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U.S. Competitiveness: The Innovation Challenge
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Introduction

Mr. Chairman and members of the Committee, it is a pleasure and an honor for me to testify before you today regarding U.S. competitiveness and the innovation challenge we face at home and from abroad. My name is Bill Brody and I am president of The Johns Hopkins University in Baltimore, Maryland.

Johns Hopkins was founded in 1876 as the first research university in America. For more than 125 years the university has committed its resources and energies to scientific discovery and innovation. Among the discoveries to come from Johns Hopkins are saccharine and Mercurochrome, transit satellites and cardiopulmonary resuscitation, gene splicing and parallel processor technology. Today, Johns Hopkins is the largest university recipient of research funding from agencies of the federal government, and for 25 years in a row has been the country's leading academic institution in expenditures in science, medical and engineering research.

I am also appearing today as a member of the Council on Competitiveness, and co-chair of the Committee's National Innovation Initiative. Members of the Committee are no doubt familiar with the role the Council plays in shaping the national discourse on business and economic competitiveness by assembling data, developing recommendations, and implementing follow-up strategies in every region of the country.

The Need to Innovate

In my work with the Council on Competitiveness I have been introduced to a novel concept: the calculus of innovation.

When we talk about competitiveness, what we mean is the capacity to increase the real income of all Americans by producing high-value products and services that meet the test of the world markets. It sounds easy, but of course as we all know, it’s not. Competition can be brutal. The need to be competitive with all comers is not an abstraction. It’s not some future worry we have time to ignore in the present. American economic competitiveness is a real issue, right now, one that’s tremendously important to us all. In recent years, productivity gains have accounted for about two-thirds of the annual growth of our gross domestic product. Much of this gain has come from innovation in the application of technology to business.

And this is where the calculus of innovation comes in.

The calculus of innovation is really quite simple:

Knowledge drives innovation;

Innovation drives productivity;

Productivity drives our economic growth.

That’s all there is to it. In the roaring 1990s, our knowledge enabled us to innovate, and our innovations increased American productivity, and hence, American economic growth.

But there is no guarantee that these productivity gains will continue. And based upon studies I have seen at the Council on Competitiveness, it looks as though the innovation pipeline is slowly being squeezed dry. If current trends continue, many of us on the Council believe there is a good chance that U.S. competitiveness in vitally important high-tech areas will fall behind that of China, India, and even a resurgent Western Europe. Here’s why:

First, we are losing the skills race. About one-third of all jobs in the United States require science or technology competency, but currently only 17 percent of Americans graduate with science or technology majors. By contrast, the National Science Foundation 2004 Science and Engineering Indicators report shows that the world average is 27 percent, Korea's average is twice ours, and in China, fully 52 percent of college degrees awarded are in science and technology.

By way of example, when Harvard polled its entering class recently, it discovered only one percent of their students expressed interest in studying computer science, yet information technology lies at the heart of many of our productivity gains.

Today, foreign graduate students studying science and technology in our universities outnumber their American counterparts. They're terrific students, but historically about 40 percent have left the United States after receiving their degrees. Policy changes since 2001 have made it more difficult to come to the United States, and more difficult to stay. But consider the talent we may be sending away: 35 percent of the doctoral degrees we award in the physical sciences go to foreign-born students, as do fully 58 percent of the engineering PhDs.

Europe now produces more than twice the number of scientists and engineers as the U.S.; and Asia about three times the number. Again relying on National Science Foundation data, the U.S. share of world bachelor's engineering degrees granted dropped in half during the 1990s: from about 12 percent in 1991 to six percent in 2000.

Second, and just as worrisome as losing the skills race, we are beginning to lose our preeminence in discovery as well. Historically, innovation in science and technology has been the direct result of investments in basic research and development. America's longstanding commitment to generously fund R&D has been a major driver of our economic competitiveness.

However, as a percentage of our overall gross domestic product, U.S. federal research and development spending peaked *forty years ago*-- in 1965, at just under two percent of GDP. Today, it is now down by more than half, to about 0.8 percent of GDP. And while government spending for medical research has increased, overall R&D spending, especially in basic sciences, continues to decline.

