor specific. They are a part of the Personnel Action Form (PA) used by The Human Resources Division to employ the student and therefore are a good reference document. FY97 mentors need to give more attention to drafting the work statements.

The use of the mentor is very important and his or her efforts to develop and direct the student is an integral part of the program. Some results of their projects can be seen in the final research reports submitted by the students and the student's technical presentations given at the symposium before their peers. Mentors seem more receptive to a team effort of helping the student. This year, FY96, all phases of the program requirements were very well done. Only two students expressed disappointment in their workplan or lack of a workplan and in their overall accomplishments while at LANL.

Student career goals were progressive and focused. However, the scope was widened tremendously after being exposed to the work that is done at the Laboratory and being introduced to other possible career options. We are to keep this relationship strong because it is one of the possible avenues for moving a student from temporary to full-time Laboratory employment. Also, cost sharing is more likely if the mentor is part of the team helping the student rather than a project provider.

Professional Development Seminars

During the summer of 1996, students were offered professional seminars through the University of New Mexico-Los Alamos Campus (UNM-LA) in technical writing, technical presentation, resume writing, public speaking, interview skills, and the use of the computer software, Power Point.

Technical Research Contracts

The HBCU Program at LANL had two collaborative efforts with North Carolina A&T State University during FY96. They are both a part of a proposal "The Physics of Materials Research Initiative at NC A&T State University". Scientists from the Superconducting Technology Center (STC) and the National High Magnetic Field Laboratory at Los Alamos assisted with these projects. Three papers have been produced from these contracts. They are

1. A. Kebede, C.M. Buford, J. L. Smith, et.al. "Silver Alloys for High-Temperature Superconducting Wire", *J. of Electronic Materials*, Vol. 24, 1995.
2. A. Kebede, C. M. Buford, J. C. Cooley, J. L. Smith, et. al., "Studies of the Correlated electron system SmB6," *Elsevier Science B. V., Physica B*, 1996.

(3 Figures from Challenge)

3. Clinton B. Lee, Prabhat Tiwari, David Watkins, et. al. "A Study of Ferroelectric Thin Film on Semiconductors Substrates Using Conductive Metal Oxide Electrodes for Memory Applications", in draft form.

PREP Initiative

The Texas Southern University's (TSU) " Science and Engineering Career Awareness and College Preparatory Program" finished with a visit to LANL, Sandia, and some of New Mexico's four-year colleges and universities, July 19-21, 1996. This program is directed by Dr. Etta F. Walker, Chair, Computer Science and Physics Departments at TSU.

Program Evaluation And Assessment

An evaluation survey was distributed to the students and mentors at the end of the 1996 summer session.

Job information – Overall, the job experience was rated highly. Having a positive work experience rated a 96 percentile and acquiring knowledge through the research experience that would help in future career goals rated an 85 percentile. Having the Laboratory position relate well to an intern field of study rated an 83 percentile. An 80 percentile was the rating for having the work plan describe the actual work done during the internship.

Mentors (as evaluated by students) - In all areas of the evaluation, the mentors received in the 90 percentile. The students felt that the mentors played a significant role in making the summer position a productive experience. They also felt the mentors were interested in them as a person and were concerned for their well being.

The mentors did an outstanding job. Mentors are key to the success of the internship programs. Their enthusiasm and cooperation is very much appreciated.

Program – Program aspects ranked lowest of all categories. Meeting with the students as a group allowed them to express their disappointment in the lack of funds available for the program, their disgust with the housing office, and the poor way in which they are hired into the Laboratory.

The communication with the students has room for improvement. Although we developed a student handbook, more emphasis needs to be placed on fine tuning the student orientation, so that students fully understand the process and what is expected from them while they are at LANL. This will allow the program staff to do routine checks on progress and work situations of the students.

Mentor's Evaluations of the Students – The forms used by the mentors for evaluating the students had a different format than the student evaluation forms. The mentors could evaluate the students as

E. Historically Black Colleges and Universities (HBCU)

Description of the Program

The Historically Black College and University (HBCU) Program was established in 1981 by the United States Department of Energy (U. S. DOE) after the passage of Congressional Act 12320. The intent of the Act is to create an avenue through which HBCUs will have increased access for participation in federally sponsored science and engineering programs. The HBCU program has been funded, although at a decreasing level of effort, since its inception by DOE.

The three major objectives of the HBCU Program are (1) to encourage and facilitate the HBCU's ability to do research which would strengthens their graduate curricula, (2) to provide career oriented research opportunities and financial assistance to HBCU students thus advancing their careers to a point of potential employment or further professional studies; and (3) to assist with HBCUs outreach to pre-college level students. The Pre-Freshman Enrichment Program (PREP) holds summer projects funded by the HBCU program. This includes courses in decision making, effective communication of ideas, and analyzing new situations. During the school year PREP hosts workshops on the selection of and success in college. PREP activities are held at the HBCU campuses.

There are three components employed to effect this change in HBCUs participation from less to greater research in science and engineering. They are (1) grants to institutions, (2) fellowships and research grants to faculty at HBCUs; and (3) internships for upper-level undergraduates students (UGSs) and graduate research assistants (GRAs) from HBCUs. With the exception of the institutional and faculty research grants, all work is done at an affiliated DOE National Laboratory that are listed here with their contacts.

- Los Alamos National Laboratory, Betty Harris (505) 667-8353
- Sandia National Laboratory, Ken Holley (505) 271-7841
- Lawrence Livermore National Laboratory, Kennedy Reed (510) 423-1112
- Idaho National Engineering Laboratory, Una Tyng (208) 526-1626
- Lawrence Berkeley Laboratory, (510) 486-4858
- Sandia Livermore Laboratory, Brenda McFarland (510) 294-3371
- Pacific Northwest Laboratory, Curtis Nettles (509) 375-3880
- Westinghouse Hanford, Dan Carter (509) 376-1199
- Oakridge National Laboratory, Mamie Johnson 615-576-1065
- Princeton Plasma Physics, Pamela Lucas (609) 243-3049
- Argonne National Laboratory, Linda Washington (708) 252-1751
- Allied Signal Inc., Sharil Campbell (816) 997-5793
- Sanvanna River

"outstanding", "very good", "satisfactory", or "not acceptable". The forms also gave an opportunity to list strong and weak points and to comment on the program.

All students except one received an "outstanding" or "very good" rating. Also, this was manifested in the high quality of the research, written reports, and technical presentations.

Long-Range Assessment – Abstracts and final papers of the participants will be added to the data base. This will serve as a quick reference for the student's activities and allow the LANL University Programs (UP) staff to write letters of reference. Through the use of this data base, UP plans to continue to track the participants in order to evaluate the impact of the program on their careers.

Community

Social functions sponsored by Science and Technology Based Programs and the University Programs Office afforded each participant the opportunity to interact with a broader community of students, mentors, and program personnel. In addition the African-American students formed a support group that developed an informative web page and held information sessions with LANL officials to discuss some concerns of the group. To find a church to attend rated very high on the student check list we developed for FY96. Most students had moderate success in this endeavor.

Conclusions

This was a very good year for the HBCU Program. The small number of participants compared to previous years allowed for more one-on-one interaction and personal attention. The success of the students and the dedication of the mentors advanced the idea of helping through program and group relationships. A future effort will be made to cultivate this awareness and support.

F. National Science Bowl

Description of the Program

Dennis - Edit as needed. I pulled both of the recent quarters for your reference.

Regional Science Bowl (2nd Qtr 96)

During the 2nd quarter of FY96, the New Mexico Regional Science Bowl was planned and run in conjunction with Sandia National Laboratories. To help prepare for the event, four training sessions were held at Canyon School for all volunteers to go over the format, rules and procedures of the competition. LANL designed and produced the event program, and designed and printed 240 T-shirts. The T-shirts were distributed to all competitors, staff and volunteers on the day of the event. The remaining

tasks, including facility set-up, training information, packet preparation and distribution, and team registration were done cooperatively with Sandia National Laboratories.

The event was held at the Hyatt Regency Albuquerque on February 26, 1996 from 8 AM - 5 PM with 15 teams competing in the Los Alamos National Laboratory sponsored event. Sandia National Laboratories held their competition with 16 teams at the same time as LANL. The winning team in the LANL bracket was Highland High School, which will represent New Mexico at the National Science Bowl to be held in Washington, D. C. on May 3 - May 6, 1996. After the competition, the awards banquet was held at the Hyatt Regency Albuquerque from 6:00 PM to 8:00 PM. Keynote speaker was Dr. Samuel Billison, one of the last of the Navajo Code Talkers from WWII.

Following the competitions, a debriefing session for all competition staff and volunteers was done over E-Mail in order to identify the strengths and weaknesses of the 1996 competition. LANL began planning for the trip to Nationals for the Highland High School team, and practice sessions were arranged for both the LANL and Sandia teams representing New Mexico.

Regional Science Bowl (3rd Qtr 96)

The program coordinator escorted the regional winning team, Highland High School, to the National Science Bowl in Washington, DC on April 28 - May 1. The program coordinator also participated as a volunteer in National Science Bowl competition. A follow-up survey for DOE-HQ was completed.

New Mexico volunteered to host one of the national teams in August. In cooperation with Sandia National Laboratories, LANL planned and will coordinate a trip to New Mexico for the second place team at the Nationals, Lowell High School from San Francisco, California. This trip will emphasize the research of both Laboratory facilities and will incorporate hands-on activities designed to engage the students. The trip will be held from August 10-17, 1996.

G. Underrepresented Minority/Female Initiative

Description of the Program

The Underrepresented Minority and Female Initiative (URMF) was conceived to assist underrepresented minorities and females from the Southwest to achieve parity representation in science, mathematics, engineering, and technology. The URMF program focuses on students from New Mexico, Texas, Colorado, Arizona, and California and it currently involves undergraduate and graduate university students and graduating high school students.

College enrollments of women and minorities lag behind those of white males, yet the demographics of U. S. school-age children clearly indicate that the pool of white males is shrinking. The pool of students entering the pipeline to careers in science and engineering must be expanded to include more of those who have been traditionally underrepresented. The principle goal of the URMF program is to encourage students from underrepresented classes to choose careers in science, mathematics, and engineering and to encourage them to excel in these fields, thus helping provide our nation with an essential resource: the next generation of its scientists, mathematicians, and engineers.

URMF believes that education must challenge all underrepresented minority and female students to reach their potential and must involve resources of the Laboratory. To accomplish this, the program provides internships that allow direct experience in and exposure to a wide variety of science and technology at LANL and at local universities and industries.

Program Implementation

During FY96, thirty-eight undergraduate students, ten graduate students and two faculty were placed in internships.

The URMF had three different components. One was the high school summer program at the University of New Mexico-Los Alamos Branch. Twenty graduating seniors from local area high schools commuted to attend college preparatory classes. The courses were designed to increase their skills in mathematics, present an introduction to technology, give them an opportunity to explore career options, and to provide them with college survival skills.

Another portion of the project took place at the New Mexico State University campus in cooperation with the National Science Foundation/Alliance for Minority Participation (NSF/AMP) Program. Six students from two-year colleges in the state of New Mexico that had completed an associate degree and were in transition to a four year institution were placed in laboratories with mentors and were assigned specific tasks. Based on this research experience, they were required to submit a final paper and to give an oral presentation to their

mentors, the staff of the Alliance for Minority Participation, and the staff of URMF.

The final component of URMF took place at LANL. Twelve undergraduate and ten graduate students from colleges in the southwest were placed in research laboratories with mentors and assigned tasks. Their projects were presented in final papers and twelve of the students were selected at random to present oral presentations. The final papers will be scanned into a database for future references.

During the summer, there were professional development seminars that included training sessions on technical presentations, technical writing, and the seven habits of highly effective people. Social events were provided to encourage interaction among the students of the different programs.

Program Evaluations and Assessments

An evaluation survey was distributed to the participants at the end of the 1996 summer session. Separate surveys for students and mentors were distributed. Evaluations were designed using a likert scale of one to five. An average rating was determined and that rating was turned into a percentile with a 100 percentile meaning all respondents gave that particular question the highest possible rating.

The surveys and final reports filled out by the URMF participants indicate that these internships motivate the participants to continue. Many of the students indicated that as a result of their experience in the programs, they have decided to pursue a higher level of education than they had planned previous to their internship. Mentors as a whole were positive about their experience with the programs. Many had helpful suggestions and were eager to participate again next year.

Based on preliminary feedback, it is the opinion of the URMF Program staff that the format of the program is on target to achieve its educational goals.

H. Atomic, Molecular, and Optical Physics Summer School (AMO)

Program Description

The Los Alamos Summer School in Atomic, Molecular, and Optical(AMO) Physics, a joint program of the University of New Mexico(UNM) and the Los Alamos National Laboratory(LANL), has just completed its eighth year. The School targets upper-level undergraduates and first-year graduate students, who will soon be making career or field choices, and recruits nationally to gain the most diverse possible class. We give the students an intense exposure to basic research by concentrating on the fascinating, diverse areas of AMO physics, both through lectures by distinguished scientists on the latest developments and through mentored term projects. AMO

physics provides a particularly fertile area for such an exercise since its tenets permeate a diverse set of other self-disciplines such as astro-, weapons, condensed-matter, plasma, bio-, and laser physics. We also have the broader goal of teaching certain basic physics skills not commonly emphasized in the university curriculum, of introducing high performance supercomputing, and of fostering a personal interaction between research scientists and students. A knowledge of the workings of scientific research, of the frontier discoveries, and of the newest computer techniques will greatly aid students, no matter what their ultimate career choice. For the past five years, the School has been funded by a National Science Foundation(NSF) Research Experience for Undergraduates(REU) site grant to UNM and by the Science Educational Programs at LANL through the DOE Defense Programs Office in addition to in-kind support from the Theoretical Directorate(LANL) and the UNM Center for Graduate Studies and the Department of Physics and Astronomy.

The session divides into two complementary tracks involving lectures and a mentored student research project. First, the lectures focus on current "hot topics" in the field of AMO physics, motivated from the speaker's own research projects: The lecturer introduces basic physical concepts from the perspective of on-going research endeavors. This mode of presentation gives the students an opportunity to participate in new investigations. Second, each student works on a research project for the whole summer term. A mentor from the senior scientific staff of LANL or UNM oversees and guides the student through this endeavor. A variety of projects are available; most center heavily on high performance supercomputing. The mentors carefully craft each research project to fit the background of the student in order to guarantee the greatest and most effective participation. We have found that this dual track of lectures and research best stimulates the students in an active interest in science and avoids the pitfalls of a program devoted exclusively to one track or the other.

The School typically runs for eight weeks concurrent with the UNM summer semester. The students receive three hours of course credit from UNM as Physics 501. This credit has been readily transferred to home institutions and, in many cases, has substituted for a senior research project. We hold the lectures in the mornings and reserve afternoons for mentored research projects, attempting to strike a balance between these two activities. Classes and research sessions are held on the campus of UNM at Los Alamos; the UNM computer center has a fast link to the LANL network while providing powerful local capabilities. The common class and computer rooms as well as their close proximity within student housing, all encourage a natural cohesiveness within the class. We further foster this class spirit with tours of Laboratory facilities such as the Advanced Computing Laboratory and the Neutron Scattering Center and of local points of interest. The friendships made during the course of the School form an important, enduring feature of the program as commented upon by almost all students, past and present.

Implementation

In 1996, fifteen students from universities in thirteen states participated in the combined curriculum of lectures and individual research projects. Given the charter of the program, most projects emphasized high performance supercomputing both on large mainframe machines such as the CRAY-YMP and on smaller distributed computing networks, which provided experience in parallel computation. Eight different projects evolved, treating such diverse areas as the experimental investigation of coherent control of molecular processes, heavy particle and reactive scattering, spin-polarization in electron scattering from atoms, quantum optics, magnetic fields in dense plasmas, color vision in birds, and transient quantum mechanical processes. The research scientists who acted as mentors included from LANL [Drs. A. Taylor and G. Rodriguez (MST-Material Science), Dr. K. LaGattuta (XPA-Plasma Applications), Dr. S. Cohen (NMSM), Dr. J. Kress (T-12, Molecular and Chemical Physics), Drs. D. James, J. Cohen, G. Csanak, M. Murillo, and L. Collins (T-4, Atomic and Optical)], from UNM [Prof. H. Bryant (Physics)], and from Cal State Fullerton [Prof. Heidi Fearn(on sabbatical at LANL)]. All students submitted detailed final reports, illustrated with intricate graphics, on their research accomplishments.

