



*A program funded by the National Science Foundation is helping teachers put the 'IE' in prodigies*



# Are you experienced?

CHILDREN WHO ARE ENGAGED BY SCIENTIFIC AND mathematical pursuits at an early age will grow into adults with similar interests. Such is the thinking that led the National Science Foundation to fund the Research Experiences for Teachers (RET) program. Initiated in 2001, the program augments existing grants designed to promote interaction between universities and their surrounding K-12 schools. Proponents of the program hope that by involving K-12 teachers in college-level engineering research studies, those teachers will introduce engineering research trends into their classrooms.

Any college interested in designing a curriculum for the program may apply for funding. The program gives teachers new skill sets and novel ways to engage students in learning about math, science, and technology while planting the seed for future careers in engineering. At the same time, colleges gain invaluable information about how children learn and how they can best be prepared for college study. Participating corporations receive the benefit of the research done in the program and good will in the community. The students are given access to tools and experiences that might otherwise elude them until college, if not forever.

In the summer of 2002, Auburn University in Auburn, Ala.,

and Florida International University in Miami hosted the first RET projects to focus on industrial engineering.

## Tiger's tale

Cynda Fickert, an eighth-grade math teacher from Auburn Junior High School, and Mark Jones, a sixth- and seventh-grade science teacher from Drake Middle School, were selected for Auburn's inaugural RET research team. IIE fellow Alice Smith, Ph.D., chair of the industrial and systems engineering department at Auburn University, facilitated the project in cooperation with the interdisciplinary Center for Advanced Vehicle Electronics (CAVE) and Daimler/Chrysler Electronics in Huntsville, Ala. The research, titled "Relating Field Data to Accelerated Life Testing," was commissioned to correlate wear and degradation of solder connections on under-the-hood electronic components through accelerated testing via temperature cycling. The tests were conducted on the transmission controller used in Jeep light trucks.

Though actual research was being conducted, the primary goal of Auburn's RET program was to provide experiences that Fickert and Jones could integrate into classroom modules for their students. Drawing on his background in the natural



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sciences, Jones focused on properties of the solder joint material. The solder was analyzed using mechanical testing and scanning electron microscope photos. Meanwhile, Fickert assembled and analyzed the data the team was collecting. Using statistical modeling, she helped chart the correlation between the mileage accrued by the field units and solder joint degradation as measured through joint shear strength.

“The interaction with the entire CAVE project challenged me in many ways,” said Fickert. “I enjoyed learning how the project relates industry to education at both the graduate and junior high school levels. The interaction with professionals, the financial opportunity, working with graduate students, operating the machines in the lab, and helping with the CAVE project all helped to make this a very meaningful opportunity for me personally and professionally.”

After completing the initial portion of the program, Fickert and Jones were given the tools, both literally and figuratively, to devise hands-on class modules reflecting what they had learned.

Inspired by the shear strength tests she had observed being performed on the solder joints, Fickert devised an experiment that her math students could perform to determine the strength of different types and sizes of wood. Various wood samples were mounted on a loading block and used to suspend buckets of sand. Digital force sensors, provided through the RET grant, measured the stress on the wood beams as the students gradually increased the load of sand. Electronic data loggers conveyed the information to a computer. The students continued to add sand until the wood snapped and spilled the ballast, giving the classroom floor a vaguely beach-like appearance. In subsequent classes, Fickert helped her students break down the data and formulate results.

Jones, who had worked directly with the solder, decided to replicate the experience for his classes. Many of the students recognized the look of soldered pipes from under the sink or in the basement but had no idea how they were achieved. First, the participants were taught basic soldering techniques using a soldering iron. They then graduated to solder kits and propane torches provided by the RET grant. Working in teams of four, each student soldered one length of copper pipe to make a functional whole. The goal was to create a watertight length of pipe using as little solder as possible, correlating with the CAVE labs research goal of helping industry produce safe, functional, and dependable products while minimizing costs. Pipes that did not leak were immediately ranked ahead of those that did. Leaky pipes were then ranked by the amount of water they lost, while the watertight pipes were judged by the amount of solder required to keep them sealed.

In addition to the innovative classroom activities, students in the Auburn project got a special side benefit. More than 100 math students from Auburn Junior High and an equal number of science students from Drake Middle School enjoyed a field trip to the CAVE labs, including a tour of a clean room where circuit boards are manufactured. Clad in lab coats and booties, students were shown how sticky mats help limit the dust and debris that enter the closed lab. Afterward, some engineering students from Auburn University showed off mini Baja and formula racing cars that they had designed and built in conjunction with the company.

“I use a great deal of discussion in my classroom to promote inquiry in my classroom culture,” explains Jones. “One aspect of that culture is the students’ perception of the teacher as an expert on certain topics. The experience with CAVE allows me

## are you experienced?



Teacher Mark Jones models a fashionable clean suit during a visit to the CAVE labs.



Middle school students were given lab coats and booties to wear during their tour of the CAVE labs, where high-end circuit boards are manufactured.

to put myself in a professional setting if I find the opportunity to use that experience within the context of the classroom. I expect that I will be able to use CAVE within my own testimony when my class begins a unit on properties of matter.”