As you would expect, these numbers have very real consequences. Science and technology articles published in Western Europe already exceed those in the U.S. By 2010, it is anticipated that the emerging economies of Asia will produce more patents and spend more on R&D than the United States.

The Washington Post reported last week on the world's most competitive economy: Finland. It wasn't until Nokia surpassed Motorola and Japanese competitors to become the leading cell phone maker that many of us paid much attention to Finland. But we all know now that Finland is a world-class competitor. Two factors in particular seem to support their achievements: first, they have what is largely acknowledged to be the best educational system in Europe. Finnish students, when tested, are the world's best readers, and among the best in science and math. The second factor is that the Finns have an extraordinary commitment to research and development. The *Post* reports that through government and private industry, the Finns devote 3.5 percent of their gross domestic product to research and development, almost a full percentage point more than the total U.S. private and public research investment (which is 2.6 percent of GDP) and nearly double the average for Europe as a whole.

The lesson of Finland is the same lesson the United States taught the rest of the world in the past 50 years: investment in education combined with investment in research and discovery pay enormous returns. I believe--and Council of Competitiveness studies show--that investment in education and R&D is probably the single best way we can address some of our most persistent and difficult challenges.

For instance, we are all aware that our country has a huge trade deficit. We have lived with this imbalance for years, driven in part by our thirst for imported oil. But here too the recent numbers are worrisome. Since the end of World War II we have always maintained a positive balance of trade in high-tech exports. It has always been a source of strength. In 1980, for instance, the U.S. produced 31 percent of global high-tech exports; Japan produced 15 percent, and emerging Asia 7 percent. But by 2001, those numbers had turned around. Now the U.S. was producing only 18 percent, Japan 10 percent, and the emerging nations of Asia fully 25 percent of high-tech exports. Our once-positive balance of trade for high-tech items is now in deficit, and continuing to fall rapidly.

Declining leadership in innovation suggests our standard of living will decline as a result. Some say that has already happened. In fact, research by the Council of Competitiveness shows that the real income of many Americans did not improve even during the economic booms of the 1980s and 1990s.

Fueling Innovation

Knowledge drives innovation; innovation drives productivity; productivity drives our economic growth.

In order to master the calculus of innovation, promote economic growth, and support the genius for innovation and discovery that has been the hallmark of American prosperity for two centuries, we must reaffirm our national belief in the transformative power of knowledge. To do so, we should rededicate ourselves to both transmitting existing knowledge to the next generation through the world's best educational system, and continuing to lead the world in the discovery of new knowledge by aggressively funding research and development in all areas of science and technology.

In the remainder of my testimony I am going to draw extensively (and borrow outright) from the Council on Competitiveness National Innovation Initiative Report, *Innovate America: Thriving in a World of Challenge and Change*, which is one of the most succinct and prescriptive analyses I have seen of the challenges we face and the actions that we can take to ensure our future technological leadership and economic prosperity.

Talent is our nation's most important innovation asset, and so it is vital that we build the base of scientists and engineers working in this country at the frontiers of new discovery. Innovation capacity in a modern technological society depends almost entirely on a broad class of scientists and engineers who can imagine, and then implement, bold new ideas. But unless the United States takes action swiftly, the demand for science and engineering talent will soon outstrip supply. The number of jobs requiring technical training is growing at five times the rate of other occupations, yet the average age of our science and engineering workforce is rising, the number of new entrants into fields other than the biological and social sciences is static or falling, and the all-important perception of these jobs as being remunerative, important and exciting career options is declining.

Many of America's working scientists and engineers are products of the National Defense Education Act (NDEA) of 1958, passed in the wake of Sputnik. The NDEA sparked a half-century of remarkable innovation and wealth creation--and it may help explain why approximately 60 percent of the CEOs of the Fortune 100 have science or engineering degrees. In the knowledge economy, the ability to understand technology, and anticipate the technological foundations of growth, is becoming increasingly critical to every career path.

