

“The Changing Higher Education Context”
REMARKS BY GEORGIA TECH PRESIDENT G. WAYNE CLOUGH
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It is an honor to join my distinguished colleagues, Presidents Casteen and Young, to consider the changing context of higher education. Let me point out that while I may not look it, I am the babe in the woods on this panel. Both John and Chuck have been presidents for much longer than myself and at two institutions each. On the other hand, I am the engineer of this bunch and have been both a department chair and a dean of an engineering college along the way. Since I have walked in your shoes, I am going to defer to John’s and Chuck’s experience and focus my comments about higher education from an engineer’s perspective. The title of my remarks might be “Engineering’s Role in the Changing Context for Higher Education.”

At the outset I would say that the opportunity exists today for engineering to play a larger role than ever before in higher education, and in society for that matter. After all, technology is more pervasive in education and society than ever before. But whether engineering positions itself to take advantage of its opportunities for broader leadership will depend on the decisions engineering education leaders make today. Whether our engineering graduates have the knowledge and skills to become leaders in this broader arena will depend on how we configure our curriculum and on our ability to attract talent from a student pool that is growing more diverse. It will depend on developing the ability to influence national policy decisions and to re-invigorate federal support for our cutting edge research endeavors. These are the issues I am working on with a group of colleagues in the “Engineer of 2020 Project,” an initiative of the National Academy of Engineering and its president, Bill Wulf. And I’ll say a little more about that later.

Our topic today is the changes taking place in and around higher education. There is no question that the world is changing, and those changes continue to have a major impact on higher education. I think we would agree on most of the drivers, although I believe many of them take on a unique twist when it comes to engineering. My list would include: Economics, especially for state institutions; technological developments; world events; federal and state policy decisions about higher education; trends in research funding; shifting student interests; changing demographics; increasing expectations and accountability; and the clash between the ponderous pace of university governance and the rapid pace of change in society.

Universities spent the nineties adjusting to dramatic changes thrust on us in the 1980s. Remember those meetings many of us had with our faculty and university

administrators about the Total Quality Management movement and how much of a stir that created? Just as TQM subsided and we were congratulating ourselves on completing the resultant changes, a new wave has broken on our shores, calling for more adaptation and in some cases for returning to the way things worked before.

If TQM takes you too far back, remember just a few years ago when experts like Peter Drucker and Jim Duderstadt were predicting that online learning would put traditional brick-and-mortar universities out of business? The Internet did have a dramatic impact on higher education, but many of the experts, and many of us, misread the tea leaves. Traditional universities used their resources and name recognition to gain a significant share of what turned out to be a distance learning market that works best primarily as a supplement to conventional face to face education.

Applications for admission to traditional universities have never been higher, and visions of hordes of students taking courses via distance learning are being replaced with the reality of hundreds of thousands on traditional campuses using the Internet to access information, make course support materials available, do campus business, and interact with fellow students and faculty. As these uses of new technology have evolved on our campuses, most universities have invested heavily in Internet-based technologies and dramatically altered the way they do business. So information technology and the Internet have changed us drastically, but in ways we did not foresee.

These are some of the forces driving the new context for higher education, and each one deserves its own discussion. In the interests of time, however, I want to focus on three issues that are unique to engineering and engineering education.

First, let's consider the trend lines in research funding. A robust research funding base is critical for engineering to develop the next generation of ideas and offer strong, well-developed graduate programs. Unfortunately for engineering, the end of the Cold War, the rising concern over health issues, and the increased pressure on industry to produce short-term profits have changed the context for research funding during the past fifteen years. The federal government has reduced its overall commitment to R&D, and federal funding has fallen from 1.5% of the Gross Domestic Product in the mid-80s to 0.6% in year 2000.

In addition to a declining level of commitment, the emphasis of federal funding has shifted away from science and engineering toward the National Institutes of Health and other health related agencies. Next year will be the last of a five-year congressional plan to double NIH funding. By that time NIH's R&D budget will be over \$28 billion, while

the budget of the National Science Foundation, which provides much of the federal support for engineering research at universities, will be a mere \$4 billion. A recent NRC report showed that federal funding for research in mechanical engineering dropped by 40 percent from 1993 to 1999. Electrical and chemical engineering also saw significant declines. During the past decade, many key fields in engineering have seen federal funding dwindle, and have either narrowed their scope or increased their level of industry-sponsored research.