The mixture of talents in such a diverse group always leads to surprises, especially due to the informal atmosphere fostered between professionals and students as demonstrated by the Einstein translation project of last year. These projects have far ranging ramifications. For example, the study of spin-polarized electrons attracted the attention of experimentalists at the Jet Propulsion Laboratory in California and of Prof. Kazantsev, a renowned theoretical expert in the field, in St. Petersburg, Russia. Another project concerned with heavy particle collisions provided an opportunity for the student to make movies of the simulations. Such movies supply great pedagogical insight into these intricate scattering processes. We have instituted a new twist to our mentor program with a highly cross-disciplinary project involving the study of color vision in birds. The project centered on the basic optical physics of the color-producing mechanism. Prof. Dominique Homberger, a ornithologist at LSU, provided a biological complement by visiting with the students and discussing the implications of their research in her field studies of parrots.

Lectures

In addition, the students attended a full set of lectures on an extensive range of AMO topics including quantum optics, quantum and massively-parallel computing, electron atom collisions, computational physics, propagation methods, interactions with strong magnetic and electric fields, femtosecond phenomena, laser cooling and Bose-Einstein condensates, negative ions, atomic structure, nanostructures, exotic atoms and molecules, atomic processes in astrophysics, Planck's development of the quanta , and collisions with Rydberg atoms. These were presented by distinguished visiting lecturers from

outside universities and research organizations[Prof. Ravi Rau (LSU), Prof. Ilya Fabrikant (Nebraska), Prof. Barbara Whitten (Colorado College), Prof. Jon Weisheit (Rice), and Dr. Eddie Timmermanns (Harvard)] and from the University of New Mexico [M. Zeilik, H. Bryant, I. Deutsch, W. Rudolf, S. Seidel, and N. Duric] and from the Los Alamos National Laboratory [R. Hughes (P), R. Boland (CIC), J. Abdallah (T), M. Murillo (T), G. Csanak (T), D. James (T), and L. Collins (T)]. Lecturers from previous years have included Neal Lane(Rice), Phil Burke (FRS, Queens), Joe Macek (Tennessee), Joe Eberly (Rochester), Volker Schmidt (Freiberg), John Delos (William & Mary), Larry Spruch (NYU), Eugen Merzbacher (North Carolina), Marvin Mittleman (CCNY), Hans Kleinpoppen (Stirling), Alex Dalgarno (Harvard), L. Ponomarev (Kurchatov Institute, Moscow), C. Nicolades (Athens), Diane Lynch (Thinking Machines), Tom Rescigno (LLNL), Peter Winkler (Nevada-Reno), and John Kenney (Eastern New Mexico).

We also have introduced a new lecture component: science and the arts. This year, Dr. Csanak[LANL] presented a series of talks on Japanese No theater and its relation to scientific paradigms. This complements our traditional AMO night at the Santa Fe Opera and talks on pueblo astronomy. We also had our largest participation from UNM, six lecturers from the Albuquerque campus, due to the intrepid recruiting of Prof. Bryant. This large contingent further demonstrates the important ties between the University and Laboratory generated by this program.

Recruitment

Unlike most REU sites, we recruit nationwide with an emphasis on students from Schools with little or no graduate research programs. The Center for Graduate Studies at UNM typically handles the recruitment phase consisting of an extensive mailing of fliers to all members of the American Physical Society Divisions of Atomic, Molecular, and Optical Physics and Chemical Physics (about 2000). In addition, a color poster was sent to all physics, chemistry, and astronomy departments in the United States. Special mailings went to minority-designated institutions. We worked closely with other efforts within the Science Education area at LANL, including the Historically Black Colleges and Universities program. We have also developed a Web site that gives general information and allows direct applications. For 1996, we received over 100 applications. We admitted twenty, of which fifteen accepted. This class was very strong scholastically, filled with many honors students. We maintained our high participation of women(30 %), far above university enrollment at this educational level. In fact, this year we accepted equal numbers of men and women.

Evaluation

Evaluation of such a project has always been difficult. Owing to the efforts of Ann Brandenberger, through a work-studies program at UNM, we have made a concerted effort to contact as many alumni as

possible. So far, forty past students or about 35% of the eight-year enrollment have responded. Of these, twenty percent(20%) have received Ph.D. degrees in the physical sciences, principally physics; sixty percent(60%) are enrolled in graduate studies in science; and twenty percent(20%) have embarked on other professional careers in medicine, computer software, law, and market analysis. The graduate programs involve such diverse locations as the Universities of Colorado, North Carolina, Nebraska, Harvard, California, and NYU as well as Imperial College of the University of London and McMaster in Canada. This year, we also performed an impact evaluation, asking the students the immediate importance of their participation in the School. The consensus this year followed remarkably closely that of previous years. The following general findings about the course emerged: (1) well organized and at about the right level, (2) helped improve understanding of basic concepts in the field, (3) required a reasonable amount of work, (4) provided skills applicable to their careers, (5) gave appreciation of high-level computer power, and (6) fostered an informality that nurtured interactions with renown scientists. We were gratified with the response from most of the students that the School had "renewed their interest in science and computation." In fact, the main complaint was that the School was too short! Therefore, the short-run effects of the School were clearly very positive. We also participated in a UNM survey for ranking the course among others given at the various campuses. The general level of instruction and material received the highest ratings.

Budget

Besides the funding from DOE Defense Programs, the school received funding from an NSF-REU grant. In addition, considerable in-kind support comes from both institutions including materials, computer time, and staff. The students are paid a stipend for the session that covers UNM tuition, travel, and subsistence. Housing costs, always a major expense in Los Alamos county, are borne directly by the School. In addition to being enrolled as non-degree students at UNM, we place them on assignment at LANL so as to enjoy the many facilities such as the Library as well as provide easy access to the mentors.

Relation to DP Mission

The School began as an internally-funded project within the Los Alamos Weapons Program, to encourage greater participation by outstanding students in AMO research, deemed vital to many DP missions. While the advent of the REU component five years ago has broadened this mandate to include applied research science in general, the goals remain aimed at many aspects vital to DP initiatives and Laboratory core competency areas. The long-term efficacy of such programs as Science-Based Stockpile Stewardship depends critically on recruiting highly talented young scientists into various DP research projects. The School fosters such recruitment through contact with DP program personnel in lecturers, research projects, and tours.

Commentary

In recent years, concern has focused on the divergence of basic research and basic student education. The Summer School fills a valuable niche by fostering a personal involvement of senior research scientists with undergraduate students, thus closing this gap. Through the School and other similar REU sites, talented students, who likely will serve in leadership positions in the near future, glean a flavor of the inner workings of a research project by direct participation. Whatever the student's final career choice, this knowledge of an activity, perceived as arcane, but influencing all aspects of modern life essential to the general public weal from industry to defense, will foster informed decisions in the public forum on its implications and applications.

I. Science Engineering Research Semester (SERS)

Description of the Program

The Science and Engineering Research Semester (SERS) program at Los Alamos National Laboratory provides unique and challenging off-campus research opportunities for upper division university science and engineering students. To date, Los Alamos National Laboratory has hosted 337 undergraduate student in the SERS program. Currently, 26 students are conducting research for the fall 1996 semester.

Students and scientists work together on a wide variety of research problems. Science mentors from across the Laboratory volunteer their time to mentor SERS students in the fine art of research. The mentoring relationships that develop throughout the semester, are known, in many cases, to directly influence the undergraduates' decisions to attend graduate school and pursue technical careers.

SERS participants have access to facilities and state-of-the-art equipment at Los Alamos not ordinarily available on a university campus. The SERS program enhances and facilitates the historic interdependence between the university community and the Department of Energy laboratories, thereby contributing to the national goal of strengthening the quality of science, mathematics, engineering research, and education. Supplementary educational activities that complement the research appointment enrich the participants' technical background and perspective for future career decisions. The SERS program encourages participation by women and under-represented minorities in science and engineering fields.

Goals And Objectives

The principal goal of the SERS program is to

Use the Department of Energy's unique national laboratories to develop a diverse workforce of individuals with enhanced

problem solving and technical skills to enable the nation to meet current and future scientific and technical needs and to contribute to the research of the national laboratories.

The principal objectives of the SERS program are to:

- Increase student knowledge and skills in science, mathematics, engineering, and technology topics
- Increase student understanding of the research process
- Attract students to Department of Energy related areas of research
- Strengthen and focus their field of study and career plans
- Increase the diversity of students that participate in the SERS program

Implementation

Los Alamos - SERS students spend 16-weeks engaged in research guided by Laboratory mentors and attend supplementary educational activities. The program participants spend approximately 80% of their time conducting research under the direction of a Laboratory scientist or engineer and approximately 20% of their time attending the supplementary educational activities. These activities include a wide variety of planned events. The activities are designed to enhance the students' experience at Los Alamos and allow students to see the types of initiatives that are underway at this national laboratory. Tours, lectures, and field trips also permit students with diverse interests to get a feeling for a variety of research facilities and to have an opportunity to visit with other Laboratory personnel directly involved in a particular field. The overall feedback from the students regarding the supplementary educational activities is very positive.

For the 1995-96 academic year, participating Laboratory divisions have included Life Sciences, Nonproliferation and International Security, Earth and Environmental Sciences, Materials Science and Technology, Chemical Science and Technology, Physics, M. Lujan Neutron Scattering Center, Accelerator Operations and Technology, Engineering Sciences and Applications, Computing Information and Communications, and Theoretical. In addition to the mentors, each student will come into contact with technicians, post doctoral students, graduate students, and other Laboratory scientists that will provide additional guidance and collaboration with the SERS participants during their stay at Los Alamos. In addition to the team of researchers that work closely with student participants at their Laboratory sites, the coordinator plans all of the weekly educational activities for the students which are led by Laboratory volunteers.

The SERS appointment methodology exemplifies a total immersion into research. Students are expected to be a part of the research team in their respective laboratories and contribute to the best of their abilities. This hands-on approach to student learning provides valuable training and skills to the participants as well as confidence in

their own abilities. Based upon evaluation data collected for 1995-96, participating mentors found 1) students can make a significant contribution in moving the research effort forward, 2) provide new ideas and perspectives, 3) provide additional experimental time to a project, and 4) explore new research areas. The students are typically eager to learn and contribute, and they ask important questions that allow the researcher to explain and interpret the project and results. The students learn valuable lessons in developing scientific habits of mind.

The mentoring component of the SERS program continues to play a very important role. Mentors are prepared and supported in a variety of ways. Mentors receive information to help them to understand the intricate relationship with the student researcher and appreciate the important role they play in the success of the student.

Students are offered an optional opportunity to take a university course offered through the University of New Mexico-Los Alamos Center for Graduate Studies or Branch College. In both the fall 1995 and spring 1996, approximately half of each group attended the Los Alamos campus for course work. Since the SERS program requires that students take a semester away from their home institution, the university courses help to provide an opportunity for the students to continue to move toward their academic goal of graduation.

Program participants are asked to present a technical talk to their sponsoring group (peers and colleagues), design and present a poster display of their research, and submit a technical summary of their research to the program coordinator. These requirements typically occur at the end of the SERS appointment. Students are coached on presenting their findings through several workshops, by their mentors, and the SERS coordinator. Students discuss their poster with the guests at a special reception.

Evaluation

To study impact of the Laboratory program on the participants (students and mentors), a variety of evaluation tools are used, including a student post survey (scaled and open-ended questions), a poster session, technical talks, observation from the site visits, student feedback throughout the program, and mentors responses to a post survey.

Responses from participants indicate that the program continues to be very successful, although some students thought the experience could have been more challenging for them. Students felt the mentoring relationship was a positive experience and students indicated they would stay in contact with their mentors after leaving. As a direct result of the mentoring relationship, many SERS students were asked to continue on through the summer in other student employment programs. Overall, the students enjoyed the educational activities at

Los Alamos. The tours and field trips were most definitely the highlights of all the activities.

In response to an open-ended question about what influence (if any) the SERS experience had on their career plans and goals, the response was overwhelmingly positive. The program strengthened their future plans, confirmed the desire to continue on to graduate school, and provided much needed experience, knowledge, and opportunities they would not have typically received at their home university.

Mentors were also asked several scaled and open-ended questions regarding their experience with the student in the SERS program. Mentors were asked if students made a contribution to their research. Mentors agreed that having a SERS student conducting research with them made a positive contribution. Students helped them meet their research goals, often resulting in authorship or co-authorship of a paper in a journal. The majority of students in both the fall and spring will be author or co-author on a paper. The benefits of working and mentoring a SERS student invoked many positive responses such as, "pleasurable experience", "helped to focus our research question at a critical time", and the experience reminded mentors that guiding students is a rewarding part of research.

J. Science and Technology Alliance

Description of the Program

The Science and Technology Alliance grew out of a continuing effort on the part of the U. S. Department Of Energy (DOE), in response to Presidential Executive Order 12320, to link DOE laboratories and minority research universities in educational and research collaborations. The mission of the Alliance is to increase the representation of African-Americans, Native Americans, and Hispanics in the fields of science and engineering. This is to be accomplished by strengthening mathematics, science and engineering education capabilities of the participating minority universities and by affording opportunities for faculty and students of participating universities to engage in research at U. S. government research laboratories and in private sector research and development programs.

Charter Members of the Alliance include North Carolina A&T State University, New Mexico Highlands University, Ana G. Mendez University System, Los Alamos National Laboratory, Oak Ridge National Laboratory and Sandia National Laboratory. The Montana Science and Technology Consortium, consisting of Fort Peck Community College, Little Big Horn College, Rocky Mountain College, and Salish Kootenai College, joined the Alliance in 1992. A keystone for success of the Alliance is collaboration. In a Memorandum of Understanding and Intent, the charter members stated their goal, "To attain and sustain excellence in mathematics, science and

engineering, by cooperating, collaborating and pooling resources whenever appropriate and necessary."

At LANL, Alliance activities are held jointly with the HBCU and other University Outreach Programs. Internships are provided by several groups and programs throughout the Laboratory. Student selections are made based upon their experience, career goals, and major field of study. They are selected by project leaders or mentors who assign them specific projects. The final paper is written at the end of the internship and a technical presentation is given at the annual summer symposium. Alliance participants are included in the same professional development seminars and social events as the HBCU participants.

Program Implementation

This has been a very successful program for the Alliance members and the student interns. In FY96, four students completed a 15-month internship at LANL; 8 students returned for their second summer; and two new students were added from Universidad Metropolitana at Rio Piedras, Puerto Rico.

The quality and potential of the students were excellent. Site visits revealed some unrest among the 15-month student who had out-grown their assignments and wanted more of a challenge. Some mentors were accompanying their interns to other areas and other projects to get this additional exposure. Returning students quickly picked up on projects where they left off the summer 1995. They formed a network of information and assistance for new students that helped to facilitate their adjustment to the new Laboratory environment.

Non-LANL participants sent in papers for publication that summarized their projects. LANL interns completed research projects, some course work, and gave technical presentations at the annual symposium at Los Alamos and at Sandia National Laboratory. The two new students worked very hard and were able to complete their projects, write a summary paper, and present a technical talk at the Los Alamos symposium on their research. Only an abstract was required.

Program Evaluation And Assessment

An evaluation survey was distributed to the participants at the end of the 1996 summer session. Separate surveys for students and mentors were used. Evaluations were designed to assess the job, the mentor, the student, and the program. None of the students thought that they were misplaced. Mentors scored above average in rating in knowledge of project and willingness to help the student adjust and grow professionally. The workplan was a bit of a problem. Not much effort went into writing them and they did not describe the actual work required to complete the project. The program scored about average. Students wanted more information about the program, the mentor, and the work environment before they arrived. Communication needs to be

improved between the participants before and during their visit to LANL.

