

Appendix B: Science, Technology, and America's Future

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Our nation can succeed in the 21st century only through its mind power and technological innovation, not through geographic advantage, inexpensive labor or military might. Innovation is the key to productivity, and therefore to jobs, health, security and quality of life.

Indeed, technological innovation has been responsible for 50 percent of the growth of the U.S. economy during the last sixty years. Technological innovation is driven by basic research.

Today, our universities are our primary source of basic research, because industry now does very little R&D with a long time horizon. Technological progress must be underpinned by such basic research.

And, even more to the point, our universities are also responsible for educating the next generation of scientists, engineers, managers, entrepreneurs, doctors, and leaders.

Indeed, we have a national innovation system—a loosely coupled alliance of universities, industry, and government that create new knowledge and technology through research; educate young men and women to understand and apply it; and use it to create new products, processes, and services and move them into the marketplace.

But the effectiveness of our universities as engines of innovation and prosperity can be maximized only if we engage talent, mind power, and perspective from our diverse citizenry.

How we engage this diverse citizenry in science

and engineering is the question that has brought us together this morning.

I have been asked to share some thought in this regard from the perspective of academia.

The thoughts are my own. They are not very original, but I hope they will be helpful to our deliberations—deliberations that I believe are crucially important.

Why We Need Diversity

Many of us observe and believe that diversity of our student bodies contributes to the richness, relevance, and effectiveness of the education of all college students. This is validated by various studies. But I do not intend to elaborate on that point, as important as it is, because today we should concentrate on our roles and responsibilities regarding the diversity of America's future workforce and leadership in science and engineering.

I would like to state a number of personal observations and views that frame how I think about the matters we are here to discuss today.

1. Our reason for gathering here is because we believe that we have a major and important responsibility to our nation—creating the STEM workforce and leadership of the future, and maintaining U.S leadership in science and engineering in an age in which our ability to have a vibrant economy, be secure, and enjoy good health and quality of life will almost certainly require such leadership.

2. The percentage of U.S. students entering college and university intending to major in science and engineering has been steadily declining for many years.
3. The fraction of those who as freshmen intend to study science or engineering, but who move out of these fields before graduation is also increasing.
4. African American, Hispanic American and Native American students follow all these same trends, but the fractions are substantially worse in each.
5. A diverse technical workforce in American industry is more likely to conceive, design, and develop products, processes, and systems that perform well in the market place formed by the increasingly diverse U.S. population.
6. Non-U.S. citizens now dominate PhD programs in science and engineering.
7. To take a specific example: We are not generating the necessary science and engineering talent and expertise for our defense departments and industry. Much of this work is properly restricted to U.S. citizens, and the government cannot accept many of its components being designed and manufactured in other countries.

In my view, it follows from these and other conditions that we must work hard to inspire and attract more of America's most talented young men and women into these fields, and we must create educational environments that enable them to develop their talents to the fullest. We cannot achieve this goal if we leave women, African Americans, Hispanic Americans, Native Americans, or any other group behind.

Yet in my experience, and in my examination of decades of data, it is an inescapable conclusion that there are real or perceived barriers to attraction to, entrance into, and success in science and engineering that are statistically unique to each of these groups. These barriers to attraction, entrance and success have complex historical, societal, and psychological origins that cannot be denied or ignored, as much as I wish that were not the case.

The history of slavery and race in our country, the disproportionate poverty in these groups, self perception of some members of these groups, societal messages that lower the attractiveness of STEM careers, and, above all, the failures of our K-12 system for many of these students all create a situation in which we find that:

1. Disproportionately fewer minority students are attracted to science and engineering; and
2. On the average, minority students' performance, as measured by graduation rates or grade point averages, are lower than the cohort of Caucasian and Asian American students with identical academic potential, as measured by test scores, grades, etc when they are admitted.

From all of this I conclude that we—government, industry and academia—have a serious problem to solve for our nation.

We must increase the diversity of our future workforce and leadership in science and engineering.

This requires that we increase the attractiveness of STEM careers for young minority students; that we improve their path to entrance into universities, graduate programs, and the professions; and that we create environments that maximize their opportunity to be successful in fully developing their talents and expertise.

Solving the Problem

We have a problem to solve. We have a responsibility to meet. But the context in which we must meet this responsibility and solve this problem is complex, and frankly ill defined.

This context is the subject of intense philosophical, political, and legal debate and formulation. The ground continually shifts.

The rulings in the Michigan Supreme Court cases clarified parts of the context within which we must work. They confirmed that race may be taken into account in college admissions to build broadly diverse student bodies. And they confirmed the discretion of higher education to make academic decisions, including one of our highest academic responsibilities—selecting our students.

But they also raised many more questions than they answered as we think about elements of our solution space beyond the specifics of college admissions policy.

