PUTTING IT INTO PERSPECTIVE

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Two years ago, the state of New Mexico was looking to overhaul its system of supplying unemployment insurance to 72,000 claimants each year. The system was paper-based; information was entered into a 30-year-old mainframe, and field officers had to travel long distances to collect and verify information.

New Mexico's Department of Labor did not have the IT expertise to create a new automated system for processing claims. The work had to be contracted out. The state took bids from companies that would overhaul the workers compensation system. TRW said they could do the work for $18 million; IBM came in at $12 million. Both companies said the work would take about six years.

A third company, Tata Consultancy Services (TCS), also bid. The Indian company said it could do the job for about $6 million and could complete the work in 15 months. TCS used 110 employees to do the job: 30 in New Mexico and the rest in India. With a 24/7 operation and using a Web-based system of collecting data, TCS was able to save the taxpayers of New Mexico a significant amount of money and made the system of filing unemployment claims far more efficient.

The irony of the New Mexico case is that some of the people using the new system are, undoubtedly, out-of-work IT workers whose jobs have been lost to this type of outsourcing. The underlying question in the outsourcing debate was made very clear in the choice New Mexico made in picking a company to handle its unemployment insurance: Namely, are the savings and efficiencies that TCS brings to the table worth the loss of some American jobs? More importantly, is this an inevitable trend?

Raman Unnikrishnan, dean of engineering and computer science at California State University-Fullerton, says the trend is not only inevitable, it's not necessarily a bad thing. For Unnikrishnan, the nature of work in the new knowledge economy has changed in a fundamental way. "Instead of qualified people seeking work wherever work is available," he says, "work is seeking qualified people wherever they are."

The reason, Unnikrishnan notes, is that the products of information technology—whether that be computer code or reading X-rays or developing engineering plans for architecture—can now be transported around the globe with few costs. There are no transportation charges, no shipping delays, no tariffs. Traditional boundaries in the workplace have vanished. If a computer engineer can do useful work at $25,000 a year, and the same work costs a company $60,000 in California, the market will place that work in India, Unnikrishnan says.

“Outsourcing is a natural outcome of the information technology field,” Unnikrishnan says. “It is not going to end with IT or customer service. But that doesn’t mean that globalization is a bad thing. It is going to force the American science and engineering community to do what we have always done best. And that is innovation.”

The issue of outsourcing white-collar jobs to emerging markets like India, China, and Russia, among others, has become a hot-button issue of late. Gartner Inc., a high-tech forecasting firm, estimates that one in every 10 software jobs will be moved overseas by the end of 2004. Forrester Research, a marketing research firm, predicts that 3.3 million high-tech and service-industry jobs will move overseas by 2015, jobs that will provide $136 billion in wages.

A Change in Course?

While politicians and economists wrangle over solutions to the perceived problem, engineering educators wrangle over how to respond. The debate over this complex issue boils down to some simple choices. Namely, should U.S. engineering education continue to provide the basic science foundation for its students that encourages innovation—whatever that might be—or should engineering schools tweak their curriculum to provide their students the necessary nonscience skills to compete in the global economy?

“We have a tendency to overreact to the immediate crisis,” says Nino Masnari, dean of the College of Engineering at North Carolina State University, and a professor of electrical and computer engineering. “We have to continue to give our students the best scientific education. But we must always re-evaluate what an engineering education is all about. It boils down to the question of whether we are adding enough value to our students so the American companies will see that value and hire our students. Adding that value is key to re-evaluating our programs.”

The situation facing engineering educators is how to view the outsourcing problem. On the one hand, a variety of factors—the economic slowdown, vastly improved communication, routine IT work becoming commoditized – have led to the outsourcing boom. On the other hand, many engineering educators feel universities need to better emphasize the skills used in the new global economy—teamwork, systems over specific knowledge, and marketing.

“When I talk to CEOs from industry, they say they will observe young engineers that reach a career plateau relatively early, usually within about five years,” says Richard Miller, president of the Olin College of Engineering in Needham, Massachusetts. “It is not because they are deficient in some technical way. Instead, it is because they have problems in relationships with people. They may be working on a team where they have to deal with marketing and manufacturing people. They will be dealing more and more with the business office or a client.

“The people skills needed to work overseas are more important than ever before,” Miller continues. “Our graduates have to learn to be willing to accommodate and not offend. That’s hard enough to do when you’re sitting

across the desk from someone. It's even harder to do when your contact is primarily by phone or e-mail."

Miller suggests that American engineering schools must play to the strengths of our system in the new global economy. American engineers, he says, lead the world in two fundamental ways: innovation and the ability to recognize and improve systems. While India may be good at writing specific computer code, Germany excels at precision, and Japan at continuous improvement, American engineers excel at creativity, Miller says. "About the time we begin to lose jobs overseas, we change the game, and it makes the argument irrelevant," Miller says. "The business of being creative is fundamental to our long-term economic health. This creativity needs to be nurtured, needs to be emphasized, needs to be measured.

"The cultural and ethnic diversity foster this creativity," Miller continues. "This diversity is not replicated anywhere else around the globe. A diverse group of people has a better chance of recognizing opportunities. We need to encourage diversity, from within our own country, to having students from other countries study here. That flow of incredible talent really enhances the rate at which we innovate."

It is clear the globalization trend is affecting the job market for engineers in several ways. The first is that graduates with specific, individual skills will more than likely find that their jobs can be done as well and cheaper in emerging labor markets. For example, a student whose expertise is to provide improved ways to apply paint coats to an automobile may find that an engineer in Russia can provide the same service at one-third the cost. The second trend is that the traditional job promotion track, where an engineering graduate may spend his entire career with one company, is a thing of the past.

