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ABSTRACT

This booklet, the third publication in the Foundation for the Future series, illustrates how involvement in the Directorate for Education and Human Resources' (EHR's) projects has been a watershed for many people. The personal profiles contained within describe how EHR programs are: changing people's lives, opening people's minds to new possibilities, setting people on new courses and new directions, energizing people to develop new ideas and make them a reality, and leading people to revelations about how change can be accomplished. (MKR)

National Science Foundation programs make a difference in people's lives.

Turning Points, the third publication in the *Foundation for the Future* series, illustrates how involvement in the Directorate for Education and Human Resources' (EHR's) projects has been a watershed for many people. The personal profiles contained within describe how EHR programs are

- changing people's lives,
- opening people's minds to new possibilities,
- setting people on new courses and new directions,
- energizing people to develop new ideas and make them a reality, and
- leading people to revelations about how change can be accomplished.

In short, EHR programs are providing the impetus for personal change. This personal change, and the new ideas, convictions, and energy that result, is often infectious and has a ripple effect. One person can create excitement about educational improvement, thereby having a profound effect on a school's educational culture that leads to permanent change and improvement.

The National Science Foundation (NSF) recognizes that its systemic approach to educational reform will require the involvement and energy of educational pioneers such as those described in this publication. Furthermore, the success of America's future scientific and mathematical enterprises will depend on students who are excited and prepared for the study of technical fields. NSF programs are providing the mechanism for personal improvement of educational leaders and students, thereby providing the human capital for producing an improved educational system for the country.

Luther S. Williams

Luther S. Williams
Assistant Director
Directorate for Education and Human Resources
National Science Foundation

Tom Cech

The NSF Graduate Fellowship program has provided the opportunity for young Americans to pursue mathematics, science, and engineering graduate studies. Many have gone on to make significant contributions to the scientific community, and 12, including Cech, have been honored with the Nobel prize.

Tom Cech remembers his NSF Graduate Fellowship as the vehicle that gave him the spirit of independence that continues to influence his life. Not content to limit himself to the challenge of basic biochemical research, Cech regularly dedicates time to a variety of community activities. He volunteers to teach freshman chemistry classes to more than 500 students and gives "Mr. Wizard" lectures to younger audiences—all in all, not behavior typically associated with a Nobel-prize-winning chemist.

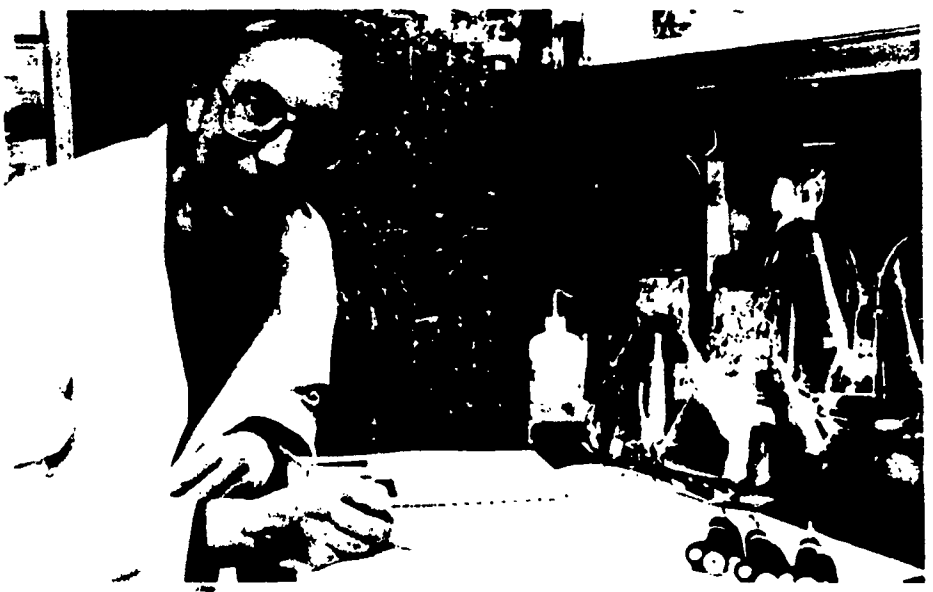
Today Cech heads a research group at the University of Colorado at Boulder that he characterizes as "eclectic." Its interests range from synthetic, organic, and physical chemistry, to biochemistry and structural biology, to retrovirology and medical applications. Increasingly, it is the serendipitous research from such interdisciplinary groups that fuels significant new discoveries.

Although he started out in physical chemistry, Cech found real satisfaction with biochemistry and the study of the DNA molecule, thus launching his productive career. This love is also the basis of his great interest in teaching freshmen, an experience that allows him to incorporate the key ideas of biochemistry into the chemistry curriculum.

Cech's association with NSF began during high school with his participation in a Summer Science Training project in radiation physics at the University of Iowa. Later, in his senior year at Grinnell College, he won an NSF Graduate Fellowship for Ph.D. work at the University of California, Berkeley. The next fall, when he and his wife entered graduate school at Berkeley, he was free to focus his research interests without regard to whether his mentor could support him.

That is precisely how the Graduate Fellowship program works. It seeks to identify the best young scientific and engineering talent in the United States and gives them the chance to pursue their dreams in whatever research group is most appropriate. In recent years, Cech notes, the "shoe has been on the other foot." The occasional participation of NSF Fellows in his current research group greatly increases Cech's flexibility in working with graduate students.

The NSF Graduate Fellowship program has provided the opportunity for young Americans to pursue mathematics, science, and engineering graduate studies. Many have gone on to make significant contributions to the scientific community, and 12, including Cech, have been honored with the Nobel prize. Today, almost 2,800 American graduate students in nearly 180 colleges and universities around the world are continuing this tradition and creating a talent base that will be prepared to meet the unknown scientific and technological challenges of the next century.



Mazie Jenkins

Mazie Jenkins is the first to admit that her participation in the Cognitively Guided Instruction (CGI) project led to her success. CGI ". . . made me a better teacher. I worked very hard as a teacher prior to my involvement with the NSF grant. Now I have the knowledge to make better decisions about students." The improved teaching ability that Jenkins gained through the CGI project contributed to her receiving the 1990 NSF Presidential Award for Excellence in Elementary School Science and Mathematics Teaching.

CGI, funded by the NSF Research in Teaching and Learning program, is based on the idea that children in grades K–3 possess intuitive and analytic mathematics abilities. CGI promotes this fundamentally sound problem-solving approach as an alternative to the mechanical application of arithmetic. Jenkins found that this approach allows her "to reach all kids at all levels. It makes you feel good about what you are doing."

Jenkins, who is primarily a Team Teacher at Lincoln Elementary School and a CGI Resource Teacher for the Madison, Wisconsin, school district, also works to spread the news. She acts as a resource for others, visiting classrooms around the country and conducting workshops for teachers and administrators. Jenkins wants to inform other teachers about the method and philosophy for reaching students that she finds both effective and professionally fulfilling.