Conclusions

Like other University Outreach summer students, the Alliance students completed the summer on a positive note. The feedback received from these students indicates they were all pleased with their decision to come to Los Alamos. The experience advanced their career potentials and some expressed an interest in returning next summer and to work .

K. Regional Two-Year College Initiative

Description of the Program

The Department of Energy's objectives for the nation's economic growth builds on an investment that supports a highly skilled work force, a strong scientific and technological research and development community, and the development and transfer of innovative technologies. DOE is looking to the community colleges to become more involved in technician training. LANL is committed to working with two-year colleges in the state and in other regional academic partnerships. This commitment was demonstrated through the development of the Two-Year College Initiative (TYCI) Program. This year participating institutions included Luna Vocational Technical Institute, Northern New Mexico Community College, San Juan College, Navajo Community College, University of New Mexico - Los Alamos Branch, Crownpoint Institute of Technology, Santa Fe Community College, New Mexico State University-Carlsbad Branch, Albuquerque Technical Vocational Institute, United World College, Southwestern Indian Polytechnic Institute, and the New Mexico State University – Doña Ana Branch.

Prior to the inception of the TYCI, the two-year colleges identified an area of advanced technology in which their schools could specialize. Technologies targeted for this program have been: advanced manufacturing, environmental restoration and waste management, biotechnology and computer technology. Under the college initiative program, student and faculty teams have participated in an internship program at LANL. Interns were placed in various technical areas with mentors who assigned specific tasks. Along with this research experience, the program provided a seminar, lecture, and conference series. At the end of the internship, participants were required to submit an abstract as well as give an oral presentation of their research experience.

The objective for student development was to increase the number and quality of students pursuing degrees in these emerging technologies and to motivate the students to continue their academic pursuits. The objective for the faculty was to strengthen the academic environment at the colleges by enhancing the teaching and research capabilities.

Experience at LANL gives the interns exposure to the cutting edge technology necessary in this competitive world and it is the exposure that leads to the achievement of the objectives.

The TYCI sponsored a Manufacturing Technologies Summer Institute at New Mexico State University(NMSU). Eleven faculty members from New Mexico two-year institutions participated. The goal was to expose faculty to modern manufacturing technologies with the intent that they would incorporate their knowledge into their curriculums. The effort was headed up by George Mulholland (NMSU-Director of the Teaching Factory). This approach is intended to enhance LANL's need for trained technicians in the area of stockpile stewardship,

One team of three students and a faculty member worked on environmental restoration/waste management projects gaining field work experience. They had assigned mentors from one of the LANL environmental clean-up field task units.

Four students assisted a LANL staff member at the Advanced Materials Laboratory (AML) facility in Albuquerque in setting up the semiconductor clean room training facility. This facility will be used primarily by the Albuquerque Technical Vocational Institute and the Southwestern Indian Polytechnic Institute.

During FY96, twenty-five students and twenty two faculty were placed in internships, participated in summer institutes, or worked on research contracts.

Research contracts were awarded three institutions.

- Navajo Community College (NCC) faculty/students were involved with the Navajo Tribal government in a Geographic Information System (GIS) mapping project at NCC with the mentoring from LANL EM Division. The goal was to involve the students in the decision-making process in land-use planning utilizing GIS and to develop data to be used by the Navajo tribes and other tribal organizations. As a result of this project NCC plans to introduce GIS courses as part of their curriculum.
- The United World College (UWC) faculty/students continued to work with EES Division on the potential of a hot dry rock geothermal project in Las Vegas, NM. The state of New Mexico awarded a grant to NMSU to do some test drilling this past summer on United World College property. If successful, this could be the first commercial hot dry rock project.
- Northern Network of Rural Educators were involved in a project with LANL and the University On-line program, whereby 100 credit level courses were awarded, as a pilot project, to ten participating school districts. The pilot provided interactive education credit courses to rural students via the Internet.

Program Evaluations and Assessments

An evaluation survey was distributed to the participants at the end of the 1996 summer session. Separate surveys for students and mentors were distributed. Evaluations were designed using a likert scale of one to five. An average rating was determined and that rating was turned into a percentile with a 100 percentile meaning all respondents gave that particular question the highest possible rating.

The Center for the Study of Evaluation from the UCLA Graduate School of Education and Information Studies completed a comprehensive evaluation on the TYCI. The report evaluated the program for the past three years. A copy of the report can be made available upon request.

The surveys and final reports completed by the Two-Year College Initiative Program participants indicate that these internships are inspiring for the participants. Many of the students indicated that as a result of their experience in the programs, they have decided to pursue a higher level of education than they had planned previous to their internship. Faculty participants have stated that the program inspired them to incorporate new ideas into the courses that they already teach and to participate in the development of new curriculum. Mentors as a whole were positive about their experience with the program. Many had helpful suggestions and were eager to participate again next year.

Collaborations are developing. The program coordinator and George Mulholland from NMSU will be meeting with the two-year institution administrators to further explore research activity at their respective campuses during the academic year. There are plans to create a New Mexico Two-Year postsecondary consortium in Advanced Manufacturing next year.

The research contracts have proven to be a very positive way of doing business with the educational institutions. They have challenged them to develop hands-on projects that have led to enhancing existing educational programs and to new curriculum. They have also provided LANL with a "value added" component.

Based on preliminary feedback, it is the opinion of the program staff that the format of the program is right on target to help achieve the broader educational and economic goals of the Northern New Mexico region specifically and the DOE in general.

N. Pre-Service Institute for Science and Math (PRISM)

Description of the Program

The Preservice Research Institute for Science and Mathematics (PRISM) is a program designed to increase undergraduate student success in completing degrees in science, mathematics, engineering and technology. Using research conducted by E. Seymour and N.

Hewitt that examined the factors (and their relative importance) that contribute to undergraduate attrition in these fields, PRISM identifies and applies strategies that help students complete their BS degrees. Findings from the research indicated that a disproportionate number of well-qualified undergraduates migrate from these majors based largely on two broad concerns - - the “learning environment”, that is, the institutional factors and context within which these fields of study are taught and learned, and - - “intrinsic factors” that include students’ choice of majors and careers. Additional factors, such as lack of preparation in science process skills and mathematics and little, if any, exposure to a technical work environment, further affect the number of local students who complete their technical degrees.

PRISM brings recent high school graduates through a two-year experience that consists of two summer institutes, academic year enrichment workshops, and a semester course in developing student-directed research. The program couples science and mathematics enhancement with activities and information that helps students overcome obstacles to persist in their undergraduate courses and obtain their degrees.

Goals

PRISM is designed to reduce the attrition of SMET students by:

- providing opportunities to explore and conduct undergraduate research that is personally meaningful
- demonstrating how science fits into a broader human framework and not merely as a set of discrete, formulaic problems to be solved
- providing opportunities to establish and strengthen personal reasons for choosing a science, mathematics, engineering or technology major
- providing opportunities for students to form perceptions of the applicability of a science, mathematics, engineering or technology major to a satisfying and rewarding career.

Implementation

PRISM participants begin the program with an intensive summer immersion experience where they receive an orientation to the academic environment, instruction in specific science and mathematics topics, first-hand experiences that promote group interaction and cooperation, one-on-one sessions with upper division undergraduates, and an opportunity to design and conduct a team project that promotes critical thinking and problem solving. The summer institute is followed by regular academic-year workshops and individual sessions to support the students as they begin their university studies. A special course in student self-directed research was offered during the spring semester to help prepare the students for their second summer institute and integrate new knowledge and skills gained during the previous semester .

Eighteen students from the second cohort, combined with four students from the first cohort (who have not yet transferred to UNM main campus) completed the FY96 academic year workshops, and the summer institute. Ten students enrolled in and completed the FY96 university course in self-directed research.

Summer Institute

The FY96 summer institute was designed to build upon the foundation laid in the first summer institute which focused on systems thinking, modeling and simulation. By coupling the two summer institutes, PRISM students receive an introduction to key processes necessary to design and conduct experiments. They learn to answer self-generated questions and then, using these new skills (and others developed during the academic year) they are ready to tackle a more in-depth rigorous topic in the second summer. Students form small teams and develop criteria to assess their effectiveness in focusing their research questions, gathering relevant technical information to shape the experimental design, conducting the experiment and analyzing their data, and in interpreting and presenting their results. Group interaction and teamwork is an important part of the PRISM research process. Each team was responsible for all facets of their work including identifying weaknesses and finding resources to address these areas. Laboratory technical staff, university faculty, undergraduate and graduate students and program staff were all available to assist as needed, however, the students led the process.

The summer institute was divided into three main sections: coursework, research, and academic systems support. The main theme of the summer was astronomy and UNM-LA offered an introductory astronomy course that ran concurrently with the summer institute. PRISM students enrolled in the course (which ran two evenings a week during the institute) and were introduced to a number of scientists and upper division students who helped form additional supportive networks. These students, as well as the PRISM students not enrolled in the course, all were eligible for university credit arranged through the institution.

The FY96 institute had been scheduled for six weeks and, at the request of the students, the institute was extended for one additional week to provide an opportunity for participants to more thoroughly analyze data and prepare results. The curriculum centered on core concepts in physics and mathematics as they apply to astronomy. Many of the students were not well prepared in physics or mathematics and had to devote a substantial amount of their personal time to building their skills in these areas not only to meet the demands of their course but to accomplish their project. Research projects included the development of a computer package to study variable star light curves, building a functional radio telescope, and using a CCD (charge-couple device) telescope to create computer images of variable stars.

Weekly reports, both oral and written, were presented to peers for feedback and suggestions. At the end of the institute each team prepared and presented their findings.

Throughout the institute, PRISM students were encouraged to identify and apply strategies that helped them succeed both in their astronomy coursework and their team research project. This component (academic systems support) was designed to develop students' abilities to self-direct and monitor their learning processes. By having the PRISM students generate their own criteria for success and then use that criteria both individually and as a team, evaluation became an integral and very successful part of the learning process. The students were delighted to find that this approach was adaptable to a range of learning situations.

Academic Year Course

During the spring semester PRISM students could enroll in a UNM-LA course developed by LANL staff to introduce them to scientific research. The course (Topics: Self-Directed Student Research) provided instruction and a framework in which the students had to carry out a well-developed procedure that could be replicated. They chose to investigate whether cheap sunglasses worked as well as the more expensive name-brand varieties. From understanding the visible and neighboring regions of the electromagnetic spectrum, to building an apparatus that could test how much ultraviolet radiation passed through the sunglasses to comparing results to data obtained by state-of-the-art laboratory equipment, PRISM students had to develop and evaluate their research skills. Their experimental findings agreed well with the replicated data, indicating that the students had, in fact, designed and conducted an effective investigation.

Evaluation

To determine how well the program is meeting its goals and objectives an evaluation plan has been developed that uses a number of instruments and techniques to gather data. A program profile has been completed that identifies components of best practice for the summer institute and academic year workshops, pre- and post-surveys are used for the summer institutes, small group discussions and informal feedback provide additional data, and student products illustrate achievement. Observations and interviews by program staff also contribute information used to assess program design and impact. In FY96 the PRISM students' performance levels have increased in several areas: coursework, research and learning strategies. In terms of coursework, students were pre-and post-tested on key physics concepts in astronomy. Of the questions asked, PRISM students increased the percentage of correct answers (60% increase) by the end of the institute. The test was developed by the university professor that had authored the astronomy textbook used in the course.

Students indicated on their post-institute survey that their research experiences were the most valuable aspects of the program and that, specifically, the new knowledge and skills in designing and conducting experiments had made a substantial impact on their confidence to do science. Results indicated their abilities to tackle difficult technical topics, ask questions and access resources had increased significantly. Many students stated they now felt they could take risks in their learning processes, using skills and a new awareness of self-motivation they had developed during the course of the program. One physics faculty member commented.... "conceptually the PRISM students are way ahead of my main campus students". Following the student presentations at the end of the summer institute a Laboratory astrophysicist stated, ... "the students were clear about what they were doing and exhibited a good foundation of understanding".

M. Mentored Collaborative Research Project

Description of Program

In FY96 a new program was established, the "Mentored Collaborative Research Project" (MCR) project. The MCR program was conceived to provide student and faculty teams an opportunity to work alongside Laboratory researchers on "target" project areas that have direct relevance to LANL's stockpile stewardship mission. The MCR program focuses on undergraduate and graduate students and faculty from new Mexico and regional universities. Faculty and students work as a team that is "project" oriented. The teams are usually made up of students from multiple disciplines, for example, computer science, engineering and material science. This provides the additional experience of working together in a multi-discipline manner, much like the common work experience at LANL.

This year's project focused on the Microstructure and Properties of Erbium Oxide (Er_2O_3). The purpose of this investigation was to develop a fundamental understanding of the structural and mechanical properties of both polycrystalline and single crystal Er_2O_3 . The synthesis of Er_2O_3 included the development of techniques for the fabrication of single crystal and polycrystalline samples. The properties of these materials were then investigated.

Program Evaluations and Assessments

As part of the evaluation process, MCR student research projects were presented in final papers and at oral presentations to their student peers and mentors. The success of the project was determined by an evaluation form distributed to both the intern participants and the mentors. This form is based on a Likert scale which is turned into a percentile rating for the various aspects of the program. The project was monitored on an ongoing basis. Students and mentors provided feedback, via questionnaires, for each of the major program components. The purpose of the monitoring evaluation was to determine whether or not the program components were

accomplishing the project's goals and what strategies should be taken to fine tune the program. Evaluation surveys were designed to address: orientation sessions, student workplan, and student evaluation of the project.

Conclusions

In FY96, the MCR program was piloted with a single team of four students. One graduate student from the team will remain at LANL working on the research project for one year. The host technical organization will cost share the student's salary at a 50% level. It is expected that future participating university faculty will continue their LANL research experience at their home institution; with technical support from LANL staff. In FY97, the program will expand to two teams.

V. EDUCATIONAL TECHNOLOGY

A. Teaching Hearing-Impaired Students to Speak

Program Description

In this project, we are applying advances in computational technologies to problems of teaching speech to hearing-impaired students. Certain aspects of the project are extremely technically challenging. In fact, they have been previously considered impossible. Nonetheless, we are clearly making demonstrable progress, to the point that we now have a fieldable prototype system that has recently been placed at the New Mexico School for the Deaf in Santa Fe, where it has been used with students and has been very favorably received. One teacher has commented: *"We're excited to be in at this stage in the development. Most software we find does not have our specific needs in mind. By working with the Los Alamos team, we can affect everything from what kinds of technical feedback we get to how the display looks, considering the needs of both teachers and children."*

Another teacher has stated: *"Showing the back of the mouth is nearly impossible [using prior methods]; we often resort to hand gestures which never fully communicate what we want the students to do. This [Adam] is a tool that not only shows how the tongue ought to be placed, but also shows the students what they are currently doing. It doesn't just tell them that they are wrong, either. It gives them a direction in which to make a change. This is very important."*

The project consists of two main aspects: 1.) Using a computational neural network to learn the relationships between speech sounds and the vocal tract movements that are used to produce them, and 2.) Computing the movements that are used to produce speech sounds in combination with each other in fluent speech. In effect, this aspect of the project amounts to creating a "visual speech synthesizer," *i. e.*, a speech synthesizer that *shows* how fluent speech is produced rather than *speaks* the sounds of speech aloud.

During the past year, we have built the computational neural network capability into an IBM-PC that operates in real-time, thus allowing us to place a prototype system at the School for the Deaf. We have added sounds and improved the accuracy of the computation. Perhaps most important in practical terms, we have developed an interface that allows the system to be used by teachers, although refinement of the interface is clearly needed to allow it to be used by students as well as teachers. Among the interface refinements we need to add is the ability to record and playback the sounds of speech. This was not originally apparent to us, but we have learned (on putting the prototype system at the School for the Deaf) that many of those whom the teachers believe will benefit most from the system have a small but significant residual amount of hearing.

