TIE Project Uses Technology to Spark Learning, Enhance Teaching

The MITRE Corporation has always had a strong commitment to education. We offer scholarships to graduating seniors in our local communities, conduct outreach programs with local schools, provide tours and demonstrations for students and teachers to help them understand what engineers and scientists do, offer summer internships, and donate surplus equipment to schools.

In late 1991, we decided to do even more. Since we work on the forefront of modern information systems technology, we wanted to help schools use that kind of technology in education. We formed a partnership with the Springfield Massachusetts public school system and launched the Technology in Education (TIE) project. This project emphasizes the systemic application of modern technology in K–12 education, using the systems engineering processes that have worked well in government and industry.

TIE was not simply to be yet another program to donate computers and money to schools. Rather, we wanted to help schools create the processes and infrastructure necessary to make technology an integral part of the classroom and the curriculum. We also wanted to stimulate the development of more and better educational technology products.

TIEing Technology to the Classroom

We started TIE as a joint venture with the Springfield public schools, requiring the school system to commit resources to the project. Each respective school department had to handle all necessary facility modifications, such as providing electrical power, telephone lines, and physical security. The department also had to provide release time for teachers to attend training sessions and meetings. Since we are not educators, we made it clear from the beginning that we would rely on teachers to determine what technology was appropriate for their classes. Our role would be to help them understand the technology that is available and how to use it. We offered to show, by example, what needs to be done to plan, prepare for, and support the integration of technology into schools. We then challenged the teachers to evaluate and assess the educational effectiveness of technology in their classes.

We approached this project by applying the same systems engineering principles that we use in our mainstream work. The accompanying table identifies some of the key principles and what we did to apply them in the Springfield schools.

In the resulting design, one classroom contains Apple Macintosh computers, and another contains IBM PC-compatible computers. This reflects the need to have access to educational software that runs on one or both of these machines. It also responds to the need to be able to mix

Applications of Systems Engineering Principles

BASIC PRINCIPLES	WHAT WE DID
Focus on Working Directly with the Real "End-Users" Classroom teachers are the key to success and should decide how technology will be used in their classrooms.	**Sponsored a Technology Workshop** In summer 1992, we brought 16 Springfield teachers to MITRE for a one-week technology workshop, to expose them to information systems technology and to stimulate their thinking about how that technology might be used in their classes. The teachers represented all academic disciplines, including vocational education, and came from high schools and middle schools. **Solicited Proposals from Teachers** In fall 1992, we invited Springfield middle school and high school teachers, either individually or in teams, to submit ideas on how they would like to use technology in their classes. The primary criteria were educational effectiveness and the effective use of technology. A joint MITRE/Springfield "source selection board" chose a proposal submitted by two High School of Commerce teachers: a French teacher and a social studies teacher.
Match Technology to End-User Needs and Objectives Before buying anything—to create cost-effective solutions that meet user needs—apply an overall "systems approach" to the selection of technology by conducting a formal design phase.	**Conducted a Design Review** In fall 1992, before putting any hardware or software into a Springfield school, we spent six weeks working with the two winning teachers to help them determine, in detail, what they wanted to teach, how they wanted to teach it, and what kinds of technology would best help them reach their goals. This drove our final selection and configuration of the equipment we installed in Springfield early in 1993.
Prepare the End-Users for Technology Give the teachers hands-on training—*and* the necessary technical support afterwards—so they can use technology easily and effectively.	**Conducted Teacher Training** Before any equipment was installed, we provided more than 240 hours of instruction for the two teachers, neither of whom had had any prior experience with such technology. We tailored the training to their needs and provided both group and one-on-one tutoring. **Provided Follow-Up Technical Support** We continued to work closely with the teachers after we installed the equipment. To date, we have provided more than 850 hours of training and technical support. Using a cadre of MITRE volunteers, we also developed software packages to aid the teachers' instruction. We installed *La Forme Physique* in the French teacher's classroom to help teach French vocabulary, and built a "secure desktop" for the social studies classroom to prevent accidental or malicious tampering with the computer configuration, software, or data.