While increased industry-sponsored research has helped many universities maintain and expand their research enterprise, it has also shifted our research toward short-term applications and product development and away from long-term, frontier research. Not only is fundamental research one thing we know we do well, but higher education is the nation's largest provider of the frontier research that serves as the basis for applied research and product development.

These patterns need to be examined to make sure we have a healthy and logical balance that will yield results in the short term, but also produce the kind of breakthroughs that often come from long-term research. President Bush has charged his Council of Advisors for Science and Technology, PCAST, to consider the balance of research funding, to review technology transfer systems to insure we are equipped to obtain the appropriate economic benefit from research, and to recommend which research areas need more support and which ones need less. Since I am fortunate to chair the PCAST panel on R&D, I can say with confidence we will look hard at the important areas that are not being appropriately addressed.

But study and recommendations are only the first step in a long process. It will be even more important to make sure key members of Congress understand these issues, since Congress ultimately appropriates federal funds. Engineers and scientists need to join forces and become more active in helping our governmental representatives understand the critical economic impact of science and technology research. We must make a case for engineering and science research support that addresses the big picture, not just one discipline as too often has been the case in the past.

The second factor that takes on a unique perspective for engineering is shifts in demographics and student interests. Engineering has done itself no favors by being slow to address these changes and failing to develop a coherent strategy that works consistently to grow the diversity it must have. We all know the data. White males will be the minority in the workforce of tomorrow, yet women and minorities are not being drawn to engineering.

Our failure to attract women and minorities is reflected in the declining number of engineering degrees awarded during the past two decades. Four years ago, the number of students majoring in parks and recreation surpassed the number majoring in electrical engineering, and the gap has widened since then. Women and minorities are increasingly taking seats in institutions of higher education, but we have not worked aggressively enough to recruit our share of these students. Affirmative action no longer provides an easy way to attract students, so we must develop new strategies to open our doors for women and minorities.

At Georgia Tech we are working with a group of leading universities in a program called EMERGE, which stands for "Empowering Minority Engineers to Reach for Graduate Education." EMERGE uses the web to link the universities, key corporate partners, and government agencies to students and teachers in K-12 schools as well as to minority students at universities throughout the nation. Students and teachers at any grade level will have access to information about engineering and science, see interactive learning experiments, and learn how to apply for summer programs, internships, college study, and graduate school. EMERGE is also building a system of links to faith-based institutions that are increasingly providing computer access to segments of society that have not been served by the Internet before. These institutions often are the keys to reaching the parents of minority students.

For the first time universities like Carnegie Mellon, MIT, North Carolina A&T, Morehouse College, and Georgia Tech will be able to reach out and directly touch students in places where they live and go to school. We believe we can encourage greater interest in engineering and science and help improve the pool of qualified students. EMERGE is one example of the kind of innovative thinking that we need more of if we are going to truly make a difference in the numbers of women and minorities participating in engineering.

Finally, I would like to comment on engineering education as it relates to a changed future for higher education, and the role engineering educators should take in their universities. More than 50 years ago Saul Belilove wrote an article in *The Journal of Higher Education*, in which he envisioned a world of rapid technological change and widespread use of technology. And he predicted that our society would increasingly need the leadership of engineers in broader roles for which a purely technological education would not provide adequate preparation. It is imperative, he wrote, "that their sense of responsibility and their ability to contribute to the spirit and life of our civilization be consistent with the great powers they will wield... Engineers," he said, "must become adept statesmen in dealing with economic and social problems."

The same year he wrote those words, he founded Belilove Engineering in East Bay, California, and over the following decades, he saw the world he had envisioned take shape around him. Technology has assumed a more central role at the core of society, the interaction between culture and technology has become much more significant.

Over the course of the past century, we have invented and put to use a wide range of incredible technology in a rather decentralized, disjointed fashion. Now we are taking a look around us and realizing that the world in which we live is largely a product of all of those disparate engineering efforts. And the engineering decisions we used to regard as unrelated to social, political, and economic concerns have in fact become tightly interwoven with them. Technology and social change have become a double helix – two strands that are inextricably intertwined.