Creating a visual speech synthesizer involves computing the influences of overlapping and adjacent speech sounds as they occur in fluent speech. This is crucially important for our purposes because unless we can teach these aspects of speaking, the speech of the students will not sound natural. The following figures provide examples of these issues:

Figure 1 shows the articulator positions for the /a/ sound as in “father.” The tongue shape was derived from our prior work on factor analysis of tongue positions within and across languages.¹

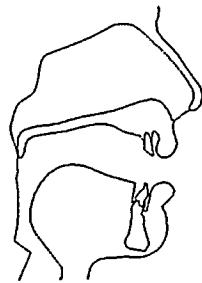


Figure 1. Articulator positions for the /a/ sound, as in “father”

Figures 2.1 and 2.2 show the articulator positions for the /g/ in /ugu/ (pronounced “ooggoo”) and /igi/ (pronounced “eeggee”), respectively. Notice that the tongue is further back for the /u/ context than for the /i/ context, and that the lips are further forward. These are the natural consequences of the vowel context. The problem is to get all the contextual effects of English correct. Technically speaking, this is a problem of nonlinear interpolation in many dimensions. Again, our prior work on the dimensionality of tongue factors is essential in solving this problem.

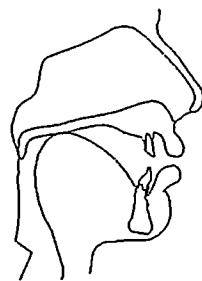


Figure 2.1
Articulator positions for the /g/ sound in /ugu/

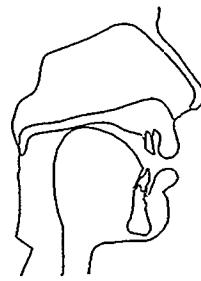


Figure 2.2
Articulator positions for the /g/ sound in /igi/

The technical accomplishments of this project during the past year have contributed to various aspects of the DOE/LANL mission that

¹ Nix, D. A., G. Papcun, J. Hogden, I. Zlokarnik (1966) “Two cross-linguistic factors underlying tongue shape for vowels,” *J. Acoust. Soc. Am.* 99 (6), 3707-3717.

extend considerably beyond their applications in education. It should be understood that this project entails indirect biometric measurement. Hence, a dramatic instance of support of a DOE/LANL mission is related to the Advanced Nuclear Facility Monitoring Program, as explained by LANL Technical Staff Member Paul Argo: *"I would like to express appreciation of your visit to me and my cadre of students last week. As you know, we are trying to learn as much about the areas of biometric identification and authentication as we can, in support of the Advanced Nuclear Facility Monitoring program I am putting together. We are therefore rather weak in many areas, and are striving to come up to speed as rapidly as possible. Imagine my delight when I contacted the leader of the Biometric Consortium, and as we were discussing directions to go he suggested I get in touch with one of the acknowledged leaders in biometrics, Dr. George Papcun of LANL!"*

"My project members and I are looking forward to a long and close relationship with you and your team of speech recognition/voice specialists. Your demonstrations are more far-reaching than anything we hear about in our searches in other places, and we hope to not only build upon your expertise in our own areas, but also to provide you with useful tools and data for your own projects."

Additionally by virtue of the challenging technical nature of this project, it has been the source of mathematical developments that are applicable to other aspects of the Laboratory missions, *and which have actually been applied to them*. For example, the MALCOM (Maximum Likelihood Continuity Mapping) technique, developed largely for this project, is now being applied to the HCFA (Health Care Finance Administration) project, which involves detecting fraud, waste and abuse by Medicare providers. The MALCOM technique is a means for reducing the dimensionality of multivariate data based on assumptions of smoothness of derived dimensions. In the context of this project, the assumption of smoothness is based on the mechanical constraints of articulator motion. In the context of detecting fraud, waste and abuse for the HCFA project, the assumption of smoothness is based on assumed characteristics of Medicare providers. Thus, in this example and others within the scope of this project, we are developing new mathematical tools that are widely applicable to the DOE/Laboratory mission.

B. Educational Networking Support (EduNets)

Program Description

The LANL Educational Networking Support Program (EduNets) was developed to support the national goal to have every school connected to an "information highway" by the year 2000. Our mission is to help school classrooms, libraries, and offices get connected to Internet resources for science, math, engineering and technology and to provide teachers, administrators and technical teams training to use and support these resources.

The LANL EduNets project is designed to use Laboratory technical

expertise and experience to help school districts plan and implement networking infrastructures for connecting their schools to the Internet and its resources. It is designed to provide a coordinated networking consulting resource for school districts in the program and to share materials and models developed with other schools and programs nationwide. It is also designed to establish partnerships with and provide support to community colleges and departments of education to help establish Regional Training and Technical Support Centers for school districts to ensure continued future support.

The current scope for direct assistance is primarily northern New Mexico school districts, with some requested advisory and training support for a few districts in Texas, Arizona, and California that are funded through partnership efforts and research grants. Requested advisory, technical, and training support is also provided as much as possible for BIA and other schools in related LANL networking and support projects for the Northern New Mexico Pueblos, the Navajo Nation, the National Indian Telecommunications Institute, and community networking efforts in New Mexico. Direct Participant Level: Administrators, Teachers, Staff, Faculty. Indirect Participant Level: Students and Teachers in the districts represented that site training teams teach. Grade/ Faculty represented: K-14.

Primary goals include: providing technology planning support, consulting, and training for schools; helping schools and school districts determine how to get connected and plan their networking infrastructure to ensure feasible and validated networking plans and implementation; developing and documenting models for successfully connecting schools to the Internet; making information gained available for educators nationally; and, developing and testing communications, networking, and internetworking applications for education. Principal efforts include: networking and computing advisement and support; establishing regional training and support centers/hubs and Internet computer labs; forming school, regional, and district Internet Education Working Groups (IEWGs); providing on-site support for schools and hub sites, teacher and staff training and

support, and Internet education resources support; and sharing information gained.

EduNets Scope: Sites Supported

	#K-12 Districts in Program	Other Districts/Programs Site Provided Support	K-12 Sites On-site Support	Regional Training & Support "Hubs"
FY95	9	3	>50	5
FY96	16	10	>80	11

Current Support and Partnerships Scope: 16 School Districts, 6 community colleges, 12 other (3 departments of education, 3 regional technology centers, 2 support cooperatives, and 4 related LANL networking programs). Based on requests and current progress, we would expect to increase these numbers by at least 25-30% in FY97. Current data indicates that in all program districts over 50% of the students are in national minority populations, 9 districts with over 90%.

Networking and Computing Consulting for School Districts – One of our main goals is to provide school districts in the program advisement and support on networking and computing. We work with the District Superintendent's office, technology planning committees and school administrations to help them develop their technology plans and grant proposals to obtain funding for internetworking their schools and to implement valid networking infrastructures and internetworking design. Primary support activities include: providing input and support for technology plans and for grant proposals for Internet access and infrastructures; conducting site surveys and needs analyses; providing wide-area network (WAN) and local area network (LAN) consulting; helping determine hardware and software needs; providing contractor liaison and estimates support; reviewing proposals and bid specifications; and, providing onset support, integration support, and testing as needed. We are currently working with seventeen (17) district offices, 16 in New Mexico and one in Texas, in an advisory and support capacity.

Providing On-site Support and Training – The LANL EduNets team made site visits to schools and administrative offices and completed initial and follow-up site surveys at 86 schools and 17 district offices in FY96. The team taught and/or helped technical support staff install software and configure workstations at more than 80 sites.

We spend approximately 75-80% of our time "in the field" with "onset" support and training. Having the technical support and training provided at the sites on the equipment the district uses allows us to test the network and equipment as we do the training and feedback indicates that it helps promote a smooth and effective implementation for the site.

Internet Access: EduNets New Mexico School Districts (at end of fiscal year)

	#K-12 Sites with Internet Access	Sites w/Direct Access	Site Internet Workstation w/Dial-Up Access	K-12 Internet Training Labs
FY95	33	7	26	0
FY96	86	26	60	16

Our primary goal is to assist schools in establish working and reliable Internet access.

In FY95, dial-up accounts and e-mail accounts were provided or obtained primarily through LANL and commercial and state Internet providers, sometimes with long-distance rates and poor access, or at high cost to the providers or the district. In FY96, we made special efforts to work with hubs and districts to set up modem servers for local dial-ups and mail servers with accounts for IEWG members. Now, for many of our sites, dial-up access is a local call through their district or college hubs. Six new dial-up hubs with 28 access lines were established at support centers this year.

In FY96, advance Internet support teams of 2-6 teachers were started and workstations for dial-up Internet access were set-up at 58 schools and district offices; direct access (56KB or better) is now available at 25 sites started this way in FY95.

Encouraging Future Self-Reliance for Sites - Internet Education Working Groups, Site Support Teams, and Technical Support

Teams – Another primary goal is to form school, district and regional Internet working groups, technical support teams, and training teams. The "advance" teams for the school districts are made up of teachers, administrators, and technical support staff recommended by the district offices. These teams are provided temporary dial-up accounts, basic workshops, and on-site training during the networking development phases and as the district Internet connections and infrastructures are installed. As district or school Internet training labs become operational and as direct lines and wide-area networks are established, the support teams take over the roles of training and site support. As sites and districts go "on-line" and their LANs and WANs are established, the site support teams are our primary contacts and we work with them closely on-site. After the sites are connected, they contact us when they need special help or advice via electronic mail or by phone and much of our support can be done remotely while we are working at other sites. This "phased" support shift helps us balance our work load and provides the sites with the basic skills needed to promote site self-reliance and independence. This way, we are able to add new districts while still providing emergency and ongoing assistance to districts in progress.

Community working groups have representatives from the school districts, the colleges and other Internet support hubs, and volunteers from other community organizations like the libraries, Indian Pueblos,

and government agencies. We try to hold periodic meetings and workshops for these groups and encourage them to meet independently.

Over 400 teachers and administrators are actively involved now in our regional and district educational working groups for Internet training and support. Internet Education Working Groups (IEWGs) were started in the Navajo Nation Networking Project and for the Zuni, Gallup-McKinley County, Santa Fe, Pojoaque, Cuba, St. Bonaventure Mission, and Central Consolidated school districts in FY95 and in Española, Dulce, Peñasco, Mesa Vista, Mora, and Bloomfield school districts in FY96. Current data indicates that approximately 43% of IEWG teacher, staff, and administrator participants are male, 57% female.

Regional Training and Support Centers – We work with interested local community colleges and university sites to help them develop support and training centers and staff for their regions. These sites become valuable "Internet resource hubs" for their communities.

In order to ensure future support and assist with staff training, we are currently working with 13 sites (seven community colleges, two departments of education, and four technology centers) to establish training labs, regional servers, and support bases or hubs for their regions. We have formed partnerships with these sites to help develop the support and training centers for local school districts and to combine and coordinate efforts and networking support for the schools in their regions. We provide support for these sites and provide regional training, access, and resource servers at some of the sites for our school districts.

EduNets New Mexico Regional Training Centers - Hubs
(End of Fiscal Year)

	# Regional Sites	Internet Connections	Internet Labs
FY95	5	2 direct 56KB	4 at 2 centers
FY96	13	5 direct T-1, 7 direct 56KB ,1 dial-up (CIT)	19 at 8 centers

Current sites include: UNM-Gallup, Gallup, NM; Crownpoint Institute of Technology, Crownpoint, NM; Northern New Mexico Community College (NNMCC), Española, NM; Navajo Community College (NCC), Shiprock, NM; Navajo Community College (NCC), Tsile, AZ.; UNM-Zuni, Zuni, NM.; Laredo Community College, Laredo, TX.; the Jicarilla Apache Department of Education (JADE), Dulce, NM.; La Plaza Telecommunity, Taos, NM; the Technology Learning Center (TLC), Santa Fe, NM.; the Kirtland Technology Center (KTC), Kirtland, NM.; Cooperative Education Services, Albuquerque, NM.; and the New Mexico State Department of Education, Santa Fe, NM. We helped with networking design, support and software installations and setups for training labs at NNMCC, UNM-Gallup, UNM-Zuni, NCC-Shiprock, the Santa Fe TLC, the Kirtland KTC, and the JADE Jicarilla Community Education Center. We use those labs for our regional teacher training sessions and meetings.

In all centers, other DOE, government, and college programs have used the labs for classes using the access almost immediately after they are set up. We provided support, initial accounts, and training for the faculties and staff at the college campuses and assisted with planning classes now offered at three of the college hubs. We also partnered with the community colleges on several funding proposals for helping the school districts and the communities in planning and implementing networks.

Schools in the projects' districts in New Mexico are spread out over 18,000 square miles and many of the areas are very remote and hard to reach, but the establishment of the central training centers enables

us to get teacher's from the district together for workshops and meetings. This has proved very helpful.

Teacher and Staff Training and Support – A program goal is to provide onsite and regional training support for school technical support teams; basic training workshops (i.e. web overview, browsers and tools, electronic mail) for all IEWG members; and advanced technical training opportunities for the district support teams (i.e. NT, Novell, web, and e-mail server support training; HTML, education applications, troubleshooting, networking, and security training). We provide advanced initial training workshops for site support teams and help the training support teams provide workshops for all teachers and staff when they get direct connections established. Through the EduNets program, we provide training for teachers, staff, and administrators on using systems, software, and resources for education.

In FY96 we completed approximately 46 days of workshops and classes (1/2 day - 2 day) for more than 800 attendees; to date we have completed the basic training curriculum for using electronic mail, resources, browsers, and search tools (2-3 days of workshops) for approximately 400 teachers and administrators. We developed a series of half-day workshop modules on the basic curriculum topics that are upgraded frequently, modified for special needs and scheduled and delivered to fit a variety of district in-service schedules and time constraints.

On-site training and small group instruction was provided for staff and teachers at more than 80 school sites and at 12 community support sites. We presented more than 20 demonstrations for groups of 5-80 at future "connected" school sites, conferences, and technology expositions.

District technical support teams (2-4 teachers or staff members) are currently being trained onsite in our districts and six regional two-day technical workshops were offered this year on NT and Novell network administration. A variety of reference books were distributed to IEWG members for review and basic reference sets are being provided to school district libraries for use by their support team and other teachers and students.

Education Resources Research and Support – Another EduNets goal is to provide education resources support. We are working with the New Mexico State Department of Education on needs analysis and network planning support and have provided consulting and installation support for their local area network, connection, and server set up. We are also working with other regional support agencies in New Mexico to better coordinate support services and efforts.

Research and testing of networking software and hardware, video conferencing, and electronic mail servers at our sites is established based on specific needs, product availability, and readiness; the information we gain is then passed on to other sites and compiled for site documentation. We have provided both hardware and software companies information that has led to modifications that have

improved educational use. We have continued to provide direct support for developing educational resources for access like the Solar System Tour available through the LANL WWW homepage.

Part of our arrangement with the districts and hubs in the EduNets program is that, as we help them complete implementation phases, they help provide dial-up access, server space, and/or use of training facilities that we help them set up for helping nearby new districts just starting in the program and help us test and evaluate new software and hardware configurations.

DP Mission Benefit

This project uses the unique resources of Los Alamos National Laboratory – extensive computing, networking, and technical training expertise and experience - to help schools and school districts (primarily in remote and rural areas) get connected to the Internet and its resources. The resources available through the websites of all of the National Laboratories, the United States Department of Energy, the U. S. Department of Education, NASA, other federal sites, and state departments of education are now available and have been pointed out to teachers and administrators at all of our hubs and districts. Resources on science, mathematics, engineering, and technology (never before available in many of these districts) are being accessed daily through these networks. The full potential of these resources is just beginning to be realized at our school sites. Other national laboratory and university outreach programs are following us into districts, using the new site capabilities for communications and to provide access to program resources and information. We have provided technical education support for other LANL initiatives involving school sites and we have been requested to partner with several new projects this fiscal year.

There is a growing "wait list" for districts requesting to be added to the program. We have already scheduled site visits and surveys for four new districts that we hope to add early in FY97 that are near districts or hubs currently in the program.