Jenkins' 1990 Presidential Award has also enriched her teaching career. "It opened doors that I never would have been able to open otherwise." Before the award, Jenkins was active in education at the state and local levels, but now she speaks at national education conferences and participates on national education panels. In addition, the award has helped her receive recognition from the African–American community in Madison.

The NSF Presidential Award is just one of the many honors Jenkins has received. Since 1990, she has been awarded the Outstanding African–American Educator Award, recognized as one of the top 50 Madisonians, and presented with the Wisconsin Educational Alumni Association Award. Mazie Jenkins is certainly doing her best to make a difference in education.

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Phyllis Robinson

When Phyllis Robinson first set foot in the 200-seat section of Calculus I, filled with students almost 20 years her junior, she already had a feeling she was in over her head. As the semester progressed, Robinson, then a returning student at Purdue University, began to lose her confidence, and her grades in the course started to fall. By the end of the long, lecture-oriented, traditional class, Robinson, like so many others, felt completely frustrated with her mathematics experience. As she puts it, "My course grade was a 'C,' my confidence was an 'F.' Though two semesters of calculus were required for graduation, I could not go on to the next semester of Calculus II."

Several semesters later, a teacher, using new calculus materials developed in NSF's Course and Curriculum Development (CCD) Program, suggested that Robinson register for his class that involved the use of computers to teach calculus. "I was computer illiterate, but rather than face another lecture course, I decided to trust Professor Keith Schwingendorf . . ."

Taking this advice, Robinson enrolled in such a class. In this course, students learned the geometric aspects of calculus using computer graphics and studied the concepts of calculus with a mathematical programming language. The class spent less time listening to lectures and put more effort into hands-on, team-oriented activities. On the first day, the 70-student class separated into groups of four that would function as teams for the entire semester. The teams worked together to reach solutions. Subsequently, other groups elaborated on their classmates' ideas. For Robinson, the course's reform techniques were tremendously successful.

"Suddenly, I knew what was missing in my first exposure—the 'why' of mathematics. When it came to homework, I discovered that I am a theoretical person and it was wonderful . . ." she explained. Robinson went on to receive an 'A' in the course and graduated with a degree in microbiology and genetics in 1991. She is currently in her junior year of nursing school and is also a master's candidate in the School of Science for physiology. Robinson claims that her experience in the calculus reform class marked the turning point in her college education. "Calculus was the one thing between me and graduation, and I put it off for 11 years!" she exclaimed. After graduation, Robinson rewarded herself with a full year of classes simply for the sheer pleasure of learning—one of those classes was a third-semester calculus course.

Courses funded by the CCD program are designed to revitalize the content, conduct, and quality of undergraduate education in science, mathematics, engineering, and technology education beyond the recipient institution. Since 1988, NSF has awarded an average of 100 grants per year totaling more than $60 million. These courses are crucial in promoting the interest and enthusiasm of students with career aspirations in the scientific fields.

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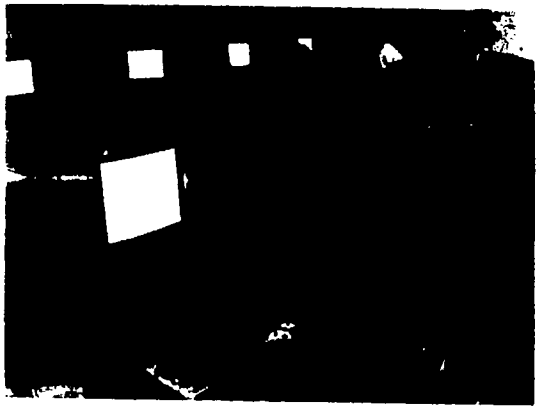

Charles Odegard

"The goal of the Center was to encourage minority students to pursue grad school," says Odegard. "This goal really came through for me. I didn't know if I could go on, and this gave me the confidence. Dr. Bronson set high expectations for us—and they paid off."

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Great expectations lead to great results. This is what Charles Odegard believes about the NSF-funded Materials Research Center of Excellence at the University of Texas, El Paso (UTEP), and he is living proof that his beliefs are justified.

Odegard, currently a doctoral candidate in materials science engineering at the University of Notre Dame, hesitantly joined the world of graduate study after his outstanding undergraduate career at UTEP. An El Paso native of Latino descent, Odegard was not confident he had the ability to succeed at the graduate level, nor was he certain he could afford the tuition. An introduction to Dr. Arturo Bronson persuaded him to go on.

Bronson directs the Center at UTEP, which is funded by NSF's Minority Research Centers of Excellence program. The Center provided Odegard with several important benefits: it alleviated some of the costs of graduate education; it allowed him to concentrate specifically on his area of interest; and most importantly, it showed the young student that he had the ability to take his education as far as he desired.

Odegard expects to finish his doctoral dissertation at Notre Dame in early 1995 and then intends to continue materials science research professionally for a nationally funded laboratory. He will focus on electrochemistry.

In the meantime, the UTEP Materials Research Center continues its tradition. Nearly 50 minority students participate in one of eight different projects focused on researching the processing and synthesizing of materials. Fourteen faculty are involved with the program as well, and further improvement seems likely.

"The program will definitely grow in the future," says Bronson. "The number of students is increasing, and so is the amount of research being conducted on synthesis and process."

For minority students with high expectations, this program is a great opportunity.

Brandi Warren

Through MESA, Warren pursued her interest in science and was supported in her competition in local and regional science fairs.

As a participant in NSF's Young Scholars program, Brandi Warren of Baltimore, Maryland, discovered her life's ambition. As part of her experience in a 1993 summer science camp, Warren interned for three weeks at the Baltimore Center for Urban Archaeology. During her internship, Warren had the opportunity to learn more about a field that she was very interested in through hands-on activities, such as treating artifacts and investigating excavation sites. These experiences eventually inspired her to choose anthropology as her major, which she is currently studying at Towson State University.

Warren began participating in NSF programs at an early age. In fact, as soon as she began high school at Forest Park Senior High, she joined the school's Mathematics, Engineering, Science Achievement (MESA) program, which met regularly after school. The MESA program is sponsored by NSF's Comprehensive Regional Center for Minorities program and works with individual schools to prepare women and minority students better for the rigor of college study in science, mathematics, and engineering. By the end of her senior year, she was not only president of the MESA club, but also valedictorian of her class.

Through MESA, Warren pursued her interest in science and was supported in her competition in local and regional science fairs. Warren placed in at least the top three in every competition she entered. One of her favorite projects was a mathematics game she developed to help young children overcome math anxiety. Warren's teacher, Harriett Symonette, says that NSF programs had a substantial effect on Warren's education. "If anything, her involvement with MESA helped her to develop leadership roles and provided an outstanding opportunity for learning."

Warren's parents, who are both involved in education in Baltimore County, encouraged her interest in science since childhood. Education is very important to the Warren family; three of their children have completed undergraduate work, and Brandi is just beginning her college career. Even today, the family still gathers together often to observe the night sky through their home telescope.