If we had taken Belilove's advice and looked to the future, we would have broadened engineering education beyond its technical aspects to help engineers become more useful to society. The NAE initiative, "Engineer of 2020," I mentioned earlier is bringing together creative minds to anticipate possible scenarios for the future, so that we can design our educational experience to graduate engineers who are better prepared for that future. It is my honor to chair this two-year initiative. But it is important to note that it derives from the engineering education committee of NAE, chaired by Steve Director, dean of Engineering at the University of Michigan and a member of this group, and the work will ultimately conclude with a focus on engineering education and its future.

We can make some reasonable guesses about some of the outcomes. George Fisher, chairman of Eastman Kodak Company, recently wrote in NAE's *Bridge* that "Integrating human needs is engineering's biggest challenge." Our goal should be to educate engineers who not only exercise technological skills, but also use technology to help lead society to a new level of prosperity and quality of life. At Georgia Tech we are introducing a series of leadership classes and exercises that will cross the curriculum for engineers as well as for the other majors on our campus. Every student will be offered opportunities to learn about leadership and to practice it.

Engineers of the 21st century will also need a higher level of awareness and sensitivity to diversity and cultural differences, and an ability to work across cultures. Even if our graduates never leave home, they need to be prepared to work as part of an international team that collaborates and shares work electronically around the globe.

The Boeing 777 on which some of you may have flown to get here has more than 132,000 uniquely engineered parts that were designed by hundreds of suppliers in 12 different nations using compatible software on networked computers. This kind of

international technological collaboration will increasingly characterize the work of engineers, and it means that we must become more knowledgeable and sensitive to broader differences in culture, in custom, and in the way business is conducted around the world.

Our engineering graduates also enter a world in which intangible assets are as important if not more important than tangible material assets, as Jeremy Rufkin points out in his book *The Age of Access*. The currency of the 20th century was physical goods and its measures of value were weight and property; the currency of the 21st century is information, ideas and service, which are weightless. The cell phones and computers that engineers design are often deeply discounted or even given away as part of a service contract with a service provider. It is the service that contains the value, not the product. Engineers must pay more attention to the end use of the technology they create.

Technology is also a driving force in public policy, and engineers need to play a greater role in informing and shaping policy decisions. It is not a stretch to say that if good engineering analysis had been applied to California's energy deregulation plan, the outcome would have been completely different. Our elected leaders have too little time to learn about complex issues in depth, particularly those as complex as energy deregulation, but how many times do engineers, who do understand complex technical issues, take an active part in public policy debates? How many engineers have the educational experience that prepares them to do that?

Environmental sustainability is another issue that calls for engineers to exercise their expertise in a broader social and cultural context. Recent news stories have reaffirmed that political solutions to problems like global warming are very difficult. Political solutions inevitably call for someone to make a sacrifice, and nobody wants to volunteer.

Engineers can step into the breach by creating sustainable technology that helps to reconcile the conflict between economic development and environmental conservation without short-changing either one. But that requires a new breed of engineers who view their profession through the prism of sustainability, and concentrate on designing products and developing manufacturing processes that do not destroy the Earth even as they try to improve it.

Sadly, public perception surveys show that 85 percent of the general public believes scientists can help solve our environmental problems, but only 5 percent believe engineers have a role to play. In a lot of respects, engineering is a "stealth" profession.

At best, most people know that engineers design engines and their components. We need to participate in the highly visible “front room” activities where public policy is decided, as well as working in the “back room” to develop the technology that will solve society’s larger problems.

These examples touch a few of the broader economic and social issues that we need to understand and address if we are to create a curriculum that will produce an engineer who is prepared for 2020. We are now educating the engineers of the future using a model from the 90s which we developed in response to the changes that engulfed business and industry in the 80s. We are still reacting to events of 20 years ago rather than anticipating the future and preparing for it.

The changing context for higher education places engineering education on a balance point. Whether it is through enhanced research activity, opening our profession to all elements of society, or educating a new generation of engineers with a broader view, the lessons of the past show us that we must take the initiative and not wait for events to occur that will control us. If we take positive action, engineers can become participants on a larger stage, and in the process, elevate the value of engineering to society and enhance its view of the profession.