C. Distance Learning and Educational Technology

Description of the Program

The University On-line effort was established to provide rural New Mexico educators experience with the possibilities of distance learning. UOL has the rights to distribute courses previously developed by Digital Equipment Corporation under Plato. These courses are accessed via the Internet and include both high school and lower division college courses. UOL agreed to provide 100 courses to New Mexico schools, including registration, distribution, and reporting support. One course equates to one student taking a specific course on-line.

The opportunity and some Laboratory support was offered to the Northern New Mexico Rural Educators Association which opted to try

the system out. Eight schools will participate in the program at the high school level. Generally, courses that will be made available to students will be those used and approved in North Dakota for high school credit. Laboratory support to NNMREA has been to defray communications costs and to administer the program.

In July, UOL will conduct a training session for school personnel at the Albuquerque Academy. During this session, school representatives will learn how to use the UOL system, register students, and participate in customizing the Land of Enchantment distance learning network.

MegaMath and Public Service Announcements

While started last fiscal year, certain efforts related to MegaMath have just come to fruition. First, in FY 95, the Laboratory was approached by EnterLearn Technologies to establish a CRADA for MegaMath. The CRADA would permit EnterLearn to further develop and market MegaMath. During this reporting period, the CRADA was finally approved by the DOE and forwarded to EnterLearn. Unfortunately, delays in the CRADA process resulted in a change in the EnterLearn position in that they must develop new funding sources for the project.

As part of the MegaMath effort in the summer-fall of 1995, a public service announcement was produced. The message was that success is as easy as one-two-three, the allusion being to mathematics. Two hundred tapes of the announcement were distributed to TV stations, split fifty-fifty between large and moderate service areas. Recently, reports have been received of airing of the tape, to include a major network affiliate in San Francisco.

A Non-Euclidean View of Teaching

An article, titled as above, was completed and published as an LA-URA. This paper examines trends in educational technology and distance learning as separate fields and concludes that the fields are merging. Further, based on developments in cognitive science as it relates to teaching and the automation thereof, it suggests an approach toward integrating and adopting educational technology that can potentially improve performance standards of students. Currently, the paper has been submitted for publication and response is pending.

Molecular Science and Educational Technology at UCLA

After visiting the UCLA Department of Chemistry, the opportunity of competing for a US Department of Education Challenge Grant was suggested to Santa Fe Public Schools. After SFPS declined because of internal reorganizations, the opportunity was presented to San Juan College. The Challenge Grant opportunity involved adaptation of many of the UCLA-developed molecular science computer programs for use at the high school and two year college level. While this particular

effort did not result in the submission of a proposal, it did serve to introduce the UCLA technologies to a variety of educators.

D. Hypermedia Compact Disc as an Educational Tool for the Use and Maintenance of Machine Tool Enhancements

Description of the Program

The production of Inertial Confinement Fusion (ICF) targets for the National Ignition Facility is an important goal being pursued at Los Alamos National Laboratory (LANL). The geometry of these targets must be very well controlled because surface perturbations can create hydrodynamic instabilities when the targets are imploded during the fusion process. To understand the impact of these perturbations and to estimate the surface finish requirements, targets with known surface perturbations are being built. Experimental data for surface perturbations with a known amplitude and shape can then be compared with theoretical data generated by computer models. To assist LANL in this effort, the Precision Engineering Center (PEC) of North Carolina State University, is designing a fast tool servo (FTS) system to be integrated into a diamond turning machine at Los Alamos. This system will allow the fabrication of non-rotationally symmetric features on the target surface and will improve the speed and capability of the target fabrication facility. The FTS will be added to a Moore M-18 Aspheric Generator and will utilize an Aerotech Unidex 31 controller. A second phase of this project will involve the development of a Hypermedia Compact Disc (HCD) which will document the use of the FTS. The HCD will use multimedia tools such as animation, graphics, still photos, video and text to describe the setup, operation, design and maintenance of the fast tool servo.

Target Specifications

The manufacturing of ICF targets requires high machining accuracy and precision. Current LANL work involves machining surface features around the circumference of 430 mm diameter cylindrical targets using a precision fly-cutter mounted on a diamond turning machine. These surface features resemble a sine wave pattern with an amplitude of 0.5 mm and a frequency of 10 waves per target revolution. The use of a fly-cutter is time consuming as it requires multiple cuts and an elaborate part mounting setup. A true sine wave surface geometry could be produced with a single machining pass using a FTS. It is expected that additional ICF tests will require the production of similar sized targets with up to 50 sine waves per revolution. LANL also has plans to produce spherical targets which will involve machining two hemispheres with diameters less than 500 mm. The production of these hemispheres will require the machining of combinations of spherical harmonics on the outer surface with amplitudes similar to those of the sine wave targets. Spherical targets can not be produced using LANL's current diamond turning equipment, but should be machinable using a FTS mounted on a rotary table. The desired figure accuracy of both the cylindrical and spherical target's surface

perturbations is 10 nm peak to valley. The desired surface finish along the length of the cylindrical targets is also on the order of 10 nm peak to valley.

FTS Structure

Design specifications for the FTS have been developed based on the target specifications and the hardware to be utilized. A cross section of the FTS is shown in Figure 1. Tool motion is produced by applying voltage to a piezoelectric actuator, while position control is maintained using feedback from a capacitance gage. The support flexures provide a preload to the piezoelectric actuator and insure that tool motion occurs perpendicular to the cutting surface. Only 1 mm of tool motion is required to machine all current ICF targets. Thus, a total range of motion of 10 mm has been selected for the FTS. The machining of ICF targets will require tool motions at a frequency much higher than that which is attainable with conventional diamond turning machine slideways. Thus, a design goal for the FTS is for the physical system to have a natural frequency on the order of 10 kHz. To achieve high-resolution in the sine wave features produced, the spindle speed will be limited to 200 rpm. This speed will allow the controller, which can maintain an update rate of 15 kHz, to generate 90 data points per sine wave for the maximum of 50 sine waves per part revolution.

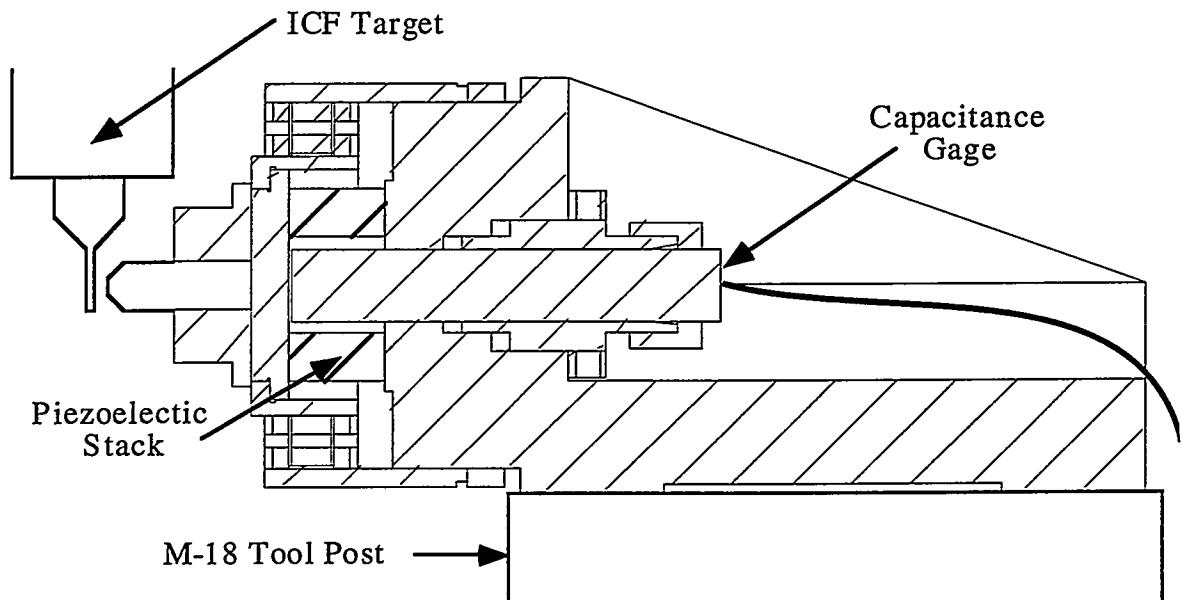


Figure 1: Fast tool servo cross-section.

The fast tool servo will be designed to mount on a Moore M-18 Aspheric Generator diamond turning machine. The M-18 has cross axis slides and a rotary table. The FTS structure will be attached to the tool post such that the tool tip can be located at the center of the rotary table in the horizontal plane and level with the spindle axis in the vertical plane. The FTS will also be designed such that it can be

mounted on a Raⁿk Pneumo Nanoform 600. The Nanoform is located at the PEC and will serve as the initial test bed for the FTS. This DTM is a T-based design without a rotary table.

Capacitance Gage Position Feedback

The production of ICF targets requires figure accuracies of less than 10 nm. Thus, it is desired that the position feedback system be able to measure tool position to within 1 nm. The capacitance gage which will be used with the FTS is a Lion Precision PX405HC probe with a DMT10 remote driver module. Tests were performed at the PEC using a probe calibrated to operate with a measurable range of 20 μ m and a noise level of 1 nm. The tests showed that the probe did have a rms noise level of approximately 1 nm. These tests were performed as the probe measured the stationary surface of a fast tool servo currently used at the PEC. The FTS and the probe were set up on the Nanoform 600 to simulate the actual operating conditions for the FTS. A Lion Precision capacitance gage system with similar calibration has been ordered, and its delivery is expected by the end of April.

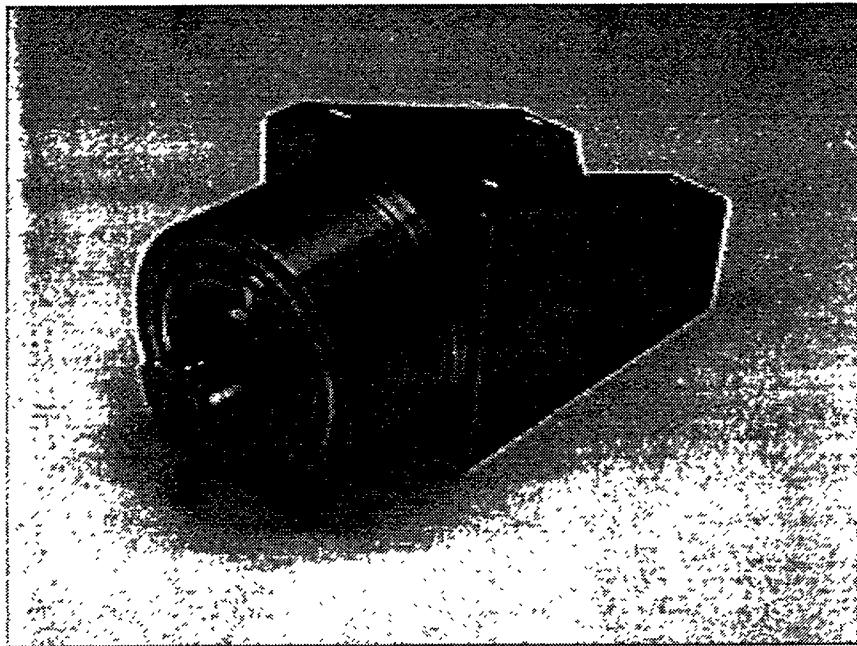


Figure 2: Fast tool servomechanism.

FTS Status

The physical design of the fast tool servo has been completed, and the mechanical components of the system have all been manufactured. Figure 2 shows the FTS upon assembly. A piezoelectric actuator made by EDO Corporation has been ordered and received. The actuator consists of 24 discs made of EC-76 PZT piezoelectric material which are 0.508 mm thick. The actuator has a 25.4 mm OD, a 12.7 mm ID and a length of 13.7 mm. It has a maximum expansion of approximately 11 μ m at an applied voltage of 800 V.

Controller Status

Both the M-18 and the Nanoform 600 will use an Aerotech Unidex 31 controller. Software modifications will be made such that the U31 will control the FTS position based on the capacitance gage feedback data. Hardware modifications will also be made to include an auxiliary DSP board in the U31 VME-bus to interface with the FTS. Any software or hardware modifications to the controller operating the Nanoform 600 should be transferable to the M-18 at LANL.

A Pentek 4284 VME-bus DSP board has been purchased and interfaced to the hardware of the Aerotech U31 controller on the Nanoform 600 DTM. A Pentek 4242 Analog I/O board will provide the interfaces necessary for the feedback control of the FTS.

Modifications to the U31 controller software are needed to coordinate the control of the axes and spindle of the Nanoform 600 with that of the FTS. These changes will be made by Aerotech to facilitate the transfer of the system to the M-18 at LANL.

Work is also underway to develop a control algorithm to be utilized by the FTS. Two different control schemes are under consideration, a proportional-integral-derivative controller and a pole-placement observer controller. Work will be performed to implement both types of algorithms. Tests will then be performed using the FTS system to determine which algorithm provides the optimal system response.

Hypermedia Compact Disc Documentation

The addition of the fast tool servo to the M-18 will produce a one-of-a-kind machine tool which will not be operated by a large number of people. One of the problems associated with similar types of equipment is a lack of adequate documentation. Recent growth in the development of multimedia technology has provided computer users the opportunity to use text, graphics, animation, sound and video in detailing almost any subject. The combination of these different forms of communication provide a powerful tool for the documentation of technology such as the fast tool servo. The hypermedia compact disc which is to be developed will contain information describing the setup, operation, design, safety, maintenance, and fault identification of the FTS. The production of the HCD will initially be done on a Macintosh using the software package SuperCard. Since the Aerotech Unidex 31 software operates on a PC using OS/2, the Macintosh version will be converted to a PC format so that it may be read by the controller. Originally, the Windows compiler was to be available before the completion of this project. The release of the compiler, however, has been postponed until the end of this year. Thus, the HCD documentation will be completed in a Macintosh form, and will be converted to a PC format once the compiler is available.

Although the FTS system has not been completed, work has already begun on the creation of the HCD documentation. Considerable work

has been performed on the HCD's organization and structure. An outline detailing the subjects found in the documentation has been created, and the SuperCard scripts necessary for the documentation to properly function have been generated. The visual organization and layout of the pages of the HCD have also been completed. Thus, all of the components required for the documentation to operate correctly are in place. Work must now be done to generate the text, graphics, pictures and movies which will be used to provide information to the user of the HCD.

E. Systems Modeling for Education

Description of the Program

The Systems Modeling for Education (SME) Program is an initiative to create a computer-based apparatus that will allow middle and high school students to construct a computer model of physical phenomena, such as heat transfer. This innovative technology is based upon extensive education research that suggests students can best develop their abilities to understand and apply core science concepts by creating a model, conducting appropriate hands-on workbench activities to gather experimental data, analyzing the parts of the model and interpreting their relationships, and refining the model for new applications. The SME technology will embed learning objectives "in context" providing both the teachers and students with a set of unique technology tools to support effective classroom teaching and learning.

Science education staff have worked closely with the Laboratory's Industrial Partnership Office to secure an industrial partner, Media Gardens of Austin, TX. The technology consists of five major components: a data acquisition system, a graphical user interface with animation, simulation tools, a data analysis and report writing function, and a resource database. With input from SME teachers who have developed the technology attributes and designed and piloted the workbench activities, Media Gardens has completed the preliminary data acquisition system and experimental planner. These components will be integrated into the visual models with animation needed for students to accurately simulate their constructed models.

Using the design attributes for a proof-of-concept prototype, Laboratory technical staff and the industrial partner are developing a computer-based platform which consists of a multi-platform graphical user interface with control/communication capabilities. This interface supports a number of components that include: a simulation tool that allows the students to create and save scenarios to explore heat transfer; a set of workbench activities and a data acquisition system with sensors that accompanies these activities; a report function that permits students to save and present their work; special resources for teachers and students such as a database of materials and their properties, for example; and animation tools for illustrating heat transfer and related physical processes. Using these simulation tools,

students will be able to construct a model of physical phenomena, such as heat transfer. They can then conduct a real-time experiment, controlling sensors and collecting real-time data, inputting results and animating and refining the model. Results can then be stored in a database.

