NEW DEMANDS IN Engineering, Science and Technology

By John Brooks Slaughter, NACME President and Irving Pressley McPhail, Executive Vice President, NACME

This is a critical time for our nation. Thirty years ago American corporations com-peted with one another. Today's competition is on a global scale. Among other things, corporations that depend upon a position of leadership in research and development in science, technology, engineering and math (STEM) must confront the reality that the sources of brainpower needed to maintain their preeminence are changing and that new and creative approaches will be required to ensure an adequate talent pool in the future.

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Given the tremendous progress in science and technology that is taking place in developing countries, the serious shortcomings of our public education systems, shifting immigration policies and the historic under-representation of sizable elements of our population, our nation must act quickly to maintain a strong position of leadership in the STEM disciplines and to ensure a future of prosperity and security. Preeminence in innovation and entrepreneurship will reside in the hands of those most adept at dev-eloping and retaining talent. Other countries, certainly China and India, are moving faster than we are. This is the dilemma facing our nation today.

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Huge changes have occurred in our economy largely as a result of globalization and technological innovation. Manufacturing has declined and the information age requires more professional and high-tech skills from employees. We find ourselves importing talent and exporting jobs, not just because it is less expensive to have the work performed by lower-wage skilled workers in developing countries but also because we do not produce enough scientists and engineers in our nation's colleges and universities.

The situation has been recognized and addressed by the highest levels of government and by corporations, foundations and academic institutions. Offshoring, outsourcing and increasing H-1B visa allotments either have been employed or are under consideration. But in the midst of the activity that has been inspired by widely-read publications such as Thomas Friedman's book The World is Flat and the National Academies' report, Rising Above the Gathering Storm our leaders seem to have lost sight of the fact that there are many persons in America for whom participation in science and engineering has been and continues to be less likely. And their numbers are growing dramatically. In the numerous calls for immediate, strong and broad action to address the problems that have been identified, too little attention has been given to the recognition that steps to

increase the presence of underrepresented minorities in the study of STEM courses could represent a part of the ultimate solution to the problem of the dwindling cohort of students entering the fields of science and engineering. (See Figure 1).

While outsourcing and offshoring may be here to stay, depending on foreign countries to fill our requirements is not a tenable practice in the long-term. Exporting jobs and importing talent do not constitute sound national policy. Certainly we need to develop a more rational set of immigration policies for those wishing to study and work in science and engineering. But perhaps even more important is the need to increase opportunities for native-born students to prepare for study in these disciplines. America will be unable to retain its leadership in scientific and technological innovation and keep its competitive edge in the global marketplace unless it does so.

THE NEW AMERICAN DILEMMA

To NACME and other organizations that focus on the needs and interests of underserved and underrepresented populations in science and engineering, the relative absence of African Americans, Latinos and American Indians in scientific and engineering study and careers is The New American Dilemma. The disparity in the representation of minorities


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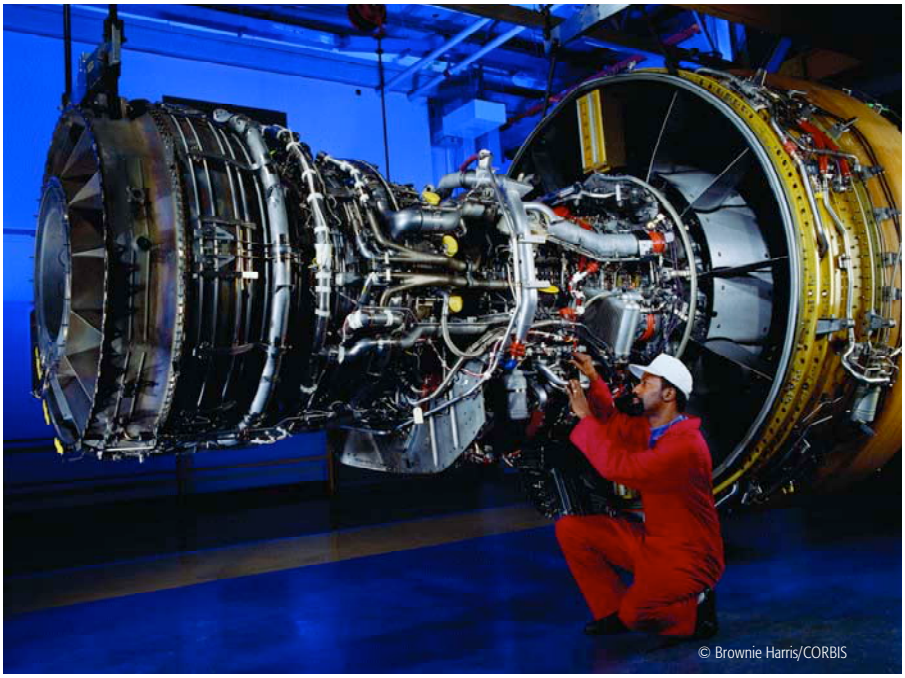
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and women is increasingly becoming a problem for the STEM disciplines. Figure 2 shows that African Americans, Latinos and Am-erican Indians constitute 30 percent of the nation's undergraduate students today, a proportion that is projected to grow to 32 percent in 2010 and 38 percent by 2025. Latinos will account for 90 percent of the growth. Engineering, in particular, has largely ignored the trends and failed to acknowledge that diversity drives innovation and that its absence imperils our designs, our products and our creativity.