It was during high school that Warren developed her aspiration to become an archaeologist. Her involvement in the Young Scholars program offered her the perfect opportunity to explore this interest.

One of her favorite projects [in the MESA program]was a mathematics game she developed to help young children overcome math anxiety.

Ryan Iwasaka

Their stories began in Hawaii six years ago, a teenage experimenter and a fledgling NSF program, each interested in the study of science. Now, separated by half the globe, the stories of Ryan Iwasaka and the Young Scholars program continue, both with great success.

Iwasaka participated in the Pacific Region component of the Young Scholars program after his sophomore year in high school, studying the control of the pineapple beetle through biological parasites. By his senior year, his efforts had earned him first place in the International Science and Engineering Fair, a $10,000 scholarship from the Office of Naval Research, and a finalist position in the Westinghouse Science Talent Search.

At Claremont McKenna College, Iwasaka pursued his natural science research, as well as political science, in a biology–government double major that earned him high honors from both departments. Upon his graduation in May 1994, the Phi Beta Kappa associate was named a Rhodes Scholar and is currently studying at Oxford.

"The summer [after sophomore year] I spent with NSF was incredible," said Iwasaka. "I experienced living away from home for the first time, and I experienced one-on-one research. I worked with great people, like Dr. Marshall Johnson (University of Hawaii, Department of Entomology), and I learned to be methodical—something that has helped me throughout my academic career."

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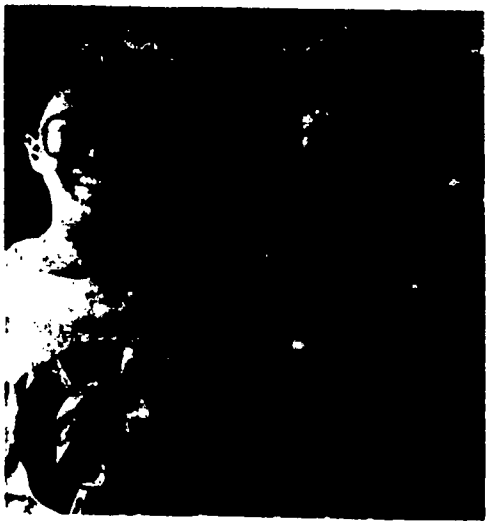
The Young Scholars Pacific Region program is designed to bring students in the Pacific Region together in a university setting, which teaches self-discipline, independence, and responsibility. A follow-up study of participants shows that more than 60 percent of the participants enrolled in college are majoring in science, mathematics, or engineering, and most credit the summer experience with their choice.

The Young Scholars Pacific Region program is part of the overall Young Scholars program initiated in 1988, which gives precollege students exposure to the fields of science, mathematics, and engineering; increases their understanding of career opportunities in science; and provides experiences unavailable at their local schools. To date, more than 30,000 students have participated in the program.



Deborah Penry

Since her childhood, Deborah Penry knew she would someday study oceanography. "I think it's because my father took me fishing on the Chesapeake Bay a lot when I was a child," she jokingly explains. "My parents put great value on education—it was always assumed from the time that I was a small child that I would of course go to college, and they encouraged me to pursue my education as far as I wanted to."

Her parents' encouragement and her personal determination led her to pursue education to its limits. As a senior at the University of Delaware, Penry was awarded an NSF Graduate Fellowship that she used to complete a master's degree in oceanography at the Virginia Institute of Marine Science of the College of William and Mary. She went on to obtain a Ph.D. in biological oceanography at the University of Washington. "The best thing about the NSF Fellowship for me was that I was able to design and pursue my own research project as a graduate student," comments Penry.

"Typically, because oceanography is a graduate science, there are not a lot of teaching assistantships or university-funded fellowships. Most of the graduate work in oceanography is funded by the National Science Foundation or the Office of Naval Research. When you work on a grant—and it depends on your major advisor—you are often constrained by what your advisor had intended to do in the proposal of that grant. Sometimes, you can take a piece and make it your own, but often you are not able to pursue your own research project. However, the NSF Fellowship allowed me to pursue a research project that was entirely my own."

NSF plans to award approximately 1,000 new three-year Graduate and Minority Graduate Fellowships in March 1995. The stipends during 1994–95 are $14,400 for 12-month tenures, prorated monthly at $1,200 for shorter periods. In addition, NSF provides fellowship institutions a cost-of-education allowance of $8,600 per tenure year on behalf of each Fellow. NSF Graduate Fellowships are intended for students at or near the beginning of their graduate study in science, mathematics, or engineering. Fellows may choose as their fellowship institutions appropriate non-profit domestic or foreign institutions of higher education that offer advanced degrees in science or engineering.

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As a result of the fellowship program, many Graduate Fellows have become excellent teachers and well-respected experts in their fields, both nationally and internationally. Penry is currently an Assistant Professor in the Department of Integrative Biology at the University of California, Berkeley. She teaches both invertebrate zoology and biological oceanography courses to upper-level undergraduates. Also, she is responsible for conducting graduate seminars, advising undergraduates, and supervising undergraduate and graduate research projects in her laboratory.

In 1993, Penry became only the second woman to win the Alan T. Waterman Award, a prestigious honor given by NSF and the National Science Board to an outstanding young researcher in any field of science or engineering supported by NSF. The award recognizes scientists who are at the forefront of their fields and is presented to exceptional professionals 35 years of age or younger.

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Kay Toliver

Try to catch a glimpse of math teacher Kay Toliver through the sea of students excitedly waving their arms in the air, eager to be called on. In the award-winning NSF-sponsored video, "Good Morning Miss Toliver," viewers are given a glimpse of her tiny classroom in Public School #72, East Harlem Tech, in the heart of Harlem, New York. In this classroom, Toliver employs innovative and motivational teaching methods that are winning plaudits from educators nationwide.

Her technique emphasizes hands-on, interactive learning delivered with personal enthusiasm that contagiously spreads to her students. One day, she teaches about estimating by giving students, who are broken into small groups, a box of raisins. "How many raisins are in the box?" she asks. Each group is given time to discuss the problem and devise a reasoned plan on how they might find the answer. No group is wrong; instead, other students offer their suggestions on different possible solutions.

"Kay Toliver is a teacher's teacher," says Maurice R. Sykes, Deputy Superintendent of the Washington, D.C., public school system. "She has what is required to teach in the urban schools in the United States, the inner drive to make sure all kids meet with success on a daily basis, and the determination to give them a challenging curriculum that's at a high standard."

Her students respond to this determination with fierce loyalty, respect, and admiration. "In her class, we're not considered hoodlums—we're considered students," one student explains.

Toliver says that her father was most influential in her decision to become a teacher. "He stopped school at a young age because he had to work and wanted all of his children to be fully educated." She says she wanted to be a teacher since she was a little girl, but her active involvement in teacher training did not really begin until the late 1980s. According to Toliver, her participation in the NSF-sponsored Project Team program "made me quite conscious of the important role math plays in everyday life . . . and also helped me come out of myself as a leader."