The SME technology is designed to be open-ended to stimulate inquiry and to encourage both teachers and students to expand their topics of investigation. Heat transfer has been selected as the initial topic for development and is particularly suitable to illustrate a key physical science concept that is frequently misunderstood. Other topics, such as density for example, may be added as the project matures.

The program is organized into several phases:

- Phase I: development of data acquisition systems with sensors, controls, graphical display capabilities, and analysis
- Phase II: development of the graphical user interface that supports the visual models with animation
- Phase II: development of the resource database and the reporting functions.

All phases will be integrated and piloted with the accompanying workbench activities and teaching guidelines.

Goals

SME is a research and development project that will enhance science and mathematics teaching and learning by developing an innovative computer-based technology that supports increased student understanding of physical science concepts, principles and their applications.

Implementation

The FY96 development of the SME technology involved three face-to-face summer work sessions with the teachers, supported throughout the academic year with monthly Saturday follow up sessions. These workshops provided the teachers with in-depth information on heat transfer. They were also used to refine the design criteria for the SME technology, test appropriate workbench activities with students for future integration, and provide input and feedback to assess the various stages of the development of the prototype. Laboratory scientists and engineers presented special topics in software engineering to help guide the teachers in their research roles while presenters and special sessions on effective science education helped shape the development of the workbench activities and supporting teacher materials.

Laboratory computer scientists began the development of the graphical user interface with animation. Dave Modl and Bill Barber initiated the software design using JAVA, a new programming language particularly

well suited to the SME project. A graduate student worked on the administrative interface that allows teachers and students to log on, create folders, make assignments, and transfer work products. Media Gardens has completed the data acquisition systems, matching them to the workbench activities that the teachers have developed, and refined their display capabilities.

Evaluation

The evaluation plan focuses on the development of the SME technology and the degree to which the parallel efforts of the teachers, Laboratory computer scientists and industrial partner contribute to the prototype. The summer sessions, Saturday meetings and on-line meetings are assessed using surveys, observation protocols, and teacher feedback. The development of the technology components are evaluated using the design attributes and piloted by the teachers with their students. Feedback from the Laboratory technical staff members and graduate students is used to chart the progress of the software engineering and adjust the development schedule if needed. A primary finding is that the teachers now view themselves and function not only as educators but also as researchers actively involved in product development. The technical staff and students are proceeding well and on-track with the development schedule and have formed an effective integrated research team.

F. Science Outreach Program

Description of the Program

The Science Outreach Program supports the efforts of the New Mexico Systemic Initiative in Math and Science Education (SIMSE) to improve science, mathematics and technology education through comprehensive systemic change. The program helps teachers at SIMSE schools, as well as others, to enhance their instructional effectiveness through linkage to the unique technical capabilities of the Laboratory.

Science Outreach consists of a variety of activities and experiences which taken together should result in improved mathematics and science learning and different roles and responsibilities for math and science teachers. The program is modeled on the principle that systemic change begins with excellent and motivated math and science teachers who participate in a program designed to deepen their understanding of technology-supported learning. Following an in-depth summer institute, the teachers' new understandings and skills are supported and enhanced throughout the school year through site visits from Laboratory staff, scheduled workshops, ongoing Internet communications between participants, and participation in other educational technology-related projects and initiatives that complement the Science Outreach core curriculum.

The program brings 25 teachers from northern New Mexico to the Laboratory for two years during which they attend core activities that include two three-day summer sessions, a one-week summer institute, and three academic year workshops. Throughout the experience the participants interact via the Internet and participate in supplementary activities that include the On-line Internet Institute (OII) and the Regional Educational Technology Assistance (RETA) initiative.

Once the teachers feel confident about how to use technology to improve science instruction, they form a small network of colleagues from their school/district and partner with a neighboring district to share strategies that work. The Science Outreach teachers' schools become "hubs" (currently there are five in northern New Mexico) through which the program brings Laboratory support in terms of staff and equipment. Eventually, these teachers become leaders in their region, bringing with them a new vision of science learning supported by effective instructional practices that incorporate technology.

In response to teachers needs during the academic year, the FY96 Science Outreach program focused on enhancing teachers' instructional skills using technology to deliver more effective classroom instruction. Using the 'hub' model, Science Outreach was able to orchestrate efforts to over 40 educators thereby leveraging and disseminating core instruction to a broader pool of interested teachers and administrators. The Outreach participants were supported in their collaborative efforts, particularly as they worked to integrate technology into school and district wide instructional plans.

Using recent findings from our national study of networking effectiveness (Model Nets) and other research we chose a new delivery strategy for the summer Outreach activities. To address a wide-spread tendency to separate understanding how to use educational technology tools from content (a "mechanics" approach versus an "integration" approach) we chose to focus Science Outreach as a cross-cutting capability within three existing teacher development programs: TOPS, NTEP and TEAM. Each program had a distinct technology strand that included basic skills such as telecommunications (e-mail/Internet), software applications, modeling activities, data acquisition and display, reporting, and occasionally publishing, for example. Science Outreach provided technology - related instructional sessions in these topics tailored to meet the needs of the individual programs.

Goals

The goals of the program are:

- to contribute to fundamental change in how science, mathematics and technology are taught and learned, and
- to increase the use of effective educational technologies in support of student achievement.

To accomplish these goals, the program implements the following objectives:

- increase teachers' use of technology in classrooms to enhance student learning
- increase teachers' knowledge of selected topics in science and of the skills used in scientific research
- enhance teachers' skills in integrating technologies into instructional plans
- enable teacher teams to assume leadership roles with colleagues for systemic change in K-8 science education
- establish a cadre of effective regional technology leaders
- develop a community of mutually supportive educators who form a sustainable resource base.

Implementation

Science Outreach concentrated the delivery of its services to six SIMSE northern New Mexico sites; Cuba Middle School, Cuba NM, El Dorado Elementary School, Santa Fe NM, Memorial Middle School, Las Vegas, NM, Cimarron Middle School, Cimarron, NM, Los Alamos Middle School, Los Alamos NM, and Bloomfield Elementary School, Bloomfield, NM. These sites were selected based upon their strategic geographic distribution, their supportive administrations, and their demonstrated commitment to teacher excellence. Each site developed a technology plan that was tied to their district Educational Plan for Student Success (EPSS). Science Outreach used these planning frameworks to help design a program that would provide appropriate instruction and support for the teachers to refine, implement and evaluate their site specific plans

Educational technology, as a focus, offers an excellent arena to facilitate learning in that there are a number of technologies available for use in a classroom and their appropriate use requires sound educational goals, effective instructional practices, good assessment procedures, and proper integration. Collectively, these areas can substantially impact teaching and learning in classrooms and tie the resources of the Laboratory to the needs of the education community. The success of the program was dependent upon: (1) the availability and performance of the technical infrastructures in the hub schools, (2) the knowledge base of the appropriate application of the technologies, and (3) mastery of the instructional techniques that foster the attainment of education goals with the technologies. Success with these three factors required the collaboration of education specialists in Science Education Outreach Group (SEO), technical specialists from the Computer Technology Division (CIC), and teachers and administrators in key position at the hub sites.

The teachers and administrators attended the summer workshops and the integration institute where they learned how to select and apply instructional technologies to specific science and math topics. Laboratory technical staff played a key role in these workshops and the institute, providing instruction and supporting the teachers as they developed their integrated technology plans to take back to their districts. During the academic year, SEO and CIC staff visited the hub sites, reinforcing the summer instruction and helping the teachers implement their plans.

In addition to these core activities the Science Outreach Teachers also participated in the On-line Internet Institute and assumed leadership roles in the Regional Educational Technology Assistance (RETA) initiative. In RETA OII, the teachers joined approximately 40 other New Mexico educators to develop a virtual community working together to create innovative curricula using Internet resources. During a six-week summer session OII met for two, three-day face-to-face sessions supported between sessions by on-line discussion.

As participants in RETA, Science Outreach teachers joined other educators and technology coordinators to form a cadre of technology leaders to establish a regional educational technology capability in districts throughout the state. Three RETA workshops brought all members together and six RETA Fiestas (technology fairs) brought over 500 K-12 teachers to community and branch colleges and four year universities for a Saturday of mini-sessions on educational technology topics. The funding for RETA participants was provided by the State Department of Education through their Technology Unit. The Fiestas were very popular and generated a lot of enthusiasm for more in-depth instruction.

Evaluation

A number of instruments and techniques were used to gather data to examine how well Science Outreach teachers were meeting program goals and how well the program was using sound strategies. There were four major areas of the evaluation : educational leadership, application of educational technologies, knowledge of science and mathematics concepts, principles and processes, and sense of community and teamwork. The findings indicate that teachers have increased their use of technology in the classroom to enhance student learning and now use a greater variety of instructional technologies. They can better integrate educational technologies into instructional plans and are using the Internet to enhance student learning. Many stated they are using specific applications of LANL research topics, such as the Human Genome research, for example, as instructional themes. Through OII and RETA, the Science Outreach teachers felt they had formed a supportive community that was successful in overcoming isolation and contributed to solving immediate problems. Through RETA and the regional Fiestas, many Outreach teachers indicated they had assumed a new leadership role in their communities. RETA Fiestas were held at local institutions of higher education and this fostered new connections with K-12 educators. As a result of teacher feedback at the Gallup RETA Fiesta, UNM-Gallup designed new mini-courses in educational technology for K-12 educators. Following the Portales RETA Fiesta, Eastern New Mexico University saw a need for a state wide conference and workshop for district directors of instruction in partnership with district technology coordinators. The conference was held in Ruidoso on September 11-13 and the 130 district staff who attended rated the usefulness of the information and the networking with fellow administrators very good to excellent.

G. Robotics Challenge

For two years Los Alamos National Laboratory has conducted a Robotics Workshop, intended to introduce school students to the accessible BEAM (a multiple use acronym, with one meaning being "Biology, Electronics, Aesthetics, and Mechanics") technologies. For the most part BEAM concepts include reusing discarded electronics,

and solar power, and the kits provided for the workshop are designed around these premises.

The Los Alamos BEAM Robotic Workshop took place on the days of April 18, 19, and 20 (Thursday, Friday and Saturday). It was held at the Pueblo Complex Gym, where we could provide logistics support for a large number of students. We planned this year on providing a graded approach to building the BEAM robots, where an entry-level student could build the simplest of robots, the solaroller. Another set of more advanced students were given the next level robot, a two motor photovore called the photopopper. After finishing the solaroller the beginning students graduated to the photopopper. Once the photopopper was done students were encouraged to connect the photovores to the outside world by including touch sensors to detect walls and objects.

We ran a concurrent advanced workshop, in which very advanced students built the pinnacle to BEAM robotics, the microcore walker. Getting a successful walker took between two and three days for these advanced students.

We had approximately 65 students enrolled in the workshop, which was conducted as a three-day affair. Unlike the previous year, when people were encouraged to drop in and build a solaroller, this year we went to the school systems and asked for commitments of three days from the students and their teachers. Also, there were no BEAM Games this year, and all the workshop energy was focused on transferring technical capability to the students. We had students from many Northern New Mexico counties (Sandoval, Los Alamos, Mora, Las Vegas), as well as Albuquerque. We also had several students from the Kayenta Reservation School.

The Workshop was a complete success. One aid described the hum and energy in the room as similar to the feeling in an old church -- so much energy and yet so quiet! Almost every student got their photopopper kits working, and several more than expected graduated to building the walkers on Saturday. We had positive write-ups in all the local papers (Monitor, New Mexican, and Albuquerque Journal), as well as TV coverage by two of the area news teams.

We are presently providing solaroller kits and photoppers to local students, in hope of generating more interest in future Workshops. We are also exploring the possibility of having smaller "outreach" workshops in some of the small Northern New Mexico communities.

H. GEONet/TOPS Electronic Bulletin Board

Overview

The goal of the TOPS/GEONet Electronic Bulletin Board is to broaden students' interest in and understanding of science and mathematics by making them participants in the science process. The bulletin board

electronically connects New Mexico science classrooms with one another and with scientists at Los Alamos National Laboratory. This communication link provides a platform for discussions on scientific topics and an infrastructure for schools to participate in Laboratory science programs and experiments.

Using the bulletin board, students and teachers network with experts in scientific fields by reading and responding to "forums" written by LANL scientists and by referring specific questions to them. They can also access experimental data collected from other school sites involved in Laboratory projects. In addition, the TOPS/GEONet System is a resource bank for exemplary math and science resources, references, and software applications.

Highlights of 1996

This fiscal year was the first opportunity to test new aspects of GEONet with our entire user base, and those features were very well received. They included more on-line support, such as detailed technical help for specific bulletin board operations and on-line manuals. Another of these functions was giving selected individuals system operator privileges so that they could update sections of GEONet and perform basic user account maintenance. This gave outreach program coordinators more control over and involvement in their participant's use of the system. In addition, it allowed us more time to train users on existing features which were underutilized, such as telnet access to nationwide databases and on-line libraries.

The focus on training during FY96 was a worthwhile investment. It resulted in a larger, more active user community for GEONet. With the help of our new "superusers," those with system operator privileges, the GEONet community reached 700 users. The community is very active, in part due to telnet access into the system, and we are receiving an average of 83 calls each day. Of those calls, 3 hours of connection time are via telnet. We are pleased to see that the increase in the number of users is partly due to LANL staff using GEONet. Their participation has increased the number of public scientific discussions on the system which benefits both students and teachers.

GEONet continued to provide electronic mail to participants in Science Education Outreach Programs and to serve as a data repository for their research. Last year, New Mexico high schools in the Forum Program engaged in research regarding the disposition of nuclear materials. As part of this examination, scientists at the Laboratory served as mentors for students, reviewing student's research and scientific methods while guiding their efforts with questions and suggestions. These exchanges were done via GEONet. Another joint initiative utilizing the bulletin board system as a data collection and dissemination mechanism was the Storm Tracking Experiment. It involved tracking and studying the surface friction of storms as they moved across New Mexico. Schools in this program recorded data

with Davis Weather Stations, and uploaded their regional information to GEONet so that schools across the state could compare the effects of the storm.

I. Model-Nets: A National Study of Viable Models of Networking Technology in K-12 Education

Program Description

The Model Nets project, funded by the Department of Energy and conducted in collaboration with the US Department of Education's regional education laboratories, is a national study of K-12 computer networking use in thirty-two school districts across the country. The study resulted in findings that were used to develop guidelines of effective practice in the use of networks, and to make recommendations to help federal agencies make funding decisions and help school districts with technology planning. Based on the findings of the study and subsequent report, two products were developed and completed in draft form in FY96.

The first of these products is the *Model Nets Guide to Implementing Effective Computer Networks in K-12 Schools*. This Guide outlines the steps for a school district to plan and "go-on-line" with a computer network that helps students achieve educational goals. The second product is an interactive multi-media CD-ROM, readable on both Macintosh and MSDOS platforms, which complements the Guide and is intended to be used by school districts in their technology and networking planning.

Goals

The Guide is intended to support a district technology coordinator or other "network champion" in the schools. It provides a framework for the technology planning process within the larger context of overall strategic planning for the district. The Guide is also intended for use by a technology coordinator to increase teachers' and others' knowledge about computer networks and about how they can use networks as an integral part of student learning.

The CD-ROM will supplement the Guide by presenting materials and tools to assist educators in the development of networking technology. It will:

- contain descriptions of the study and findings in a searchable text format
- be organized into the three Model Nets study domains of technology infrastructure, policy and teaching and learning
- walk users through components necessary to effectively plan, implement, and evaluate educational networks

- provide examples of case studies in the form of video and audio clips, text descriptions, network schematics, timelines, sample technology plans and sample staff development plans
- model a networked education environment by providing software, files and links for connecting to resources on the Internet. Basic networking software will be provided whenever available without cost, with URL links for updated versions included
- include links to sites offering the latest examples of technology plans, curricula, and educational technology information and products available over the Internet.