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and match products from different vendors. Each classroom contains one "teacher's workstation" and four "student workstations." Each student workstation serves a small group of 3–5 students and reflects the teachers' desire to support a cooperative learning method of instruction. The workstations are interconnected by local area networks (LANs) and share a laser printer that supports both the Macintosh and PC computers. The teacher's workstations include an overhead projector with an LCD display panel for class instruction and demonstrations, plus a modem to permit connection to Minitel (the French on-line computer service), Prodigy, and the Internet. Since video services are an important part of the "operational concept" for the project, each classroom has a 27-in. television and a VCR. The teachers share access to a camcorder.

Promising Results

Results, to date, have been encouraging. We began in spring 1993 with approximately 150 ninth through twelfth grade students in 10 classes. Now, about a year and a half later, the technology has already changed the teachers' instructional approach.

Although there is little hard data to evaluate the project's overall effectiveness, the anecdotal evidence is very positive. Technology has become a "hook" that attracts students. Attendance in the technology-enhanced French and social studies classes has increased. This is significant in a school where 20 percent of the students are absent on a normal day and where 40 percent of the students drop out before graduating. Students want to stay after school and come to school on Saturdays to use the computers. Enrollment in the French classes increased by more than 50 percent in fall 1993, the first new academic year after the technology was installed. These results suggest that the students are ready, willing, and eager to use technology in their classrooms. All they and their teachers need are support and encouragement.

The Education Exchange highlights the experiences of scientists and engineers with local schools, along with helpful hints and resources. If you would like to share your own involvement in science education, contact: Finley Shapiro, Department of Electrical and Computer Engineering, Drexel University, Philadelphia, PA 19104, U.S.A. Phone (215) 895-6749; fax (215) 895-1695; e-mail: shapiro@ece.drexel.edu.

Looking Ahead

Using our results from Springfield as a model, we have begun working at the state and national levels to help apply modern technology in K–12 education. Two of the things we think are important in promoting the large-scale use of educational technology are:

- A family of technical specifications and standards (not instructional content standards) for educational technology products such as software and multimedia materials. These standards would make it easier for schools to select, install, use, and maintain such products. They could also create a common framework for the development of new products which, in turn, could stimulate industry to invest in developing such products at prices that schools can afford.
- Regional consortia of school systems to promote the use of educational technology, share in the development of new applications, and promote the reuse of products and efforts that have proven to be effective in individual schools or school systems.

BARRY HOROWITZ and NELSON BOLEN

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HISTORICAL NOTE

Lines of Communication

Cables used to transmit telephone calls, telegraph messages, or pictures (e.g., closed-circuit television) are designed for low voltages and small currents. They contain one or more current-carrying conductors, isolated by a surrounding insulating material.

The telegraph, invented in the 1830s, was the first system designed to use electrical impulses to transmit messages. As the use of telegraph cables spread across the United States—usually lengths of bare, hard-drawn copper wire supported on insulators are mounted on poles—an entire wire and cable industry was developed to support the undertaking. Within thirty years, most major American cities were connected by telegraph lines, and messages were transmitted over long distances in minutes.

Many attempts were made to lay down undersea telegraph cables, but insulation materials suitable for enduring immersion in sea water could not be found. Tarred rope, split rattan, india rubber, and impregnated cotton were all found unsuitable. Finally, in 1848, Ernst Werner von Siemens used the gum, gutta-percha, from a Malayan tree to successfully insulate a line transmitting signals to detonate mines in Kiel Harbor in Germany.

Two years later, on 28 August 1850, the tug *Goliath* laid the first submarine telegraph cable between Dover and Calais: 25 miles of a single conductor surrounded by gutta-percha insulation. Though this cable soon failed, its English creators—Jacob and John W. Brett—succeeded in 1851 with a second cable. This cable, consisting of four copper wires and gutta-percha insulation, remained in use until 1875.

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