Toliver's abilities have not gone unrecognized in the educational community. In 1992, she was selected as the NSF Presidential Awardee for Science and Mathematics Teaching from New York State and received the Disney America Teacher Award in mathematics. The publicity surrounding these events led, in part, to the production of the PBS Special "Good Morning Miss Toliver." The 30-minute video highlights inspirational moments in the classroom and is being used for teacher and administrator training as a model for what to look for in exemplary teaching.

"When teachers see the video, they're overwhelmed," said Sykes. "It breaks down all of our 'yes, buts.' She makes us confident of the reality we can do for children—which is that all students can learn at high levels."

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Soon after earning her bachelor's and master's degrees from Hunter College (CUNY) in the 1960s, Toliver began teaching at East Harlem Tech. Since winning the Presidential award, and the production of the video, she has become more involved in teacher training efforts. In May 1994, Toliver helped launch the Mathematics/Science Cadre teacher program, a teacher leadership program for Washington, D.C.'s, middle schools.

To date, more than 2,000 copies of "Good Morning Miss Toliver" have been distributed. A recent survey conducted by the Foundation for Advancement in Science and Education found that more than 90 percent were being used for teacher training. Education groups using the program include the Utah chapter of Mathematics, Engineering, and Science Achievement, the Los Angeles-based Achievement Council, and the Benjamin Banneker Association. In December 1994, Toliver will begin shooting a new series for public television, funded in part by NSF, called "The Eddie Files." The series will give elementary school students a new perspective on how math is used in life through the eyes of "Eddie," a fictional student in Toliver's class.

Kerry Davidson

A strong, dynamic leader with knowledge of the political process within a state and the ability to work with state education leaders and government agencies can create an astounding level of educational reform.

It is no wonder that Kerry Davidson is called "Mr. Reform" in Louisiana. His involvement with educational reform efforts is as extensive as it is noteworthy and shows how a strong, dynamic leader with knowledge of the political process within a state and the ability to work with state education leaders and government agencies can create an astounding level of educational reform.

Davidson is the principal investigator for LaSIP, the Louisiana Systemic Initiatives Program, currently beginning the fourth year of its five-year, $10 million award from NSF's Statewide Systemic Initiatives program. LaSIP seeks to reform mathematics, science, and technology education by altering the fundamentals of the system—changing teacher certification and instruction, and program content and curriculum, using technology to expedite learning, and demonstrating how leaders in business and industry can work with teachers to emphasize the role of mathematics and science in careers.

Based on the LaSIP experience, Davidson applied for, and was awarded, one of NSF's first Collaboratives for Excellence in Teacher Preparation. LaCEPT, the Louisiana Collaborative for Excellence in the Preparation of Teachers, focuses on reforming preservice curriculum to produce more relevant and intellectually challenging introductory core courses for students. All 21 Louisiana campuses that have teacher preparation programs are eligible to participate by proposal submission. Funds are allocated through a competitive process, developed by Davidson, that involves out-of-state reviewers examining the proposals to ensure that the most meritorious are implemented. Twelve institutions received funds in 1993–94, and 14 institutions indicated the intent to submit proposals for 1994–95 funding.

After two years of directing LaSIP, Davidson recognized the need to establish a statewide electronic communication network to share LaSIP's developments and to encourage suggestions. To that end, he directed the writing of a proposal and became the principal investigator of a grant from NSF's Networking Infrastructure for Education program. Since he received this award as a direct outgrowth of LaSIP, the Louisiana Board of Elementary and Secondary Education and the State's Goals 2000 office agreed that LaSIP should lead the statewide planning effort for technology use in all levels of education.

In addition to his involvement in LaSIP, Davidson wears many other hats. He bears overall supervisory responsibility for the Louisiana Stimulus for Excellence in Research (LaSER), an experimental program to stimulate competitive research. He also heads the Louisiana Board of Regents' Division of Academic Affairs and Sponsored Programs, whose staff manages both NSF funding for LaSER and the dollar-for-dollar match required by NSF. LaSER's mission to support research growth in four areas (molecular evolution, neural networks, transport processes, and lyptic peptides) will affect the next generation of scientific researchers significantly.

As if all of this weren't evidence enough of Davidson's versatility, he serves on a host of committees, from the New Orleans Public Schools' Grants Resources Committee, which advises the district's superintendent, to the State's 40-member Goals 2000 Commission and 10-member planning committee. This committee will guide the Commission's development of plans to reform K–12 education based on the U.S. Department of Education's Goals 2000 initiative. Finally, Louisiana is not the only state to benefit from his leadership; Davidson's appointment to NSF's Education and Human Resources Advisory Committee in 1994 gives him an outlet for sharing his ideas with the Nation.

Michael Hood

As a young child, Michael Hood spent many hours trying to discover how things worked. Before he even knew what engineering was, Hood was drawn to the field by an innate sense of curiosity. His mother, he recalls, always encouraged his curiosity and creativity. "As children, my brother and I would stay up until 3 a.m. drawing plans for dream houses and then building the walls, floors, and roofs from foam core we found among our mother's art supplies," he said.

Hood was born profoundly deaf and has never learned sign language; he has instead developed lipreading skills. At the age of three, he learned to speak, read, and write and in the first grade began attending schools with "hearing" students. Being mainstreamed at such an early age is very unusual. "Most mainstreamed students wait until high school before leaving schools for the deaf," he explained. Hood continued to excel through college and in 1991 became the first deaf person to graduate from Purdue University's School of Mechanical Engineering.

In 1992, Hood won an NSF Graduate Fellowship and began his graduate study in mechanical engineering at Purdue. "I am a voracious learner, reading many books on many topics. and I love to discuss new ideas; it was logical for me to continue my education in graduate school," he explained. In conjunction with his fellowship award, the National Science Foundation made a Facilitation Award of $7,795 that enabled Purdue to purchase real-time speech-to-text translation equipment for Hood.

Facilitation Awards are provided by NSF as part of its effort to encourage scientists and engineers with disabilities to fully participate in all of its programs. Designed to reduce or remove barriers to participation in research and training by physically disabled individuals,

Facilitation Awards provide special equipment and assistance for work directly related to an established NSF award. Eligible participants include principal investigators, other senior professionals, and graduate and undergraduate students.

At Purdue, equipment purchased under a Facilitation Award enables Hood to experience the classroom environment in a way not previously possible by allowing him to follow the lecture in real-time: providing the text of the lecture on a video display terminal as it is entered by a stenographer. This experience has literally opened a whole new world for Hood. Professor James D. Jones, one of his advisors, recalls Hood stating that "Before, I never realized all that I was missing." Hood can now ask questions and participate in class discussion, just as if he were not hearing impaired.