As can be seen in Table 1, today, less than 12 percent of baccalaureate engineering graduates in this country are from underrepresented minority groups. Unless there are dramatic improvements in education at all levels, the number of American students prepared to enter the engineering workforce in the future will be too small to meet our nation's needs. Given that the number of college-age minority students will grow dramatically over the next decade, we must facilitate their entry and graduation to help meet the nation's needs. This is particularly true for the disciplines of science and engineering, key ingredients to America's ability to strengthen its capacity for innovativeness and global competitiveness.

It is a sad reality that over the past several years fewer young people overall are choosing to pursue careers in science or engineering. Sadder still is the fact that many of them are robbed of the option to even consider such a career before they have left middle school. We find ourselves at this moment in history with the number of engineering graduates at one of the lowest levels of the past 20 years. And this is occurring at the time when the demand for skills needed by America's high-technology industries has never been higher.

As shown in Figure 3, 690,000 minority students graduated from high school in 2002, but only about 28,000 had taken the necessary math and science courses to qualify for admission to engineering study. Approximately 17,000 of them enrolled as freshmen in engineering schools out of a total freshman enrollment of 107,000. There were about 7,500 black freshmen and a total of 23,000 black students in engineering programs in America's colleges and universities in 2002. The numbers have not changed appreciably in the intervening period. There are approximately 3,500 black engineering graduates each year. While the degree of preparation, enrollment levels, retention and graduation rates for non-minority students is somewhat better than that of their minority peers, their numbers are also


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well below the level necessary to meet current and future demands.

The overall picture is not pretty. As the current cohort of American workers retire between now and 2030, they will likely be replaced by individuals who are less educated and less prepared for the jobs they will inherit. Since the jobs expected to exist during that period will demand higher levels of skills and education, it will mean that fewer Americans will be capable of filling them. They will find themselves competing for work and losing out to recent immigrants and people living in foreign countries who are more skilled and willing to work for less money.

It is estimated that more than a half million engineers will be needed over the next decade to replace those who retire and that at least that many new engineers will be needed to fill the demand that will exist by the end of that period. The number of high-skill jobs available worldwide will reach 5.3 million by 2010 and nearly 20 million by 2020, according to the National Association of Manufac-turers. Who will be available to get those jobs? Craig Barrett, chairman of Intel Corp., says that unless American students change their attitudes, unless schools improve their math and science education, and unless the United States invests heavily in new technologies, it clearly won't be us.

OPPORTUNITIES IN STEM

It is hard to comprehend why so few young people are showing interest in the STEM fields given the omnipresence of technology in their lives. They are surrounded by and seemingly consumed with cell phones, MP3 players, PCs, PDAs, DVDs, VCRs and countless other devices, but show little interest in knowing how they are constructed or why they work. There are many reasons for this disinterest in technology. At least in part it stems from the fact that most students are not exposed to technology in their K-12 educational experiences. And too few are encouraged to explore technological activities or inspired to do so through contact with scientists or engineers.

This is particularly true for minority students, who are less likely to attend schools with strong STEM curricula and are often discouraged from taking those courses even when they are available. Furthermore, hardly any of these students are informed about the excitement and opportunities that can be found in the STEM disciplines. The scientific and engineering professions themselves must share the blame because it doesn't do enough to encourage and inspire young people to join them. A consequence of these failures is that enrollments in computer science and engineering programs declined for four years in a row from 2001 through 2005 and fell 10 percent in the 2004-05 academic year alone.