And the debates that preceded the Michigan decision, as well as the continuing political and legal attacks on various affirmative action and diversity-building programs, make our work today all the more important—and all the more difficult.

I am an eternal optimist. So I would like to start with the premise that the vast majority of people believe that a diverse American society is good, and that opportunity for inclusion and success of men and women in fields like science and engineering should be maximized. And that we are just divided in how we think this desirable state should be achieved.

1. Some believe that we can and should simply ignore race as a factor in how we think about, and work toward our solution.
2. Others believe that we cannot ignore race and must explicitly take it into account if we are to solve our problem.

Unfortunately, these views tend to be so strongly, emotionally, and politically held, that dialog is difficult, and common ground is hard to find.

All this is rooted to a large extent in political and philosophical constructs about how to map the interests of individuals against overall needs of society.

These chasms are great, but we can perhaps advance if we at least agree that we have a common goal, and that we must progress to that goal. The beauty —distant as it usually seems —is that if we succeed in solving the problem of full inclusion and success, then we will have arrived at a time in which we all agree that there is equal opportunity and inclusion for all, and we can stop arguing.

Simply put, if we truly level the playing field, the debates would be moot.

My personal views on how we achieve our goals are based on three things—my engineering background; my lifetime in higher education; and my observations of the participation of women in science and engineering.

Engineering Background

I am an engineer. This strongly influences how I approach problems. You formulate them; you attempt an approach to solution; you observe the results; and you improve your solution based on what you observe.

Even more basically, if a problem is to be solved, it must be approached directly, and not encumbered with artificial or unnecessary constraints.

Lifetime in Higher Education

When I began my career as a Teaching Fellow and then as a young assistant professor at the University of Michigan in the 1960s it was extraordinary if I had more than one African American student in my classes every couple of years.

In fact, it was extraordinary if I had more than one or two women students in a class. And if I had either, it was virtually assured that they would be one of the best two or three students in the class, because only through unusual drive and commitment would these students have come to study engineering.

In that context, when I think about MIT's current student body whose undergraduates are 42 percent women, 6 percent African-American, 12 percent Hispanic American, 2 percent Native American, and 28 percent Asian-American—a student body that is remarkably diverse in so many other dimensions as well—it seems to me that a miracle has happened.

But that is just the point. It is not a miracle. It is not a natural occurrence. It is the result of determined, conscientious effort, over more than three decades, often against seemingly insurmountable odds.

I can only conclude that despite the length of the journey, our nation is a better place than it was three decades ago.

It can be better still.

Women in Science and Engineering

As I said, MIT's undergraduate student body is about 42% women. This too is not the result of a miracle. It is the result of concerted effort starting about four decades ago, when that percentage was in the single digits.

How did it come about?

Explicit efforts across many parts of our society, government, industry and academe began to raise our sights that women need not be constrained to pursue only what were thought of as traditional paths. And yes, many women demanded that their rights be recognized, and their opportunities be expanded. Many of you will remember that the debates were nearly as divisive and difficult then as our continuing dialog about race is today.

In terms of engineering and science, many things happened:

1. Companies began to advertise for and aggressively recruit women. They created summer intern programs for women students.
2. Universities formed groups like the Society of Women Engineers.
3. Admissions and recruiting materials were redesigned to appeal to young women as well as young men.
4. In the early years there was explicit preference in admissions.
5. Universities mounted outreach and mentoring programs for girls in junior high school and high school. Corporations frequently funded these programs.
6. The importance of faculty role models and mentors for women was increasingly recognized.
7. NSF and other federal funding agencies created specific programs to encourage young women's participation.

Slowly but surely, undergraduate enrollment of women began to climb. Today, at MIT it seems to be moving asymptotically close to 50%.

These explicit efforts led to significant achievement, and in time, our experience has shown we moved to a point where there is no overall difference in the academic performance of men and women, and their representation in more and more fields, is reasonably in line with their proportion in the population, i.e. 50–50.

I think that there are lessons here that say “Stay the course” if you want to ultimately achieve similar results for minorities.

And why is there a difference? Why, in the same period of time has the progress of women outpaced that of minorities?

It seems to me that this is simply evidence that the barriers are higher for minorities, because of an even deeper historical societal bias, even deeper psychologies about success, even fewer mentors and role models, proportionately more poverty, proportionately more kids in inadequate schools, etc.

The lesson, in my view is still “Stay the course. It works.”