The trouble is, enrollments are moving in precisely the wrong direction. A quarter of the current science and engineering workforce in America is more than 50 years old, and many will retire by the end of this decade. New entrants into science and engineering fields are not replacing these retirees in sufficient numbers.

It is clear that the science and engineering problem begins early in the K-12 educational pipeline. We are losing our future scientists and engineers around the junior high school level. In the 4^{th} grade, U.S. students score above the international average in math and near first in science. At 8^{th} grade, they score below average in math, and only slightly above average in science. By 12^{th} grade, U.S. students are near the bottom of a 49-country survey in both math and science, outscoring only Cyprus and South Africa. Less than 15 percent of U.S. students have the prerequisites even to pursue scientific or technical degrees in college. And most have little interest in pursuing scientific fields. Only 5.5 percent of the 1.1 million high school seniors who took college entrance exams in 2002 planned to pursue an engineering degree.

This brings me to the first of two urgent priorities facing our nation at the start of the twenty-first century: **We need access to the best tech talent in the world**. And to assure that access, we must take immediate and deliberate steps to expand the pool of technical talent available in the U.S. This priority has two components.

First, we must nurture, encourage, and greatly expand our homegrown pool of talent. The science and engineering pilot program offered by Mr. Gordon of Tennessee is an imaginative and innovative approach to this problem that would establish a regional pilot program to improve scientific and technological skills of elementary and secondary school teachers, and to encourage those teachers to directly participate in ongoing research projects at national laboratories and research universities. I applaud this effort to bring the excitement and challenge of scientific research into our elementary and high school classrooms, to help stimulate a new generation of future scientists and engineers.

At the undergraduate level, financial incentives matter a great deal, especially given escalating tuition costs. The Tech Talent Bill, passed in 2002 by the House and largely incorporated into the 2002 National Science Foundation Authorization Act, addressed this issue by creating a class of incentives for universities to increase the fraction of students receiving undergraduate degrees in science and engineering. However, these NSF-directed programs have not been funded as authorized, so their potential impact remains unrealized.

The availability of scholarship money is a critical factor in the choice of majors. Recognizing this, the National Innovation Initiative proposes the creation of an "Investing for the Future Fund" which would be a national Science and Engineering scholarship fund created from private sector donations. The fund would create tax incentives for corporate and individual donors who support the next generation of innovators. The goal would be to provide a scholarship to any qualified student majoring in math or science at a four-year college who has an economic need and who maintains a high level of academic achievement.

Finally, in terms of homegrown talent, it is increasingly important that we reach out to under served and under-represented students. By 2020, more than 40 percent of college-age students will be of African, Hispanic, Asian, or other non-European descent. Currently, African Americans, Hispanics, and other ethnic and racial minorities account for only 6 percent of the science and engineering workforce--a figure far below their demographic presence. Women, who make up nearly half the total workforce, represent only a quarter of the science and engineering professions. If America is to strengthen its base of science and engineering talent, it must perforce rely on these, the fastest-growing segments of the workforce, to provide significant numbers of new scientists and engineers.

The second component of this need to access the world's best tech talent for our science and technology industries concerns foreign-born students studying in the United States. Two weeks ago I was in Singapore, meeting with the nation's senior economic development leader. In the course of our conversation we touched upon the role of foreign-born students in Singapore's universities and I was amazed when this senior official walked over to a blackboard and without notes wrote out a detailed summary of the numbers and nationalities of foreign-born students in his country. Singapore actively recruits the best and brightest students from many countries to attend its world-class universities. In exchange, they require the students to remain and work in Singapore for a specified number of years, and encourage these high-tech workers to stay permanently and contribute to Singapore's high-tech future.

It is important to recognize that, like Singapore, we are in a global competition for high-tech talent. Until only recently, there was very little competition. America didn't need a global recruitment strategy, because America didn't have to compete for the world's best and brightest talent. If you wanted to play in the game, you had to come to America. But today, this is no longer the case. Tens of thousands of bright students who used to come to America to study science and engineering now have many other options. In the case of China, in particular, the Chinese government has been investing heavily in their research infrastructure within their universities, making it much more attractive for Chinese nationals to stay home and study.