### Sim High

Florida International University’s program was designed for high-school teachers. Julie Ann Hood and Dana Yancoskie from Maritime and Science Technology Academy were selected for the program. MAST Academy, a magnet school in Miami-Dade County that hosts 550 students in grades 9-12, offers a specialized curriculum focusing on marine science and technology. Hood teaches physics, mathematics, and marine geology and holds a Ph.D. in geophysics. Yancoskie teaches mathematics and recently won the Radio Shack Teacher of the Year award.

Before participating in the project, both teachers immersed themselves in simulation and queuing theory.

“One of the most challenging tasks was to learn simulation in one week,” Hood recalled.

The project, “Measurement Methodology of Scalable Enterprise Systems,” was designed to model and analyze scalable enterprise systems.

“The primary target enterprise system was a supply chain, and we aimed to determine an approach to measure the supply chain’s performance as the size, structure, and nature of the supply chain dynamically changed,” explained Ronald Giachetti, Ph.D., FIU assistant professor of industrial engineering, who facilitated the program.

Hood and Yancoskie suggested that the project model their high-school’s media center so that students would be better

## BEYOND MODEL VOLCANOES

The Georgia Institute of Technology established its own high-school magnet program in the fall of 2000. The program is a joint venture between the university and Rockdale County Public Schools. Students selected for the Rockdale Magnet School for Science and Technology are given access to Georgia Tech’s top-flight research facilities and faculty and encouraged to pursue ambitious math and science projects. The research-focused curriculum is a joint creation of Georgia Tech and the Rockdale school system.

Unlike Tech’s other K-12 programs, the Rockdale partnership is administered directly through the College of Engineering. Student participation varies from work on research projects to sitting in on freshman-level classes. Students come to the school with experiments requiring everything from DNA extraction to the handling of biological material so hazardous it is illegal to work with in

a high school. The program gives students access to faculty at the Centers for Disease Control, Dobbins Air Force Base, and the university’s campus in Lorraine, France, among others.

The return on Georgia Tech’s investment is good will in the community and a better prepared class of upcoming freshmen. In line with this overall view toward college orientation, the faculty provides mentoring services, helping the students devise projects, set up experiments, and process results. The program also stresses time-management and prioritization. The first class students attend focuses exclusively on the challenges they will face when they get to college. Research projects are also designed to show students the importance of budgeting time and resources.

Source: *Tech Topics*, Summer 2003

Teacher Cynda Fickert prepares to run an experiment at the CAVE labs.



Teacher Dana Yancoskie and assistant IE professor Ronald Giachetti analyze results modeling student flow in a high-school media center.



able to relate to the project and assist in collecting the data. The rest of the team agreed. The suggestion proved to be a good one because the model they constructed was corroborated by the results of a recent circulation census.

Later, as a part of the program, Hood and Yancoskie traveled to a teachers summit at Johns Hopkins University in Baltimore. There they attended seminars with 25 other RET-sponsored teachers from Morgan State University, Carnegie Mellon University, the University of Maryland, and Johns Hopkins. The trip included tours of research laboratories of the Wallops Island NASA Launch Facility, the National Institute of Health, and the Baltimore Museum of Industry. The pair described the trip as a good forum for interaction with other teachers, seeing real-life applications of mathematics and science, and sharing ideas about teaching and learning.

Giachetti believes it is critical to bridge the gap between FIU and schools in the community. Since facilitating the project he has served as a judge in the South Florida Science Fair and has supervised a MAST student as an intern. "MAST draws the top students in Miami-Dade. We need to get these students to explore engineering as a career opportunity, and one way is to show them early on the exciting aspects of engineering as discovered through research."

## Results

The goal of the RET program is ambitious: quick indoctrination of K-12 teachers in concepts and practices that take many students years to master. "You cannot underestimate the difficulty in incorporating high-school teachers without an engineering background into active research programs," admitted Giachetti. "However, in the end we found a good compromise where they learned some of the tools we used — queuing theory and simulation — and were able to apply it to a system they were more familiar with."

Yancoskie agreed that the program was challenging but said it was an eye-opening experience that will result in long-term rewards for both herself and her students: "I didn't realize how many fields of engineering there are: industrial, civil, electrical, mechanical, biomedical, aeronautical, et cetera. Now I can better provide my students with more information concerning career choices."

Since completing the 2002 program, Fickert and Jones have attended a weeklong soldering school conducted at NASA's Goddard Flight Center in Maryland. Using soldering kits donated by NASA, Fickert is developing new classroom modules based on her experiences. A second installment from the RET program was granted, allowing more students to visit the CAVE labs this fall. Smith says she will continue to work with the teachers as they refine their curriculum and introduce new classes of students to the early pursuit of engineering subjects.

Fickert noted that the experiences gained through the program have helped her design more effective lessons that will stretch for years to come: "I use many activities in my classroom to incorporate problem solving skills and number sense. In addition, the experience added to my knowledge of real-world applications for the skills in my pre-algebra curriculum. I will be able to help my students better understand the need for a solid understanding of statistics, graphs, ratios and proportions, and I will be able to help them connect this information with everyday electronics such as cell phones and video games.

"This was one of the most dynamic summer experiences I have had, and my students will reap the benefits," Fickert said. ~

*This article was based on the accounts of Alice Smith, Ph.D., of Auburn University and Ronald Giachetti, Ph.D., of Florida International University.*