The Higher End of the Pipeline

Every university here today can show a set of enrollment graphs that are qualitatively similar. Plotting enrollments over 30 years or so, these graphs show:

1. Strong growth in the percentage of undergraduate women in science and engineering—nearing their percentage in the population.
2. Good growth in the percentage of minority undergraduates in science and engineering—but still significantly below their representation in the population.
3. Much more modest growth in the percentage of women in doctoral programs in science and engineering—less than half of their representation in the undergraduate population.
4. Extremely small growth in the percentage of minorities in doctoral programs in science and engineering—miniscule in proportion to their representation in the undergraduate population.
5. Substantial growth in the percentage of women in the faculties of science and engineering—but far below their proportion in either the undergraduate or doctoral student populations.
6. Very little growth in the percentage of minorities in the faculties of science and engineering—but far below their proportion in either the undergraduate or the already small doctoral student populations.

I cite these facts to emphasize that even as we progress with building diversity and success at the undergraduate level, deep problems remain. Improvement in undergraduate enrollment simply does not rapidly diffuse into graduate programs and then into our faculties.

Similarly, careers in government and industry that lead to full inclusion and technical leadership require that we work hard and overtly to improve our graduate populations and make faculty careers viable and attractive.

We all know the metaphorical pipeline.

There is no question that the worst, most leaky part of this pipeline is in the K-12 system.

But we are directly responsible for the higher end of that pipeline, and I believe that we need to work hard on our own responsibilities. We cannot blame everything on the segments of the pipeline below us.

Race is a Factor

As I noted earlier, a kind interpretation of the public debate suggests that some believe that we can and should simply ignore race as a factor in how we think about, and work toward our solution.

Others believe that we cannot ignore race and must explicitly take it into account if we are to solve our problem.

Whether we are considering college admission, outreach to youth, fostering of diversity in our graduate programs, or just generally considering why students do or do not seek careers in science and engineering, I personally come to the conclusion that race is a factor. It cannot be ignored or wished away.

I see no evidence that proxies such as economic status explain away the influence of race. If one examines *The Shape of the River*, or similar studies, it appears that factors such as economic status attenuate the apparent effect of race in areas such as academic performance, but they do not erase it.

Let's consider academic performance and address an unpleasant reality. By academic performance I mean things such as graduation rate or grade point average. Every study of which I am aware, covering a variety of kinds of institutions show that there is a persistent statistical difference in the performance of underrepresented minority students relative to white or Asian students with statistically identical academic potential. That is, the average performance of the underrepresented minority cohorts is lower than would be predicted by standard test scores and performance in high school.

But if one looks deeper, one finds that the performance gap for minority women, while it exists, is far less pronounced than for minority males. Statistically speaking, these women went to the same schools, grew up in the same homes, had the same economic status as the men, but the average performance vs. the usual predictors is different. This does not seem to be the case for white or Asian students. To me, this indicates that we have a complex web of social and cultural factors involving race that cannot be wished away.

A Solution Framework

A question posed for this session by its organizers is:

If pre-college and undergraduate targeted programs are at risk, then is a “raising all boats” strategy likely to achieve academic goals?

This gets to the heart of the matter.

I believe that across most of American academia in the last two decades, generally speaking all boats have been raised. Imperfect though we may be, there has been a broad effort to improve the quality of teaching, learning and campus life in our public and private universities. A lot of innovation has gone into classroom and laboratory teaching, mentoring has been increased, the quality of facilities has gone up, investments in information technology have increased access to information and learning tools, and student support services have generally been improved.

All of these things properly enhance the environment for and chances of success of all students, regardless of race or any other characteristic.

But to the best of my knowledge, they have not erased statistical performance problems associated with race or removed the appropriateness of treating race as one of many factors in admissions.

It seems to me that we should simultaneously raise all boats and target specific services or support to groups who have a defined or observed need, including racial minorities.

The modest gains that have been made in the last couple of decades, especially in graduate enrollments and faculty appointments are fragile. In my experience they are largely driven by specific outreach and constant attention to seek out, inspire and support the best minority students. I have observed nothing in my career that suggests to me that eliminating targeted efforts will produce anything other than a reversal of gains.

We—academia, industry, and federal agencies -- have been called together today to think about how we continue to make progress toward the important national goal of an inclusive, diverse society—specifically in our own important, future-oriented fields of science and engineering.

Admissions

We were called together because one of the most important and divisive debates in public policy, politics and the law during the last several years has had to do with affirmative action in college and professional school admissions. The Supreme Court last spring made a very strong statement in this regard when it rendered its decision in two suits brought against the University of Michigan.

Our organizers posed this question: How do the Supreme Court decisions embolden or dilute current efforts?

Not wanting to practice law without a license, I will not attempt to directly answer that question. But I will tell you that from my perspective, it was a clear endorsement of the admissions practices at my institution, and that it gave me hope that when push comes to shove, our great nation usually manages to find a path grounded in principle, fairness and common sense.