At Johns Hopkins, for instance, the number of graduate students enrolled from China has declined from 328 in 2001 to 178 in 2004. Meanwhile, the number of foreign undergraduate students of all nationalities has dropped from 381 in 2001 to 257 in 2004.

Consider for a moment how critically important foreign nationals are to our high-tech industries. Foreign students account for nearly half of all graduate enrollments in engineering and computer science at American universities. Foreign scientists comprise more than 35 percent of engineering and computer science university faculties, and nearly a third of our entire science and engineering workforce.

There are indications, however, that post 9/11 American visa policies are reversing decades of openness to foreign scientific excellence. Delays and difficulties in obtaining visas to the United States are contributing to a declining in-flow of scientific talent. Meanwhile, competitor countries are quite naturally taking advantage of our increasingly cumbersome visa process to lure top talent away. And with the strengthening of foreign science, there are many attractive scientific opportunities abroad to substitute for U.S. conferences, degrees and visiting scholar positions. The number of foreign students on American campuses declined in 2003-2004 by 2.4 percent, the first drop in foreign enrollments since the 1971-1972 academic year. This appears to be a trend. A survey of major graduate institutions conducted by the Council of Graduate Schools found a six percent decline in new foreign graduate enrollments in 2004, the third year in a row with a substantial drop. As one official of the International Association of Educators remarked: “The word is out on the street in China: You can’t get a visa to study in the United States.”

In the past two decades American retailers have pursued a policy of importing the best high-quality products from China and other countries to the benefit of American consumers. There is something to be learned in this model. We should have an explicit national focus on importing the brightest students from China and from countries around the world, and keeping them here afterwards as part of our high tech workforce. Make sure it’s easy for the best and brightest to come here, to stay here, and then to find legal residency to work here when their studies are complete. It is worth remembering that there is not a university in America that charges tuition at the full cost of educating its students. Even students paying full fare are heavily subsidized by endowments from grateful alumni, and from subsidies in many different forms from the state and federal governments. It is only fair in return to ask foreign national students to repay these generous supplements by asking them to remain and work here in the United States for a set period of time and contribute to our national economy.

This brings me to the second of the two urgent priorities before us. **We should greatly increase both government and private funding in research, with a particular emphasis on "far out" frontier research that has the potential of creating new industries and transforming how we work and live.** It's just like Dale Earnhardt Jr. would tell you--when the race gets tough, step on the gas.

Let me be explicit. I believe we need to fulfill our commitment to double the National Science Foundation budget to approximately $10 billion by FY 2007, as was previously passed by the House. We must significantly increase our basic research efforts in the physical sciences, in mathematics, and in the information sciences. And we should do this without robbing Peter to pay Paul by reassigning funds already designated for the life sciences through the National Institutes of Health and other agencies.

The doubling of the NIH budget has been a tremendous boon to biomedical research, and tremendous benefits will be seen in our lifetimes. We should not allow America's real and substantial lead in these fields begin to erode by slowly whittling away at these gains. In order to assure our continuing leadership we need to continue to increase our medical research expenditures at the rate of biomedical inflation, currently about 3.5 percent a year. Anything less than that is, effectively, a cut.

At the same time, we need to find ways to encourage private industry to be more accepting of risks in the form of transformative business practices and technologies, while removing all incentives to engage in the short-term, bottom line thinking that has unfortunately become a hallmark of too many American corporations.

In an innovation economy, intellectual capital is the engine that drives economic growth and prosperity. Investment risks and rewards are increasingly built around ideas. It is for this reason in particular that we need to revitalize frontier and multi-disciplinary research, the two areas that are most likely to bring about important new scientific discoveries and technological innovations.