"I believe Michael is getting much more information in class than he ever has before. He gets immediate feedback. He not only knows what the professor is saying but is aware of the context of the questions from students sitting behind him," Jones said. The equipment is now being used by six other students at Purdue and the university has plans for expansion.

Hood says that he is very grateful to the National Science Foundation for his fellowship. He plans to pursue his Ph.D. in mechanical engineering. As for his goals. he hopes "to be able to start a business involved in developing, manufacturing, and marketing new products involving progressive technologies."

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Mel George

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Mel George didn't plan on becoming a mathematician—that's just the way things worked out. The first in his family to attend college, he recalls, "I'm one of those who was fortunate to get a really wonderful mathematics teacher who made the subject interesting and cared about his students. I suppose that's one of the reasons I've been so interested in science, mathematics, engineering, and technology education—I know what it did in my life."

Unsure about attending graduate school, George was encouraged to apply for an NSF Fellowship when he was a senior at Northwestern University. "I made the decision to apply for the fellowship before I made a final commitment to get a Ph.D. in mathematics. I won the fellowship and was admitted to Princeton," he notes. The fellowship provided monetary support for George and allowed him to focus all of his efforts on full-time study and research without serving as a teacher's aide. "I really got a head start on my career, thanks to the fellowship."

Since 1952, NSF has awarded Graduate Fellowships to more than 30,000 outstanding college and university students for graduate study in science, mathematics, and engineering. In 1994 alone, 6,227 applications were submitted from students across the nation, resulting in awards of 1,102 Graduate Fellowships on the basis of merit. In addition, NSF awarded Honorable Mentions to 1,792 applicants in recognition of their outstanding potential for success in scientific and engineering careers.

"The NSF Graduate Fellowship made it possible for me to go to Princeton and get a fine Ph.D., which was the beginning of everything for me," explains George. "I have always put the fellowship on my resume, and people have noticed it." He sees the fellowships as a foundation of NSF programs. "It seems to me that there is nothing more important than the nurture and support of bright people to pursue graduate studies in science, mathematics, and engineering."

In 1992, George served as chair of the Committee of Visitors for the NSF Graduate Fellowship program and directed the external review of the program's management. He became concerned with maintaining the number of awards granted each year, while adjusting for factors such as inflation, and stressed the importance of the program in encouraging students to attend graduate school. "We simply have to maintain the pool of talent to supply not only faculty to our academic institutions but also leaders to our laboratories and corporations."

Following a distinguished career as the president of Saint Olaf College in Northfield, Minnesota, George recently accepted the position of vice president for Institutional Relations at the University of Minnesota. His responsibilities include directing the Alumni Association and the University Foundation as well as all legislative lobbying and public relations. "It's a little different role for me," he adds, "but one that I'm comfortable in."

Melody Spence and Heather Tartara

Last year, two 14-year-old students from the rural community of Oil City, Pennsylvania, made a significant discovery in the field of astronomy. Melody Spence and Heather Tartara, described by their instructor as once shy and quiet students who sat in the back of the room, have now entered the astronomy literature with their photos of Supernova 1994I. These photos contain the last available images of the Whirlpool Galaxy before the formation of a supernova and the first image of the phenomenon after its creation.

This possibility to perform such intensive research would not have been possible for two so young had it not been for the Hands-On Universe project, partially funded by NSF's Instructional Materials Development program. Through the use of an extensive computer program, the Hands-On Universe project allows high school students from all over the United States to acquire and use real images from a telescope at the University of California, Berkeley. Central mathematics and science concepts and tools are embedded in each of the project's curriculum units and in the images that accompany the computer program. Students and teachers are able to request their own images from the centrally located professional grade telescopes. Spence and Tartara requested Whirlpool Galaxy images as part of their desire to understand the galaxy better and were rewarded with scientifically valuable data when they serendipitously discovered the supernova.

"The unique strength of this program is enabling students to do real research, to undertake state-of-the-art investigations, and genuinely to become participants in the professional scientific process. I am convinced that this hands-on partnership will be able to change the daily lives of thousands of students and teachers all over America."

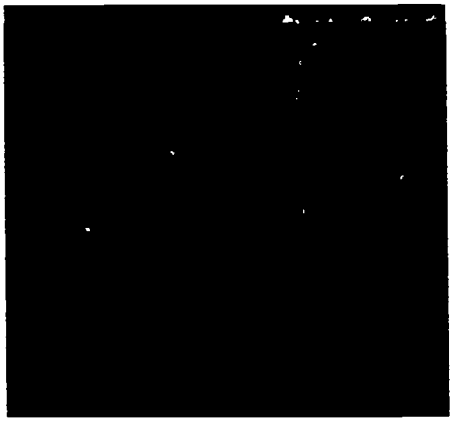
The effect of their discovery on themselves and their classmates exemplifies why programs such as Hands-On Universe are integral to educational reform. Tim Spuck, the teacher of Spence and Tartara's earth science class says the effect on his classroom was inspiring. "The next day, I had students coming in saying, 'I want to discover something today.' " Spuck also recognizes how important this discovery is to Spence and Tartara. "Their feeling of self-worth increased dramatically; both of them will see the night sky in a totally different way from now on."

Spence says the experience ". . .changed things. Learning about the sky and stuff, I didn't even know what a supernova was." Both Spence and Tartara will be included as co-authors in future journal articles about the supernova.

Oil City is a rural community in Pennsylvania with one of the highest murder rates in the country and one of the highest number of welfare recipients. Spuck says "if the Hands-On Universe project can be successful here, it can work anywhere. This project provides an avenue where curiosity is fostered—and with some dramatic results."

The effect of their discovery on themselves and their classmates exemplifies why programs such as Hands-On Universe are integral to educational reform.

Dr. Carl Pennypacker, Hands-On Universe project director and Associate Research Physicist at the University of California, Berkeley, says "this NSF-funded project has truly been a watershed of creativity, insight, and inspiration for my career as well. The process of the development of the materials has been a powerful one for me, and I believe it is a great example of how our federal government can transfer pent-up technology effectively to the education sector." Pennypacker says that "I am able to share my research with many teachers and students and experience their new-found joy at the wonders of the universe . . . The unique strength of this program is enabling students to do real research, to undertake state-of-the-art investigations, and genuinely to become participants in the professional scientific process. I am convinced that this hands-on partnership will be able to change the daily lives of thousands of students and teachers all over America."



Joan Kane and Delanie Peterson

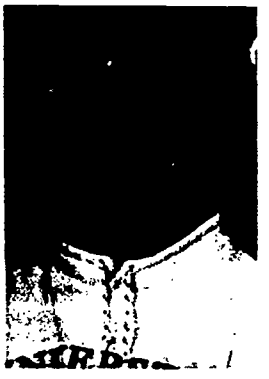
If asked to define engineering, many high school students might be at a loss, but at an NSF-sponsored summer camp, high school students from across the country are tackling the complexities of the field head-on. Each year, approximately 70 high school students from various backgrounds take a summer course to stimulate their interest in the engineering field. The project, Making of an Engineer (MOE), is part of the Young Scholars program and is designed for high school sophomores, juniors, and seniors with interests in science and technology. Joan Kane and Delanie Peterson are two examples of the success of the project.

