Building a Better Workforce through Improved MSE Education

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INTRODUCTION

With enrollments stagnating and technology demands growing, colleges and universities may need a new approach to sustaining their materials science and engineering (MSE) programs and, in turn, feeding the U.S. MSE workforce. Instead of waiting for students, they may have to seek them out. Anticipate their needs. Wine them. Dine them. Dazzle them. Enroll them.

Creative methods for improving materials science education, boosting student enrollment, and meeting the needs of technology-oriented industries were offered during the symposium Materials Education to Revitalize the Workforce at the 2004 TMS Annual Meeting on March 17 in Charlotte, North Carolina. The event was sponsored by the TMS Public & Governmental Affairs Committee and the TMS Education Committee.

TO INSPIRE THE STUDENTS, INSPIRE THE TEACHERS

The statistics have become old news: enrollment of U.S. students in science and technology programs at U.S. universities is lagging while attendance by international students is rising. Those international students tend to apply their knowledge in their home countries, not in U.S. business and industry. In the United States, knowledge has become an export.

To attract U.S. students into MSE programs, interest must be piqued when those students are young and have yet to choose their career path, participants in the symposium agreed.

“A lot of times kids are not interested in science, and it’s our fault as scientists,” said Robert A. Childs, president of the American Vacuum Society (AVS) and a professor at the Massachusetts Institute of Technology (MIT) Plasma Science and Fusion Center.

Childs, in his presentation “Making Science Exciting for the Future Workforce” suggested that scientists, educators, and professional societies need to take the lead in stirring high school students’ interest. To reach the students, though, teachers need to be engaged. To that end, the AVS offers one-week workshops in which teachers do hands-on activities, attend lectures, work on teams, and learn vacuum science. Their costs are covered by the society. And when they return to their schools, they take vacuum systems with them to use in their classrooms.

“The payoff comes weeks and months later when teachers get those vacuum systems and start using them,” Childs said. “They can develop programs that go beyond what we taught them, then conduct mini-workshops in their districts and regions.” Often, he said, the vacuum systems find their way into student science fair projects.

For younger students, an MIT initiative teaches about magnetism with “Mr. Magnet.” Graduate students work with groups of about 80 students in grades 3–7, teaching magnetism concepts through fun, hands-on activities. Last year, Childs said, the program reached about 30,000 students.

“Schools are excited by this, they are hungry for this information,” Childs said.

In a similar effort, the University of Florida offers Materials Science and Engineering for Teachers, or MSE Teach. This one-week summer school for high school and community college science teachers offers lectures, labs, tours of local factories, and science lessons using everyday objects, said Paul Holloway of the University of Florida. In an always-popular reverse engineering exercise, electronic items such as portable cassette players are disassembled. Teachers experiment with the formation of martensite on a hairpin, learn of the existence of shape-memory alloys in eyeglasses, and practice smelting with propane torches.

The goal of the program is to put abstract science principals into real-world context, Holloway said. “High school teachers need to know about
materials science and engineering,” he said.

Acknowledging that many high-school students are uninformed about career options in science and technology, TMS hosts an on-line Career Resource Center, said Gerald Leidl of Purdue University. The web site defines MSE, describes materials in everyday life, and offers career information. The on-line information is enhanced with a booklet, video, and CD-ROM, all available for sale (Figure 1).

Launched in the late 1990s, the Career Resource Center achieved an average of nearly 5,000 hits per day in 2003, Leidl said. To keep the information relevant, the TMS Education and Student Affairs committees are planning to update the content, he said. Work on the updates could begin within the year.

**KEEPING UNDERGRADUATES INTERESTED**

At four-year institutions, too, MSE programs must adapt and remain current to hold student interest, said Carl C. Koch, a professor of materials science at North Carolina State University. “MSE will develop major biologically related components in both research and teaching,” Koch said in his presentation on “Materials Science and Engineering Education, Its Continuing Evolution.” “MSE will become ever more essential as an enabling discipline for other engineering disciplines.” The danger of this evolving focus, however, is that students will be exposed to too much educational breadth, he said, and not enough depth.

At MIT, depth was added to undergraduate MSE studies through an effort to revitalize a languishing program. Enrollment had been steadily declining, said Donald Sadoway of MIT, and students were dissatisfied with the program. “They found the program boring, too easy, and that it lacks rigor and interest. They feel that faculty place the lowest priority on the undergraduate program.” In the well-publicized world of national rankings, MIT’s MSE program was not even a contender.

“We used to be number one, now we’re not even on the chart. You can’t charge top dollar and not be on that list,” Sadoway said.

To breathe new life into the program, Sadoway led a committee that revamped the undergraduate program. Faculty teams worked together to develop syllabi for suites of subjects to be taught within the same time block. The coursework was developed to be complementary in areas such as math, lab, and professional development. New content was added on biomaterials, chemical synthesis, and electronic materials characterization. Core technical knowledge was divided into three blocks: synthesis and processing, composition and structure, and properties and performance. With refreshed materials, a new type of schedule was established. The students begin with a one-week orientation to materials science history, trends, and career options.

“We want to motivate them to study the fundamentals,” Sadoway said. “Previously they were in a thermal class on the first day of school.”

Then the coursework begins with intensive study of energetics of a material system, structures, and math. After three weeks, that study stops and a week of a laboratory work begins to unify the material taught so far. As part of the lab, students learn methods of communicating their work including writing a technical paper and presenting their work.