John Anderson, dean of engineering at Carnegie-Mellon University in Pittsburgh, says these trends make it necessary to change some of the ways that engineering is taught. In September 2003, Carnegie-Mellon convened a panel discussion of industry leaders and educators to discuss what specific recommendations might help students in the global economy. The conclusions were that students must be more multidisciplinary in their skills, and that working in partnerships within teams was a skill that most American companies prized.

"We're still ahead of the world in innovation," Anderson says. "And U.S. students still integrate science and engineering into systems better than anyone else. But we can do a better job in bringing a global awareness through business and humanities courses. The constraint is that we still have to provide a good, solid technical education."

Anderson suggests the general education requirements be changed to reflect the global marketplace. For example, some schools might require a course in economics but do not allow a business or marketing course to fulfill the requirement. Anderson also thinks studying abroad for a semester or two should be encouraged. In addition, partnerships with foreign universities, where students collaborate in teams via the Internet (Carnegie-Mellon has

such a program with Technical University at Delft in The Netherlands), should be implemented.

“Students need to have an appreciation of markets, what customers of technology really need,” Anderson says. “Increasingly, for U.S. companies, those customers and markets are in foreign countries. When we are talking about creating new technologies, we cannot only think in terms of the U.S. market.”

North Carolina State’s Masnari agrees that changes should be made in general education requirements to better meet the needs of students. “In the past, accreditation of an engineering program has been a bean-counting exercise,” he says. “With the new global marketplace, we need to have the flexibility to use the general education requirement to better serve the students. We should be able to better define what our programs offer. The onus should be on the institution to do this.”

Masnari also believes that teamwork is essential in the global economy, and that engineering schools can do a better job of teaching that skill. “We used to be very compartmentalized, everyone had their specific niche,” he says. “You basically worked within your own discipline. Today, the trend is toward larger and more complex projects. It is critical that students learn the skills of working within teams.”

The U.S. Department of Commerce, in a report released in June 2003, suggests that many companies want computer science and IT workers to have a better understanding of the business side of the business. Employers, according to the report, are stepping up their recruitment of people with M.B.A.s or master’s degrees who also have technical skills. Overall, 12.3 percent of IT workers hold a business degree. The ability to understand the business side, according to the report, provides “a deeper ‘foundational’ knowledge’” that “is likely to prepare them for technological change and learning new technical skills when needed, rather than just knowing the ‘skill of the day.’”

The challenge for engineering educators is to provide some of the “softer” skills required for the new global economy, without sacrificing the necessary “hard” science that drives innovation. At Olin College of Engineering, the curriculum is being “bundled” in ways that combine different courses within a team project. Students participate in a team-based project every semester for eight semesters. In one “bundle,” students study biology and business while completing an engineering project. Another bundle unites history, materials science, and engineering. “This teaches students how to work and use the resources of the team, across disciplinary boundaries,” says Olin’s Miller.

“We have quite an interest in entrepreneurial thinking and business,” Miller continues. “It is a practicum that is overlayed in much of what we do. Starting with freshman, we emphasize the ability to recognize opportunities. We want them to think about business opportunities and the relationship with technology. We’re trying to weave that into the engineering curriculum.

“The strategy might be better not what to teach, but how they learn,” Miller says. “You cannot teach every chapter in every book. You cannot cram sufficient knowledge covering everything into four years. It’s certainly a matter of balance. We need to look at how students learn, instead of perhaps what they learn. How to answer questions, how to integrate within systems, how to work in teams—those skills are important but aren’t taught in books.”

Labor’s “Manifest Destiny”

None of the engineering educators interviewed for this article believe that radical changes are needed for the new global landscape. Cal State-Fullerton’s Unni-krishnan says that a historical view needs to be taken into account. “If we look at the 1980s and the technological scenery from that period, we were extremely despondent about the economy,” he says. “Japan was supposedly taking over the world, U.S. productivity was low, and trade was out of tilt with the rest of the world.

“But everything changed in a relatively short period,” Unnikrishnan continues. “Innovation led us to the boom years of the 1990s and into 2000, and Japan is nowhere on the scene, certainly not as an invincible economic superpower. The lesson we need to take is that innovation has made us great, and we are still the best at fostering creativity and innovation. That is our strength and will continue to be so.”

And that is precisely what makes the issue of globalization so difficult to get one’s arms around. The solutions being bandied about—protectionism, job quotas, trade restrictions—are precisely the policies that tend to discourage innovation. However, no one knows where and when innovation will rise up. In 1990, very few could have predicted the Internet would have such a vast impact on the world economy. And it is difficult to predict what the next big thing will be. Nanotechnology? Biomedical advances? Wireless systems?

Unnikrishnan points out that the outsourcing of lower-end jobs within science and engineering is a natural occurrence. “There was a fear that computers would lead to automation and cause unemployment,” he says. “That never happened. What happened is that low-end jobs were taken over by computers, freeing people to do high-end jobs.”

Outsourcing, Unnikrishnan contends, raises companies’ profits, providing more money for research and development and ultimately raising our standard of living. “As long as the United States continues to remain ahead in leading-edge technologies, new jobs will be created naturally,” he says.

That, in essence, is the challenge for engineering educators within the global economy. Technology has changed to allow work to be done without the traditional boundaries of the workplace, in countries with lower wages. Some critics of the trend have called outsourcing “the manifest destiny of labor.” But as long as innovation and creativity are fostered within the nation’s engineering schools, newer technologies will be created, jobs will follow, and the economy will hum along. Certainly, some changes would be welcome to better prepare students within the global economy. But the real mission of science and engineering education—creating an environment for students to

dream and innovate—is still very much in the forefront of what engineering schools should do. Outsourcing of jobs in the new global economy will not change that mission.