Kane, a senior at Bartlett High School in Anchorage, Alaska, is an Inupiaq Eskimo who learned about the MOE project through a counselor at her high school. She says that the summer course gave her exposure to a university setting and familiarity with different ethnic backgrounds. She particularly enjoyed "the close relationships with professors and the personal contacts. I enjoyed collaborating on projects with students that shared the same interests."

The MOE project includes opportunities for students to work one-on-one with professors on individual honors projects. Kane was involved with the Speech Processing academy, which gave her "exposure to a lot of technology that is unavailable in my high school. The labs familiarized us with research equipment where we analyzed samples of sound and speech." The program played a major role for Kane in developing her interests in applied sciences, which she plans to study in college.

Peterson, a member of the Lakota Sioux tribe and a senior in high school in South Dakota, participated in the project when he was a sophomore. During that year, Peterson was one of three participants from South Dakota. The MOE project gave him insight into what engineers do in the workplace, which supported his interest in becoming an environmental engineer. Peterson described being "overwhelmed when I got there, but after a while I fit in. I really liked the counselors and staying in the dormitories . . . it felt like college life."

Peterson recommends the summer course to anyone who is interested in becoming an engineer. In his academy there was a competition in which students built catapults from a variety of materials including paper clips and rubber bands. The students were judged on distance and accuracy. Peterson anticipates pursuing the study of environmental engineering at the South Dakota School of Mines and Technology.



Since its inception eight years ago, MOE has focused its efforts on recruiting students from traditionally underrepresented groups, particularly women and minorities. The program began with 12 participants and has grown to approximately 70 participants, including migrant workers, African–Americans, Pacific Islanders, and Native Americans. Most of the students come from families that are financially challenged; the fact that most of the past participants are attending college is an excellent measure of the project's success.

According to Dr. Albert Rosa, project director for MOE, the program attracts not only minorities, but a healthy cross-section of students. Dr. Rosa's goal has always been to "expose students to engineering and show the students that they can do it. I want them to know that they can succeed if they get help and work together."

The program is offered during the summer for three weeks at the University of Denver, and participants are screened by the admissions department. Students can take the course for the experience and no university credit, or they can enroll for a grade and four quarter-hours of university credit. In addition to NSF, industry and NASA also support the MOE project, enabling students to be recruited from throughout the United States, Puerto Rico, and American Samoa.

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Brock Spencer

In 1991, Brock Spencer changed the way he teaches. Spencer's involvement in the NSF-funded Project Kaleidoscope (PKAL) National Colloquium led to the revision of Beloit College's introductory chemistry course, which was experiencing an almost 20-percent dropout rate. Encouraged by the educational models presented at that conference, Spencer and his colleagues, Laura Parmentier and George Lisensky, took steps to revitalize and restructure the course. The "conversion" of Brock Spencer had begun.

Spencer's new chemistry course trades lectures and examinations for more time in the laboratory, and it employs pedagogies Spencer observed at the PKAL colloquium. The new chemistry course emphasizes taking a problem, refining the approach, evaluating the results, and finding answers to student-posed questions—questions, according to Spencer, that may be more directly relevant to a student's individual experience than those a professor would ask. As a result, students now use their textbooks as a source to solve problems, rather than as a course blueprint, and lectures have become discussions about issues students find interesting or difficult.

"Rapid advances in technology are quickly outdating some of the facts that are taken for granted in introductory science courses," Spencer says. "It is more important in today's technological climate for students to learn to ask important questions, to work with each other, and to teach themselves."

Thanks in part to PKAL, the dropout rate in the course is half of what it used to be. Now, students come away from the course with a better understanding of how science progresses and contributes to society. The only problem has been supplying enough sections to meet the growing demand; almost half of all Beloit College students have taken the course by the time they graduate.

The influence of PKAL has had a ripple effect. Beloit faculty in other scientific disciplines are impressed with the success of the changes Spencer instituted from his PKAL experience, and in some cases they have incorporated more laboratory work into their own courses. Spencer's course now serves as a basis for developing and testing materials for an NSF-funded project to introduce solid-state concepts and examples into general chemistry courses.

"PKAL's National Colloquium has brought undergraduate science to the forefront of the academic agenda," says Spencer. "Now we have a coherent picture of the challenges facing us."

In 1993, PKAL introduced Spencer's new chemistry course in the report *Programs That Work*, which was designed to provide models for other institutions attempting to strengthen and reform their courses. Since then, Spencer has presented workshops throughout the country on reforming chemistry courses, including several at PKAL conferences and one at a PKAL regional conference held at Beloit in August 1993. Spencer and PKAL have shown faculty from hundreds of colleges and universities why a hands-on approach to science should not be saved for advanced courses only.

Spencer's conversion continues. He now heads the Chemlinks Coalition formed with the support and influence of PKAL. The coalition, a group of 15 liberal arts institutions, has received a planning grant from NSF to reform the first two years of undergraduate chemistry instruction. The coalition will rely on PKAL resources and will use Spencer's new course as a foundation for its reforms as it strives to develop effective ways to attract all students, especially those with diverse learning styles, into science.

"It is more important in today's technological climate for students to learn to ask important questions, to work with each other, and to teach themselves."

John Meschter

Twice a month John Meschter, a Polaroid Corporation engineer who ordinarily designs and builds high-speed assembly machinery, spends the day teaching eighth grade mathematics. This allows the students' regular teacher, Dolores Weir, to spend her morning at a professional development program, where she learns about innovative teaching methods and mathematics applications. This scenario exists as part of an NSF-funded project, Teachers, Time, and Transformations (TTT), operated by the Education Development Center in Newton, Massachusetts.

Meschter is one of many private-sector volunteers who regularly substitute in classrooms so teachers can participate in enhancement activities. "I believe we've got to reinvest in some way what each of us learned back in school, even if just as a role model. Also, in terms of my work at Polaroid, if we don't take a hand in education, we can't complain about the results," he said. However, it's not just a matter of giving; Meschter also believes he is learning from the experience.

"It's connected me with what the issues of schooling are for kids, what directions the school should take. I know I'll vote more intelligently now in my own community." He derives special satisfaction from knowing that his work in the classroom has had a positive impact on his students. "That's the kind of thing that keeps you going," he said. In fact, Meschter has enjoyed his part-time teaching experience so much that he is considering a career switch to teaching—probably at the high school or college level.

To prepare for their work in the classroom, volunteers undergo an extensive orientation and training program that includes observing their teacher–partner at least twice in the classroom. Meschter's teacher–partner, Weir, joined the TTT program, because, after 20 years of teaching, she felt she was "ready for a change." After two years in the program, she believes "it has definitely lived up to my expectations" by offering opportunities to work professionally with other teachers

and share ideas with them, as well as learning new mathematics, and many new applications of mathematics, in the real world. Her teaching style has also changed—she lectures less and focuses more on student participation, group work, and using hands-on materials. "Most important," she adds, "the program has increased my comfort zone to try new things."