If students are looking for careers that will provide opportunities to make contributions to society, science and technology are replete with those. Opportunities abound in communications, networking and information technology, nanotechnology and the biosciences. Renewable energy, environmental sustainability, clean water and air, affordable and safe transportation, global climate change and many other issues crucial to the future of the planet are ones that scientists and engineers are tackling and will be addressing in the future.

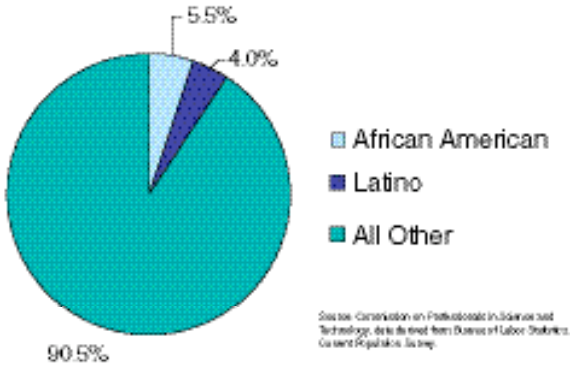
Globalization and the flattening of the world as described by Friedman present challenges as well as tremendous opportunities for today's college students. Those in science or engineering must recognize that they will have to meet a high standard in order to be successful in an environment where jobs requiring lesser skills are highly likely to be sent offshore to be performed by less expensive workers. Rather than feeling threatened by this realization, students must come to understand that terrific prospects for exciting and important work exist and those who are well prepared will be the ones who are selected to do it. Learning must become a lifelong pursuit. Technology changes too rapidly and scientific knowledge expands too quickly for anyone to rely upon yesterday's education to suffice for today or tomorrow. Students must see themselves as preparing for life rather than for a job.

To excel in the interdependent environment being created by the shrinking and flatter world, students must do more than acquire a strong scientific or engineering education. They must value learning outside their discipline as much as they value continuously upgrading their scientific and technical skills. They must also develop an appreciation and respect for other cultures, religions, languages and perspectives. They must be able to communicate well, work closely and effectively with others, respect differences and understand the importance of adhering to a strong code of ethics at all times.

This last point is critical for there are many potential conflicts between sci-

ence and technology and society and, consequently, there is a profound need for an in-depth appreciation for social responsibility in scientific and technological endeavors. This appreciation is not to be found in most courses in science and technology. It is best if those courses are offered in concert with material that exposes students to the study of ethical principles and human values. Without this grounding, the engineer or scientist is much like a machine that crunches numbers and produces answers without regard for their impact. A socially responsible engineer or scientist can interpret as well as investigate, evaluate as well as analyze, reflect as well as create.

Figure 1. Composition of Engineering Workforce, 2006



While the actual percentage of underrepresented minorities in the U.S. population is 28%, the number of underrepresented minority engineers in the workforce is less than 10%.

A COMMITMENT TO EXCELLENCE

Charles M. Vest, former president of Massachusetts Institute of Technology and now president of the National Academy of Engineering, once wrote that there are four qualities that he found to be essential for success in his MIT presidency: excellence, boldness, perseverance and optimism. These same qualities can be guideposts for students preparing for the exciting new opportunities in STEM.

A commitment to excellence is unquestionably important. This must be exhibited not only in their academic studies, but in all of their activities. Aristotle pointed out, "We are what we repeatedly do. Excellence, then," he said," is not an act but a habit."

Students must approach their tasks with earnestness and a conviction that each step they take must lead toward a goal they have set for themselves. They must have a clear sense of purpose. Above all they must begin with an intention to persevere. Perseverance, like excellence, is a necessity.

Success requires courage that can lead to bold decisions and actions that are just and right even though they may be unpopular and rebuked. Boldness, coupled with a commitment to excellence and a capacity for perseverance, is a necessary ingredient for achieving success.

And finally, President Vest wrote in his essay, "In the end, I believe that knowledge and skill trump ignorance, and that optimism trumps pessimism." It is critically important for all students — but especially minority students — to have sufficient levels of self-confidence and optimism to allow them to ignore the critics, and naysayers who would impede their efforts to achieve their goals.

Few fields offer the options and opportunities that are present in the STEM disciplines. Our nation's leadership role in engineering, science and technology can be retained and sustained only if there is a significant increase in the number of young people preparing themselves for careers in these fields. And minorities must become full participants in STEM education and employment if America is to prevail in this new era of global competition.

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