Evaluation and Summary

The Guide and CD-ROM were developed together in FY96 through a collaboration between the Science Education and Outreach group (HR-4) and the Computing, Information and Communication group (CIC-6), and a draft form of each product was created. The products now move into their pilot phase, where they will be field tested in a sample of school districts selected for a number of diverse demographic and technological characteristics. A training component, to be developed in FY97, will accompany the pilot phase, and upon completion of the testing, these products will be disseminated to school districts nationwide.

B. Equipment for Education Program

Description of Program

The 1993 Presidential Executive Order 12812 requiring all federal agencies to give the highest preference to K-12 schools in the transfer or donation of excess Laboratory equipment resulted in the creation of the Laboratory's Equipment Gift Program. While the Laboratory Equipment Gift Program makes available equipment to New Mexico schools through an MOU with the New Mexico State Department of Education, the Equipment for Education program was developed to meet the technology needs of specific science education programs sponsored by the Laboratory.

Goals

The goal of the program is to meet the technology needs of science and technology education programs at the Laboratory through the gifting of equipment, particularly computers, that are excess to the Laboratory's needs.

Objectives

The program is intended to provide schools with equipment, such as computers, that will create instructional opportunities for K-12 classrooms. Such opportunities allow for:

- teachers and students to communicate with each other and with Laboratory staff, thereby helping to reduce the isolation so prevalent in northern New Mexico;
- the contribution of field data for specific program research, thereby enhancing the quality of math/science education; and
- the understanding of Laboratory research and technology.

Impact

In 1996, the Laboratory's science education programs provided 184 excess items of equipment to 133 teachers in 82 schools across 43 New Mexico school districts and 12 out-of-state school districts. The total value of this equipment is \$568K. Equipment, primarily computers, was provided through the Equipment for Education Program to schools that have participants in 10 LANL-sponsored science education programs statewide. Working within the Laboratory's Equipment Gift Program, we provided excess equipment gifts to the schools of participants in science and technology education programs as follows:

Education Networking Support (EduNets) - Post Secondary Gift

4 Sun Workstations
 Value - \$27,618.00
 4 schools in 2 districts (Community Colleges)

Sandia National Laboratories - Teacher Opportunities to Promote Science (TOPS)

30 personal computers, 3 printers, and 3 large monitors
 Value - \$98,068.07
 18 Schools in 18 Districts
 30 Teachers

Los Alamos National Laboratory - Teacher Opportunities to Promote Science (TOPS)

19 personal computers, 1 Wang lab (1 server with 33 stations)
 Value - \$107,528.39
 15 Schools in 14 Districts
 17 Teachers

Teacher Opportunities to Promote Science (TOPS) Mentors

31 pieces of equipment which included plotters, scanners, printers, and fax machines
 Value - \$91,552.47
 14 Schools in 13 Districts
 17 Teachers

Critical Issues Forum

34 computers
 Value - \$114,404.64
 19 Schools in 15 Districts
 21 Teachers

Supercomputing Challenge

8 personal computers and 4 printers
Value - \$16,314.22
1 School in 1 District
1 Teacher

Systems Modeling for Education

2 computers
Value - \$2629.00
2 Schools in 2 Districts
2 Teachers

NTEP

20 computers
Value - \$56,733.92
11 Schools in 8 Districts
20 Teachers

TEAM

8 computers and 2 printers
Value - \$15,016.64
7 Schools in 6 Districts
8 Teachers

TRAC

17 computers
Value - \$\$38,364.25
16 Schools in 15 Districts
17 Teachers

TOTALS

Total # of Teachers	133
Total # of Schools	82
Total # of Districts	43
Total # of Districts Out of State	12
Total # of Programs	10
Total pieces of equipment	184
Total Value	\$568,229.60

Implementation/Evaluation

This program grew out of the Laboratory Gift Program operated by the Business Operations Division as a way to provide excess equipment to science education program participants. The goals and objectives of the Equipment for Education Program are achieved through its alignment with the technology goals and objectives of individual programs, and ensuring that program participants are involved in activities that reflect the science and technology of the Laboratory. In addition to providing individual programs with equipment, program participants receive technical assistance in the form of training in the use and maintenance of the equipment, as well as pedagogical

strategies for classroom use, how to use bulletin board systems and various networks, and how to access and appropriately navigate the Internet.

Evaluations of the effectiveness of the use of this equipment are embedded in the evaluation plans for each program in which equipment is gifted. In general, this involves looking at how computer/technology applications support program goals, contribute to teachers' and students' computer networking capability, enable program participants' technological skills development and literacy, and contribute to a district's overall technology plan.

VI. PUBLIC UNDERSTANDING OF SCIENCE

A. Practical Applications for Young Scientist Communicators (PAYS)

Description of the Program

Practical Applications for Young Science Communicators (PAYS), a program for high school students, has the unique opportunity to address two pressing issues: improving public understanding and awareness of science (public literacy) and tapping the talents of the "second tier" of students. As the rate of change in science accelerates, the public will increasingly rely on communicators who can translate cutting-edge science into understandable terms and demonstrate its relevance to everyday life—and will receive most of their information about science from the media, museums, and libraries. Students in the "second tier," that is, students who do not choose to pursue graduate education or careers in science, represent a wealth of untapped talent in linking science and "real life" in ways that will make science important and accessible to the general public. These students are exposed to science communication skills and careers through PAYS.

PAYS brings high school juniors and seniors interested in science and communication to the Laboratory for a semester session and a summer session to learn science and practice science communication skills. PAYS culminates in the production of a communication "product," which in the past has consisted of articles published in area newspapers; a museum exhibit, "Living With Radiation," at the Bradbury Science Museum; a multimedia project on radiation that was distributed to museums, libraries, and other educational institutions throughout the state; a series of hands-on demonstration activities that will be used at the Bradbury Science Museum to educate the public on the concept of "sound;" a CD-ROM on the use of Benthic Macroinvertebrates in water quality analysis that will be distributed to interested teachers throughout the state; and the creation of a World Wide Web (WWW) page for the Laboratory's Teacher Research Associates (TRAC) and Nonproliferation and International Security-Teacher Enhancement (NIS-TEP) teacher programs.

PAYS has an excellent track record of helping fulfill the DOE's Office of Defense Programs mission to "apply the unique resources of our national laboratories and facilities to improve understanding of science, mathematics, engineering, and technology."

In the 1996 PAYS program academic year component, students learned and then practiced science communications skills working on Laboratory-related content such as the Human Genome Project (students wrote a mock newspaper article on the topic), the ARIES Process (students attended and 'covered' a mock press conference on the topic), and the "Plutonium Legacy" (students evaluate the effectiveness of a museum exhibit at the Bradbury Science Museum on the topic).

During the 1996 PAYS program summer component, students learned about Laboratory research in the area of Acoustic Resonance Spectroscopy and Thermoacoustic Engines as they researched a series of hands-on activities on the topic of "sound;" nuclear non-proliferation and the NIS program as they created a WWW page for the Laboratory's TRAC and NIS-TEP teacher enhancement programs; and about Laboratory environmental stewardship while producing a CD-ROM on the use of Benthic Macroinvertebrates in water quality analysis.

PAYS also takes advantage of unique LANL resources: Los Alamos has an excellent forum for public communication in the Bradbury Science Museum, which receives more than 120,000 international visitors yearly. In addition, PAYS taps LANL's cadre of experts in the field of science communication.

Goals

Ultimately, the goal of the PAYS program is to increase public understanding and awareness of science. The objectives of the 1996 PAYS program were:

- (1) to enhance students' communication skills in science;
- (2) to increase students' knowledge of science;
- (3) to increase students' knowledge of science communication careers.

To meet these objectives, during the academic year component students received instruction in how to improve their skills in written, graphic, and multi-media science communication and learn and practice effective teaming skills. During the summer PAYS component students worked as communications teams to create science communications products in response to a stated 'customer' need: (1) a series of hands-on demonstration activities that will be used at the Bradbury Science Museum to educate the public on the concept of "sound;" (2) a CD-ROM on the use of Benthic Macroinvertebrates in water quality analysis that will be distributed to interested teachers throughout the state; and (3) the creation of a WWW page for the Laboratory's TRAC and NIS-TEP teacher enhancement programs. A discussion of science and communications careers at the Laboratory are an explicit part of every Laboratory specialist's presentation.

Implementation

The 1996 PAYS Program consisted of two components: an after-school, semester-long series of two-hour sessions, and a three-week intensive summer session. While it is not required that students in the academic year program participate in the summer program, participation in the academic-year component is required for participation in the summer component. Because the program is not residential—participants must commute to/from the Laboratory—

participants must be within relatively easy driving distance of Los Alamos.

During the academic year, the students participated in a variety of activities designed to help them increase their knowledge and ability in communicating science to the public. Participants came from several area high schools: Los Alamos (9); Española (6); Pojoaque (3); Mesa Vista (1); and Peñasco (1). The majority of the participants in the academic year program were female (74%); 53% of the participants were Hispanic, 47% were Anglo.

During the academic year program component, many Laboratory scientists, staff, and technicians worked with the PAYS students and discussed their work in the area of science communication:

- Newspaper Journalism: Steve Sandoval, PA; Steve Shankland, LA Monitor
- Graphic Layout and Design: Ruth Holt, CIC-1
- Technical Writing: Pat Wing, CIC-1
- Risk Communication: Susan Klein, CIC-1; Todd Heinrichs, CIC-1
- Designing Effective Museum Exhibits: Judy Machen, Bradbury Science Museum
- Hands-on Science Museum Demonstrations: Garry Franklin, Bradbury Science Museum
- Video Journalism: Kathy DeLucas, PA
- The Human Genome Project at LANL: Julie Meyne, LS-2
- "ARIES Process" Mock Press Conference: Joe Martz, NMT-5; James Rickman, PA

While the academic-year component was designed to introduce PAYS students to important elements and skills of science communication, the summer PAYS sessions focused primarily on creating a science communication project. Participants came from several area high schools: Española (6); Los Alamos (5); Pojoaque (1); Mesa Vista (1). The majority of the participants in the summer program were female (69%); 54% of the participants were Hispanic, 46% were Anglo. Students worked in teams of 3-4 students for three weeks on one of the projects below:

- (1) Update/Redesign the TRAC and NIS-TEP Program's WWW Page;
- (2) Design and Deliver a hands-on presentation on the concept of "sound" for the Bradbury Science Museum's new "tech lab;"
- (3) Develop an educational Hyperstudio CD-ROM on some aspect of the use of Benthic Macroinvertebrates as water quality indicators.

Each member of the project teams was considered a "communications specialist" that had been asked by a customer to design and deliver/implement a specific science communications project. Students met with the "customer" (person requesting the specific science communications project) who laid out the specifics of the project. Each project team was then responsible for: (1) Designing a

project work plan (what are the major steps of the project, who is doing what, etc.); (2) Designing a timeline to accomplish the project/task; (3) Keeping a close eye on project quality; (4) Delivering a completed product to their customer by the end of the program.

Each team had access to technical content advisors in each area and were able to call on the various presenters from the academic-year portion of PAYS for advice on the communications aspect of the project. Eventually (and periodically) the team also met with its "customer" to see if they were going in the right direction. The students presented their final projects to their customers in a formal presentation using PowerPoint presentation software on the final day of the program.

Evaluation

Several tools were used at various points throughout the PAYS program to ensure that the program continued to meet both programmatic goals and participants' expectations:

- The PAYS program design was assessed to ensure it reflected best-of-practice components before the program began and as the program was delivered. Program design was informed by a program profile template;
- Program evaluation took the form of discussions and other communications between the program designer and managers. The following were used to assess program design throughout the implementation of the program: (1) Monthly (academic year PAYS) and weekly (summer PAYS) written student evaluations, and; (2) Informal conversations by SEO program staff with students;
- The PAYS program was evaluated for its impact on: (1) student ability to communicate about complex science issues; (2) student knowledge of and interest in science content/issues, and; (3) student awareness of science communication careers at the Laboratory.

Data from pre/post evaluations indicate that the PAYS program met its designated objectives. Regarding the stated program objective of "enhancing students' communication skills in science," evaluation data suggest that the program accomplished this objective: the PAYS students' average rating of the statement "I gained new perspectives on how to communicate about complex science research/programs/concepts" was 4.4 where 2="strongly disagree" and 5="strongly agree." In addition, the PAYS students' average rating of the statement "The PAYS summer program increased my ability to communicate about science" was 4.5 where 1="strongly disagree" and 5="strongly agree." Finally, the PAYS students' average rating of the statement "The PAYS summer program increased my ability to plan

and develop a communication project " was 4.5 where 1="strongly disagree" and 5="strongly agree."

Regarding the stated program objective of "increasing students' knowledge of science," again data indicate positive student achievement. The PAYS students' average rating of the statement "I increased my knowledge of science" was 4.2 where 2="strongly disagree" and 5="strongly agree." These results are supported by other data: The PAYS students' average rating of their "knowledge of science in general" increased from 3.6 to 4.0, a 10% increase, in pre/post-program ratings where 1="poor" and 5="excellent." The PAYS students' average rating of their "interest in a science in general" increased from 4.0 to 4.4, a 9% increase, in pre/post-program ratings where 1="not at all interested" and 5="very interested."

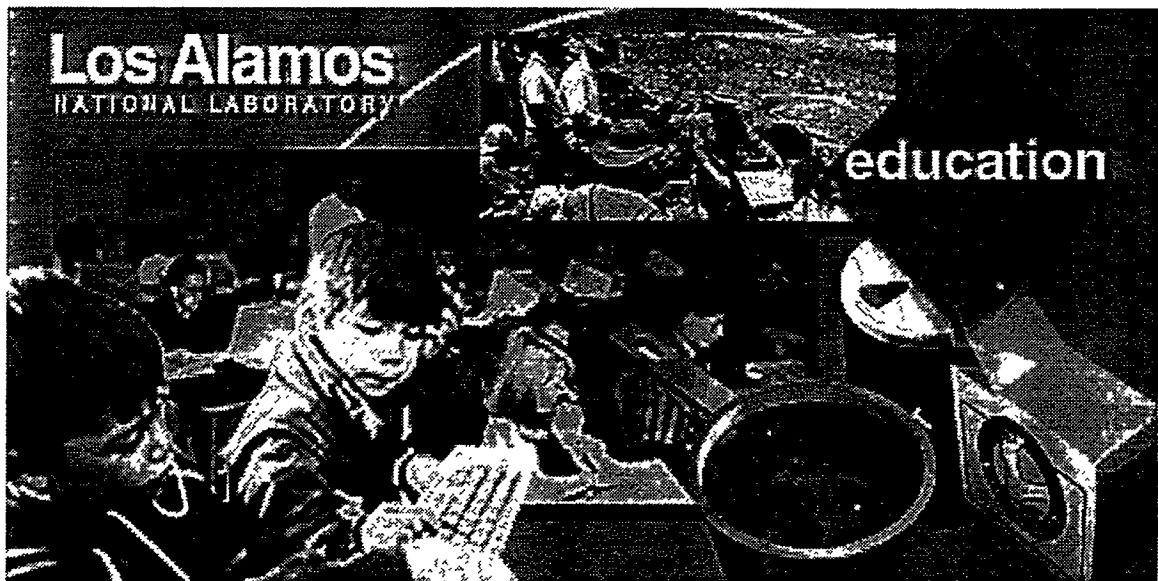
Finally, regarding the stated program objective of "increasing awareness of science-related careers," data indicate positive student achievement, but less achievement relative to the other two program objectives. The PAYS students' average rating of the statement "The PAYS summer program increased my knowledge of careers related to science and communication" was 3.7 where 1="strongly disagree" and 5="strongly agree." This despite responses which indicate that participants were satisfied with the amount of interaction they had with Laboratory scientists and/or communications specialists. These results are confirmed by other data:

- The PAYS students' average rating of their "knowledge of science-communication careers and the paths to pursue those careers" increased from 3.1 to 3.8, a 22% increase, in pre/post-program ratings where 1="poor" and 5="excellent."
- The PAYS students' average rating of their "interest in a science-related communication career" increased from 3.3 to 3.6, a 9% increase, in pre/post-program ratings where 1="not at all interested" and 5="very interested."