That is exactly what the program was designed to do: to provide teachers with time to attend inventive professional development programs while offering interested professionals the opportunity to experience the classroom environment firsthand.

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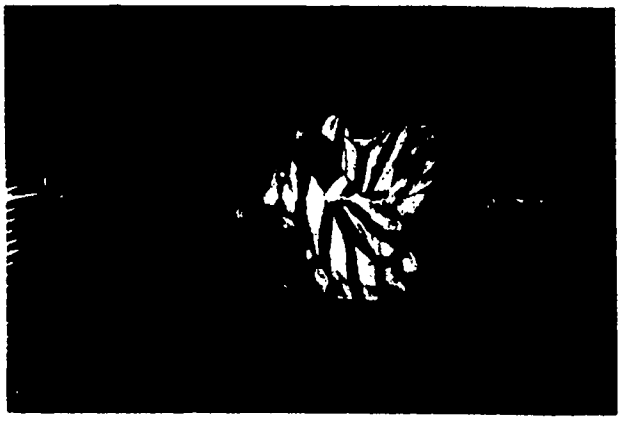

Sydney Kustu

During her VPW year at the University of Wisconsin, Kustu made some key research findings. As a result, she is currently a Professor of plant biology and molecular and cell biology at the University of California, Berkeley. In addition, Kustu was elected to the American Academy of Arts and Sciences in 1992 and to the National Academy of Sciences in 1993.

Sydney Kustu is on the fast track. After spending a year at the University of Wisconsin as part of the NSF Visiting Professorships for Women (VPW) program, she was offered a full professorship at the University of California, Berkeley, where she is currently a Professor of plant biology and molecular and cell biology. In addition, Kustu was elected to the American Academy of Arts and Sciences in 1992 and to the National Academy of Sciences in 1993.

It all started in college, where Kustu enjoyed chemistry and took a freshman biology course during her senior year. Eventually, she decided to study biochemistry as an extension student. She loved the rigor and elegance of biochemical mechanisms and decided to pursue this area of study in graduate school.

A few years later, NSF awarded Kustu a VPW grant while she was a faculty member at the University of California, Davis. During her VPW year at the University of Wisconsin, Kustu made some key research findings. She used molecular biological techniques to synthesize large amounts of a specialized form of RNA polymerase. This RNA polymerase decodes the information for biological nitrogen fixation in a number of bacteria. Achieving this synthesis helped her gain knowledge about the properties of the RNA polymerase *in vitro* and of the nature of the decoding process it carried out. Unexpectedly, this polymerase was found to be activated by proteins that bond to DNA at a position distant from where decoding started—so-called enhancer-binding proteins. Activation from a distance was previously thought to be restricted to eukaryotic decoding (transcription) systems. This research was one of the factors that led to her full professorship at Berkeley.

The VPW program provides an enriching professional experience for women scientists and engineers. The program involves the Nation's major research universities, encourages students through VPW visibility to pursue careers in science and engineering, and strengthens VPW recipients' home institutions by providing professional development opportunities.

Approximately 70 percent of the award time is spent on research and the remaining 30 percent on interactive activities that develop visibility for the VPW grantee. Kustu's interactive activities included teaching a one-semester lecture–seminar course on microbial nitrogen metabolism and its regulation, giving a seminar entitled "Covalent modification of bacterial glutamine synthetase: physiological significance," and participating in the training of postdoctoral, graduate, and undergraduate researchers.

Donna York

"My life started to change professionally as a direct result of the Presidential award. Awards like this infuse a new stimulus into teaching, not to retire, but to go further into science education reform, and to care deeply about the future of our young students."

When most people hear the word "teacher" they think of one special person who taught them an unforgettable lesson or had a style so unique and appealing that they were actually excited to attend class. These teachers, the ones who make learning a pleasure instead of a chore, deserve the recognition that comes through such programs as NSF's Presidential Awards program. How many students, however, can say that their teacher has actually won a Presidential award or, in fact, has been nationally recognized for excellence in teaching, several times over? In the years to come, the students of Donna York's junior high school science classes will remember her as both a person who made a difference and an incredibly gifted and decorated teacher.

As a science teacher, York has not only established herself in a field that is traditionally male dominated, but has excelled in a field that is particularly in need of good teachers. Despite the difficulties of being in such a challenging field, York has a great dedication to it, as indicated by her reception of the 1990 Secondary Science Presidential Award.

Each year, the White House recognizes the finest educators in mathematics and science in each state and United States territory through the Presidential Awards in Mathematics and Science program, a component of NSF's Teacher Enhancement program. Every state and territory submits three candidates for each of the disciplinary categories at each level: elementary mathematics, elementary science, secondary mathematics, and secondary science. NSF then convenes a review panel of participants from throughout the United States. The awards are designed to recognize quality teaching and to increase the professional status of teachers.

Does the award have a positive effect? York states, "My life started to change professionally as a direct result of the Presidential award. Awards like this infuse a new stimulus into teaching, not to retire, but to go further into science education reform, and to care deeply about the future of our young students."

York's achievements did not come without hard work. Besides being dedicated to education, she is on the Board of Directors (Executive Committee) for Imaginarium, a science discovery center in Alaska. After receiving the Presidential award, she was promoted to Teacher Expert for Secondary Science Education in the Anchorage school district. In this role, she was responsible for a staff of approximately 135 secondary science teachers. A year later, she became Science Curriculum Coordinator for grades K–12, spearheading the program approval process for the Anchorage school district's junior high school science program dedicated to ensuring that middle school programs reflect the national philosophy of hands-on science education for all students.

NSF continues to play a role in York's life; in 1993, she was appointed to NSF's Advisory Committee for the Directorate for Education and Human Resources. In this position, York provides a much needed teacher's viewpoint in the deliberations of the advisory committee.

David Pettigrew

You might wonder what children crawling around on a large, abstract "street" map has to do with mathematics education. Quite a bit, according to Dr. David Pettigrew, coordinator of Project CONNSTRUCT at Southern Connecticut State University (SCSU). The exercise, actually an interactive factoring game, was part of a lecture sponsored by Project CONNSTRUCT in its efforts to enhance teacher education and reconnect universities to public elementary and high schools. This exercise is just one example of the startling and exciting new avenues being explored in mathematics, science, and technology education.

Connecticut, one of the first states to receive a grant from NSF's Statewide Systemic Initiatives (SSI) program, has taken a unique approach to distributing award funds by creating the Connecticut Academy for Education in Mathematics, Science, and Technology. One of the primary recipients of Connecticut's SSI grant is Project CONNSTRUCT. The project's emphasis on critical thinking and collaborative problem solving is reflected in its various workshops and functions, aimed at making a significant social impact on New Haven's inner city schools as well as teachers at public schools and SCSU.