Indeed, it reminds me of Winston Churchill's famous statement that the United States always does the right thing—after exhausting all the other possibilities.

So on the admissions front, I think we should indeed be emboldened to continue to pursue sound, fair admissions policies in which race is one of many factors that we consider when we make the complicated subjective judgments by which we select our entering classes from the portion of our applicants who are highly qualified by the standard measures to attend our institutions.

But other areas of academic activities find themselves in ambiguous and unclear political and legal environments. Let me speak specifically to programs of outreach to high school students.

Attracting and Inspiring

MIT, during the last three decades, has been a leader in promoting opportunity in science and engineering by reaching out to talented minority high school students. And more broadly, across U.S. universities it was engineering schools that tended to lead the way. In the early 1970s we established outreach and enrichment programs like MITE2S [Minorities In Technology, Engineering and Science] to attract young

Hispanic-American, African-American, and Native-American high school students to the engineering profession—a career that tended not to benefit from a high degree of awareness in their communities.

I don't believe that we saw this task as one of political orientation or ideology. We saw it as an important duty to the nation. We saw it as a problem to be solved—a design to be improved. It flowed naturally from our connection to industry. And private industry—U.S. corporations—provided, and continues to provide, much of the financial support and summer experiences that make these programs work.

Corporations have not supported these programs because they are liberals or conservatives, Democrats or Republicans. They support them because they understand the world is racially diverse. And if they are to understand their customers, produce well-designed, relevant products, and market them effectively, they need the perspectives and experiences of a diverse workforce and leadership.

But we also must contend with today's legal landscape.

During the last two years, we at MIT have learned this the hard way.

A complaint filed against us led to a review of two MIT pre-college summer programs by the U.S. Department of Education's Office of Civil Rights. The two highly valued programs are MITE2S and Project Interphase.

MITE2S provides intense education and career inspiration for high school juniors interested in science, mathematics, and engineering. Interphase is a bridge program for incoming MIT freshmen.

For most of the last three decades, these programs served under-represented minorities, inspiring them to study science and engineering and supporting their success in school and their pursuit of science and engineering careers.

We at MIT are very proud of the decades of accomplishment of these two programs. They have served over a thousand promising young men and women very well.

We pledge to you that they will continue to serve promising minority students in the future.

But, our rigorous examination, and the best advice of every legal expert we sought out, was unequivocal—and led us to conclude that we should not con-

tinue to limit participation in these programs exclusively to underrepresented minority students.

Therefore, we have broadened the selection criteria to include other students whose backgrounds may otherwise stand in the way of their studying science and engineering, and who can support the goals of the programs. And as we do so, we will find ways to continue to meet the underlying goal of fostering the education and opportunities of as many bright underrepresented minority students as possible. I am confident that with the help of our faculty and students, we will continue to exercise the leadership and build the programs that will do just that. And we will be as proud of these programs in the future as we are today.

But the fact remains that it is very distasteful to be pushed by the government to modify programs that have served our nation and our institution admirably for many years. These programs have created inspiration and opportunity for young people of color. They have not destroyed opportunity for any one else.

My fear, and presumably the objective of some others, is that over time, such defocusing and diffusion of effort will wear down the gains that universities, industry, and government have worked together for many years to establish.

So herein lie the dilemma and the confused environment in which we operate. We are expected by our society, and indeed by the federal government, to advance diversity and opportunity in science and engineering. We are given mandates by funding agencies to include outreach to minorities, women, and people with disabilities in our plans for various research programs and centers, and we are expected to produce results.

But at the same time, we are warned that targeting such efforts to the specific populations we are supposed to advance—in ways that we know work—may not be acceptable under currently extant interpretations of the law.

Our community is confused, troubled, and frustrated.

Yet our experience tells us that the inroads made by underrepresented minorities into higher education and careers in science and engineering are fragile, and have resulted from deliberate, concerted attention and actions. We must work together to determine the pathways by which we can continue the journey to a

diverse, inclusive, and excellent workforce and leadership in science and engineering.

This is our duty to the nation.

I am very grateful to all of you for coming together today to begin the work of clearing and clarifying these pathways, so that we can get on with a terribly important job.

In due course an aggressive but sustainable legal position must be forged that does not undermine the goals and accomplishments of our programs to increase the representation of minorities and women in our science and engineering student bodies and industry.

I have no expertise to bring to bear on the legal arguments. But I have tried this morning to share some observations and experiences that may be helpful in understanding what does and doesn't work, and to stand with you in reinforcing the importance of our goal. The law is a framework that evolves over time, and that enables us to work together for the common good. But at the end of the day, the law should serve our nation's highest purposes. And in my view that includes opening and encouraging careers and opportunities for success in science and engineering to the great, diverse population of America. To do less is to put our collective future at severe risk.

Thank you.