Student-participant response to the PAYS summer program was favorable: In response to the question "Overall, how would you rate your PAYS summer experience," participants gave the institute a 1.5 rating on a scale of 1 to 5, where 1="Excellent" and 5="Poor" (n=12). Anecdotal evidence confirms participants' positive experience with the 1996 PAYS summer program:

- "(The PAYS program) made science more interesting to me"
- "I found out that science can be interesting. Before when I thought about the Lab I thought about nuclear weapons; now I know it does much more than that"
- "Science is a lot more interesting and fun than I thought"
- "PAYS was a great experience!!"

B. Science Education Information On-line



Description of Program

This Science Education Information On-line Project maintains a World-Wide Web (WWW) Server (URL: <http://education.lanl.gov/>) for science education program descriptions and content information from Los Alamos National Laboratory. We support the Science Education Program Office by keeping updated information on the funded science education programs for each fiscal year. The server also provides a central focus for all Laboratory information that might be of interest to the education community.

The principle objective of the project is to provide information to the DOE and the general public about the many science education projects at Los Alamos National Laboratory. This is done electronically via the World-Wide Web over the Internet. Additional objectives of the project are to:

- educate program leaders and participants on the WWW & Internet capabilities;
- assist programs in providing program content information via the WWW;
- provide training on how to maintain your own WWW and other Internet servers; and
- assist K-12 education with the creation and maintenance of Internet services.

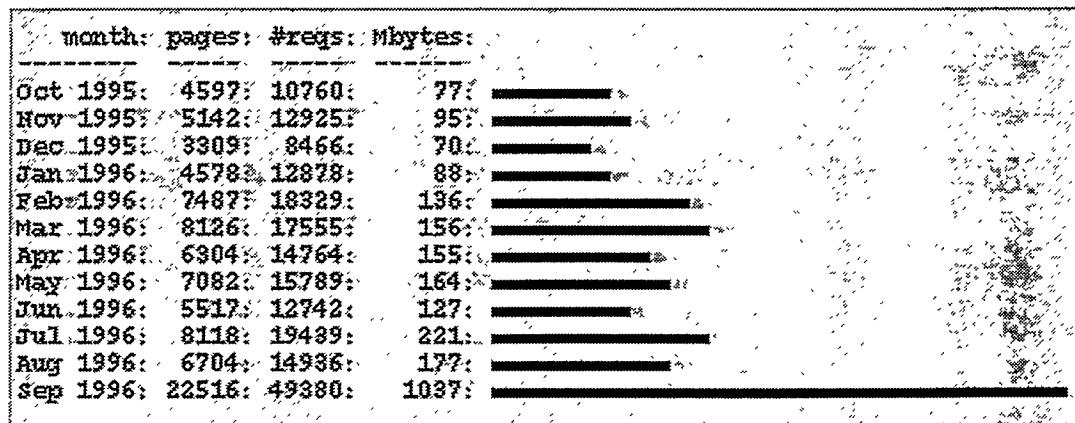
The project strives to work closely with all science education programs at the Laboratory. We have been able to support and compliment other education projects. Our efforts have also formed some strong working relationships with K-12 schools in New Mexico and the New Mexico State Department of Education.

This ongoing information service is available 24 hours a day, 365 days a year. The server requires weekly maintenance but daily responsiveness to support the projects and participants who want to update their program information. Reports on the usage of the server are generated every day and are available for viewing on the server.

Accomplishments in FY96

The project completed its second year and is currently serving an average of almost 1600 requests per day, representing an average daily transfer of over 34 Mbytes of data. During FY96, the server served almost 23,000 distinct hosts from over 83 countries, and currently contains 1,742 files containing over 207 Mbytes of information. The top eleven subject areas of interest on the server for FY96 are:

- Science Education Program project information and reports;
- NTEP project information;
- Science at Home;
- TEAM project information;
- NM On-line Internet Institute (OII);
- Hydrogen Conference information;
- TRAC-NISTEP information;
- New Mexico Supercomputer Challenge information;
- HTML tutorial notes;
- Model-Nets Project information; and
- Critical Issues Forum information.



WWW server Access by Month

A basic introduction workshop on HTML was prepared and presented to more than 900 participants in the NM Supercomputer Challenge kick-off meeting in October 1995. Several other workshops on HTML were presented to the Science Outreach Program participants at Regional Educational Technology Assistance (RETA) fiestas and the New Mexico On-line Internet Institute (OII) face-to-face meetings.

A major improvement to the system software and hardware was also made in FY96. The new system is a Macintosh 9500/120 running MacOS system 7.5.5 and using the WWW server software WebSTAR™. The server log and statistics generation process and system backup were also improved.

#. Faculty and Student Teams (FAST)

Description

FAST is a program that provides Laboratory researchers with the opportunity to develop new collaborations or expand current collaborations with a university faculty and student team. Teams include two faculty (one a faculty member actively involved in science research, the other a faculty member from the college of education actively involved in a science teacher preparation program), and two students (advanced undergraduate or graduate, one a science major, the other a science education major). Both faculty have primary responsibility for guiding the students. The program is designed to (1) increase university (faculty/student) collaborations with Laboratory researchers, (2) provide Laboratory research opportunities for students and faculty, (3) increase dialogue and collaboration between faculty from Colleges of Education and Colleges of Arts and Sciences to enhance the preparation of science teachers, and (4) increase the numbers of students and faculty that are exposed to areas of research that are related to the Defense Program mission.

The Faculty and Student Teams (FAST) program was piloted during the summer 1996 with four university teams. The program consists of an in-depth summer research experience for each team, supported and extended by ongoing academic year activities. During the summer, the university teams collaborated on a research project with a Laboratory scientist. During the academic year, the teams will continue the collaborative effort begun at Los Alamos National Laboratory using the same interdisciplinary and collaborative approach used during the summer experience.

For FY96, four teams were selected to participate: University of California at Irvine, University of New Mexico (2 teams), and

New Mexico Highlands University. Applications were received from 18 other teams from across the country.

Goals

The goals of the FY96 FAST program are to (1) increase collaboration between the Laboratory and University of California and New Mexico institutions of higher learning, (2) increase collaboration between university faculty from Colleges of Arts and Sciences and Colleges of Education, (3) increase awareness and practice of a multidisciplinary approach to teaching and learning of science and education, and (4) increase understanding of science process and research at a DOE laboratory.

Implementation

Recruitment - FY96 recruitment was limited during the pilot phase to University of California and New Mexico universities. Prospective teams were asked to submit an application in order to participate. An invitation to prospective PI's was mailed electronically to a large number of staff members and management at LANL. There was a large response by interested Laboratory PIs. Interested PIs submitted a brief written proposal for review and selection.

Laboratory PIs that participated in the FAST program for summer 1996 worked with the prospective teams to ensure that the appropriate research content fit both the interests of the science team members as well as the education team members. In addition to collaborating with the team and the research, they also attended most if not all of the scheduled meetings and special lectures. PI's demonstrated a genuine interest in science education and our evaluations indicate their interactions with the teams were invaluable. They had the opportunity to hear, first hand, what the current issues are in education and discuss with educators how research can translate into enhanced science education.

Summer Experience - Several eminent guest speakers were invited to LANL to provide an even richer experience for the teams and to encourage dialogue between the scientists and the science educators. Participant meetings were scheduled throughout the summer so that teams could discuss both education and science research issues in an open forum. These meetings promoted a substantive dialogue between scientists and educators. In addition, participants were encouraged to attend other teacher and student workshops during the summer of 1996. At the end of the summer segment of the FAST program, a forum was held, during which each team presented their plans for further team collaboration and

discussed their summer research with the other teams and LANL PIs.

A computer was loaned to each team to assist with computing needs while participating at LANL and some funding was provided for each team to use on materials and supplies, as needed, while conducting research throughout the summer. This money assisted PI's in offsetting any costs they would potentially incur. In addition, each team was provided with a set of the National Science Education Standards, Benchmarks for Science Literacy, and the Curriculum Standards for School Mathematics.

Academic Year Follow-Up/Transfer - Guidelines for the academic year proposals were provided to faculty and students to build on the summer collaborations. The students on each team were eligible to submit a written proposal for an academic year award to carry out a plan back at their university which would strengthen the science and education ties. Plans are being made to visit each team at their university during the academic year to observe and/or assist in the follow-up plans.

Evaluation

Because of its pilot phase, the initial goal of evaluating the FAST program was primarily formative. With the information gathered and analyzed, we can then begin to monitor and modify the program insuring that the needs of the Laboratory PIs, students and faculty are being met and program components produce results that address FAST goals.

The FAST program design is unique and at this time we are developing a profile to determine the "best of practice" for the program. The evaluation plan currently includes using tools and techniques to determine overall program effectiveness.

In order to study the impact of the LANL FAST program on the participants (students, faculty, and PIs), data and information were collected using the following: student and faculty post surveys (open-ended results), final presentations from each team, written proposals for academic year continuation by faculty and students, observations from site visits, student and faculty feedback from formal meetings and informal communications, and a survey from participating LANL PIs. The site visits were especially valuable in determining first-hand how each team was doing and to encourage dialogue between faculty and students.

Faculty Evaluation - Responses indicate overall satisfaction with the program. Faculty and students felt the research experience provided a very productive learning environment for faculty, both personally and professionally. Education faculty, in particular,

learned about the research process first-hand and how multidisciplinary scientific research is conducted at a national laboratory. Faculty expect, as a result of their participation in FAST, to change the way in which they teach their courses that reflects a deeper understanding of the way in which science is learned and conducted. They indicated that the 8-week format of the program was good, although, faculty encounter a variety of barriers in leaving their institution for an 8-week absence. The guest speakers provided valuable insights and perspectives on important educational issues. In summary, faculty were very excited about the prospects of working together with science and education faculty back at their home institutions. Overall, they found the summer very rewarding and informative.

Student Evaluation - Responses indicate that the students likewise found the research experience to be a great learning opportunity. They particularly enjoyed working as a part of the team to solve problems. The science students indicated they would now consider teaching as a possible career and several mentioned they were thinking about pursuing a graduate degree in education as well as science. Education students indicated they felt that taking additional science courses would be extremely beneficial to their teaching.

The faculty/student team approach worked well for students in most cases. Several students indicated they would have liked more frequent interactions with their faculty team members. Students particularly enjoyed working with another student (education or science) and felt this was mutually valuable. Most students indicated that the 8-week duration of the program may have been a little short considering the rigorous safety training schedule. All of the students attended a variety of additional presentations and colloquiums and found these to be interesting and informative. Overall, the students felt the program was beneficial to them and enjoyed the final presentation and reception. They felt it was a special opportunity for them to share what they had accomplished and learned during the summer.

PI Evaluation

A post-summer survey was conducted and Laboratory PI's were asked to respond to six questions related to their experience with their FAST team and the program in general. Overall the responses indicated the experience was beneficial in the following ways: 1) PI's observed and participated in the dialogue between scientists and educators, 2) the research projects progressed with the team's involvement, 3) PI's felt that the teams made technical contributions that otherwise might not have occurred, and 4) collaborative ties with participating universities were strengthened. Two of the PI's were very clear on the goals of the FAST program and saw them being clearly met with their team. The other two did not have as much time to

prepare for the arrival of their teams and did not feel they were as well prepared as they might have been. However, as the summer research process began, there was little difference in how the teams functioned. In preparing the PIs for their role, special attention was paid to supporting their efforts in managing a dissimilar team of faculty and students. All PIs indicated they would like to participate again if they are not constrained by other commitments.

(new from Marcia)
Hydrogen Education Outreach Activity

Program Description

Beginning in March, 1996, the Hydrogen Education Outreach Activity at Los Alamos National Laboratory was tasked by the Office of Utility Technologies at DOE to develop workshops and presentations at the following educators conferences: The American Chemical Society (ACS) Biennial Conference on Chemical Education (August, 1996) and the National Educators' Workshop (October, 1996). We were unable to participate in the ACS meeting because the decision to fund this particular activity was made too late. We have proceeded to plan for the National Educators' Workshop.

The National Educators' Workshop: UPDATE 96 (NEW) will be the 11th annual workshop/conference aimed at improving the teaching of material science, engineering and technology by updating educators and providing laboratory experiments on emerging technology for teaching fundamental and newly evolving materials concepts. The conference will take place October 27-30, 1996 and will be hosted by Los Alamos National Laboratory. The NEW:Update series has provided nearly 900 materials educators from high school and colleges with the latest developments in materials while offering them strategies for improved teaching.

The Hydrogen Education Outreach Activity developed a component of this year's conference: ***Hydrogen and the Materials of a Sustainable Energy Future***. A goal of this special theme will be to provide educators with up-to-date information about hydrogen production, storage, utilization, and related materials. Hydrogen has long been envisioned as the desired energy pathway of the future. The development of safe, practical, and economically competitive hydrogen technologies, systems, and associated materials to meet transitional and future energy needs offers high pay-offs. This is becoming a highly competitive field, and we are challenged by researchers from around the world.

New – Update 96 will offer the opportunity for educators to have direct communication with scientists in laboratory settings, develop mentor

relationships with Laboratory staff, and bring leading edge materials/technologies into the classroom to upgrade educational curricula. Lack of public education and understanding about hydrogen is a major barrier for initial implementation of hydrogen energy technologies and is an important prerequisite for acceptance of hydrogen outside the scientific/technical research communities.

Sponsors of the conference include: U. S. Department of Energy, Los Alamos National Laboratory, NASA, Norfolk State University -- Schools of Technology and Science (HBCU), and National Institute of Standards and Technology -- Materials Science and Engineering Laboratories.

Planning – The following schedule has been developed for the conference:

PLENARY

HYDROGEN -- THE FUEL OF THE FUTURE, James MacKenzie,
World Resources Institute

EXPERIMENTS/DEMONSTRATIONS

NEW participants will be shown activities that can be duplicated in their classroom.

A MODELING CODE FOR EVALUATION OF HYDROGEN POWERED VEHICLES , Salvador Aceves-Saborio, Lawrence Livermore National Laboratory

EXPERIMENTAL INVESTIGATION OF HYDROGEN TRANSPORT THROUGH METALS Rob Dye and Tom Moss, Los Alamos National Laboratory

ELECTROLYTIC PRODUCTION OF HYDROGEN UTILIZING PHOTOVOLTAIC CELLS Mark Daugherty and Christine Zawodzinski Los Alamos National Laboratory

MINI-WORKSHOPS

State-of-the-art technology being done in a major research facility will be presented by Los Alamos National Laboratory staff

MATERIALS FOR HYDRIDE BASED BATTERIES, Ricardo Schwarz

HYDROGEN FUEL CELLS FOR UTILITY AND TRANSPORTATION APPLICATIONS, Shimshon Gottesfeld

ENGINEERING MATERIALS FOR HYDROGEN SEPARATION, Rob Dye and Tom Moss

An "experiment notebook" based on the papers and presentations from the conference will be developed and distributed to conference participants and other educators.

Additional Activities

In addition to the above mentioned formal deliverables of organizing the conference and planning for the notebook, the Hydrogen Educational Outreach Activity has developed the following activities:

1. We have developed a home-page to promote the conference and provide pre and post conference materials about the mini-workshops and demonstrations/experiments . We have also created a *green link* to other related addresses and a participant evaluation/survey.
2. We will provide a real-time world wide web video conference of the hydrogen component of the National Educators' Workshop.
3. The hydrogen demonstrations/experiments will be video taped.
4. We will demonstrate a solar/hydrogen generation unit built at LANL.
5. Through LANL's Industrial Partnership Office, we have begun to investigate possible avenues of commercialization within the educational market for the solar/hydrogen generation unit.
6. We will provide an educational demonstration at NEW of a radio controlled fuel cell powered vehicle built at LANL.
7. We are providing on-going advice and information to a Los Alamos High School chemistry class that is developing an extra-curricular activity based on building a photovoltaic operated electrolyzer.
8. We are leveraging resources through co-funding from the LANL Science Education Program Office for additional scholarships for New Mexico teachers working with minority students to attend NEW.