As a teacher of philosophy, phenomenology, existentialism, and psychoanalysis, Pettigrew became aware of the problems that existed in mathematics and science instruction. He began to apply his desire to improve the quality of education for teachers as well as students. Through Project CONNSTRUCT, Pettigrew has helped to design and fashion what he calls a "community of inquiry," a group concerned with the teaching and learning of science and mathematics. The focus ranges from content and method to parent involvement and how business can support learning—focusing on any number of ideas that cut across traditional boundaries.

"The world is an interactive and interdisciplinary experience, and education must respond to that," states Pettigrew. One of Project CONNSTRUCT's responses is the Eureka Center, which features interactive mathematic and science manipulatives—a "learning by doing" environment that emphasizes analytical thinking and learning to faculty and students. The Center, space for which is donated by SCSU, is just one example of the university's support for the project. SCSU also shoulders the 50 percent of the program costs not covered by the NSF grant and administers a time-reassignment program that allows Project CONNSTRUCT participants to earn credits and defer a portion of their teaching load.

Those considering participation in Project CONNSTRUCT can forget about having summers off. As an outgrowth of the project, Pettigrew directs a Pre-engineering Summer Science Enrichment program for New Haven high school students, arranging for students to work in university laboratories and visit businesses to observe science applications. This interaction continues during the regular academic year as students are required to work in New Haven public schools, gaining hands-on experience with inner city children. Pettigrew's interdisciplinary background, coupled with his experience in community outreach and fundraising, make him the ideal candidate to guide a project intent on creating unity between higher and secondary education.

Pettigrew notes that the innovative and successful project merely takes advantage of tools that were waiting to be used. The success of Project CONNSTRUCT has institutionalized the use of these tools and made them a regular and integral part of the curriculum.

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Mary Veronica Kolesar

Mary Veronica Kolesar was pleasantly surprised when she realized that NSF's Undergraduate Faculty Enhancement (UFE) workshop on "Modern Foundations of Computer Science" would address many of the same problems in education that she herself had noted. "My experiences in the classroom, in the computer lab, and in private sessions with students convinced me that . . . many students had weak problem-solving and communication skills and were not truly involved in their own educations," she recalls.

Having had no formal training in education, Kolesar more or less stumbled into teaching: "I began teaching as a statistics graduate student at Utah State University . . . and soon found that I loved teaching!" Although she completed her degree in statistics, she found herself teaching in the computer science department at Utah State University. Concerned about her inexperience in front of a classroom, Kolesar began to investigate teaching methodology and soon found that "something was lacking in the educational process."

"I began to formulate some thoughts on how to tackle these problems within the computer science discipline. That's where NSF entered the picture!" exclaims Kolesar. With departmental support, Kolesar attended the UFE workshop and discovered that her thoughts on computer science education paralleled those of others who were far more experienced in the field. The UFE program funds workshops that enable faculty members to gain experience with recent advances and new experimental techniques in their field. The UFE workshop focused on participant interaction and topical discussions. "I gained a great deal from sharing ideas with other computer science instructors . . . and the computer laboratory sessions provided ideas for improving the labs associated with the classes I teach."

Invigorated by the experience, Kolesar began implementing some of these ideas into the curriculum at Utah State. In so doing she discovered that one of her colleagues, Vicki Allan, had similar views on handling the educational problems they had noticed. "We decided to write a CCD [Course and Curriculum Development] grant proposal for the development of a course that would address some of those problems."

Currently completing the second year of their two-and-a-half-year CCD award, Kolesar and Allan are striving to redefine students' conception of computer science by demonstrating that computer science involves more than just programming. "The class attempts to give the foundation in mathematical and problem-solving skills needed for success in computer science," says Kolesar. She continues by explaining that the class employs a "recreational approach . . . designed to minimize the frustrations encountered in a typical first course that covers programming."

Kolesar is excited about the class' potential to effect changes in the way students view computer science. "After completing the course, students have a broader introduction to computer science as well as an opportunity to gain familiarity with computers and some of the concepts of computer science before plunging into a programming course." The class has already had some noticeable effects on the Utah State students. "To date, we have seen two changes of major to Computer Science, one of which is a woman." Kolesar and Allan are fine-tuning and evaluating their progress and are anxious to "share what we're learning . . . and developing with other educators who are trying to make a difference."

"My experiences in the classroom, in the computer lab, and in private sessions with students convinced me that . . . many students had weak problem-solving and communication skills and were not truly involved in their own educations."

Emir Jose Macari

Emir Jose Macari attributes much of his success to the power of role models. Macari, an Associate Professor of civil engineering at Georgia Institute of Technology and a 1992 Presidential Faculty Fellow (PFF), says "I knew I wanted to be an engineer like my grandfather, and design better highways, since I was five years old." Fortunately, Macari had no shortage of strong role models while growing up. "At the age of 72, my grandfather enrolled in college at the same time I did. I received one degree while he received two more to add to his list," he explained.

Macari firmly believes in the influence family members have on a child's education. Both of his parents encouraged his studies and were actively involved in his schooling. His father once told him that the most valuable thing his father could leave him was the best possible education. "Today, I still remember those words and how true they turned out to be," he comments. He believes that when families don't provide role models, schools must assume this role.

As a PFF, Macari has had the opportunity to play both role model and mentor. Created in 1991 by President Bush, PFF awards are made to outstanding faculty, early in their careers, for their contributions in research and teaching in science and engineering and for their potential to become academic leaders. Each of the 30 fellows selected annually receive $500,000 over five years. "The PFF has allowed me to concentrate on my research plan without having to always search for external funding sources. At the same time, it has given me the opportunity to participate in national and international panels that deal with policy in science and engineering," Macari explained.

As a result of Macari's participation in PFF, several countries have invited him to give lectures on his research projects ranging from computational mechanics, earthquake engineering, sustainable technologies, and the use of virtual reality in engineering education. In several of these countries, Macari lectured not only to academic communities, but also to elementary and high schools.

One of Macari's personal goals is to use his skills and credibility gained from the PFF program to unite both the education and research communities of engineering and science. Macari believes that the PFF program has been integral in establishing his credibility so he may accomplish this goal.

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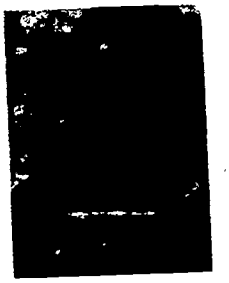
Tom Cech

Mazie Jenkins

Phyllis Robinson

Charles Odegard



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Brock Spencer

John Meschter

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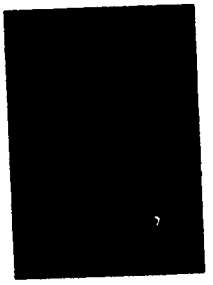
Donna York

David Pettigrew



Mary Veronica Kolesar

Emir Jose Macari

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