Investment in frontier research has always been the bedrock of American innovation. Many of the country's most innovative industries were built on decades of research that had no discernable applications. The highly theoretical world of quantum mechanics spawned the semiconductor industry and the IT revolution. Department of Defense research engineers working on file-sharing techniques invented the Internet. Scientists researching atomic motion helped create global positioning devices. But serious flaws have begun to appear in our current efforts to support American research.

Perhaps most worrisome is the gradual shift that has been occurring away from bold, transformational discovery to incremental advances and improvements in current technology. For more than 50 years the United States has been at the frontiers of discovery, creativity and research breakthroughs. This kind of research has always been a governmental function, owing to the long time-frames, inherent risks and the difficulty of capturing returns on investment. But publicly funded research has been steadily moving away from the frontiers of knowledge, heading instead in the direction of application and development. The federal research commitment has grown conservative--increasingly driven by precedent, consensus, and incremental thinking. This is especially true at the Defense Advanced Research Projects Administration, or DARPA, which during the Cold War contributed research that brought about or significantly advanced microelectronics, weather and communications satellites, global positioning systems, passenger jets, supercomputing, the Internet, robotics, sensor technologies, composite materials and magnetic resonance imaging, among other advances.

To this end, the National Innovation Initiative supports the goal set in the 2001 Quadrennial Defense Review and by the Defense Science Board that at least three percent of the total Department of Defense budget by allocated for defense science and technology. Within this amount, the Department of Defense’s historic commitment to fundamental knowledge creation should be restored by directing at least 20 percent of the total Department of Defense science and technology budget to long-term, basic research performed at the nation’s universities and national laboratories.

In the twenty-first century, scientific advancement has blurred the lines between scientific disciplines, so that advancement in one area is furthered by development in others. For example, future products in life sciences are very likely to result from a combination of modern biology, nanotechnology, information sciences and the physical sciences and engineering. Over the past half century the United States has invested considerable sums in life sciences research and development, with remarkable results. But the rate of increase in R&D in other sciences has not been as robust. Although federal funding for the life sciences has increased four-fold since the 1980s, growth in the physical sciences, engineering and mathematics has been stagnant.

It is important we increase research and development investment across disciplines, because scientific advancement today is interdependent and collaborative. Research and development funding should not be a zero-sum game that simply shifts investment from one area to another as public fashion dictates. Rather, we need a comprehensive philosophy that brings investment in other disciplines up to the level at which the life sciences have thrived.

Federal spending on scientific and technological research is profoundly important. It is the bedrock upon which the structure of American innovation rests. But it is not the only component of our past and future achievements. Private industry too has a crucial role to play, and perhaps at no other time has the need for American business leadership and vision been more acute. But here too there are trends at work that should concern us deeply.

Norm Augustine, now retired CEO of defense giant Lockheed Martin, told me that when he was the CEO of Martin Marietta, the precursor to Lockheed Martin, he one day called in the analysts to announce a series of investments in research that he felt would propel the company way ahead of its competition. Much to his surprise, as soon as he had finished his presentation, the analysts ran out of the room, sold the stock and the price plummeted -- and continued to drop over the next 18 months. Puzzled about the negative reaction to this news, Norm asked one of the mutual fund analysts why the stock had dropped. He was told: "Everyone knows it takes 8 to 10 years for research to pay off. But our shareholders only hold stock less than one year. Our fund doesn't invest in companies like yours that have this kind of management."

The drumbeat of quarterly results are driving business decisions and drowning out long-term management, investment and innovation strategies. Today, investor patience is in short supply, and the traditional "buy and hold" approach to equity investments is being abandoned by the professionals. U.S. mutual funds are holding stocks for an average of just ten months, a record low, and annual turnover rates are 118 percent, a record high. As Norm Augustine discovered, these short investment horizons pressure CEOs to focus on near-term results. Not long ago, a survey of chief executives by Burson Marstellar found that their number one business priority was shareholder return. The category “Most Innovative” ranked eighth on the CEO’s list, and was a priority for only 23 percent of the respondents. Another survey of financial executives found that fully 78 percent would give up long-term value creation in the company in exchange for smooth earnings. More than half--55 percent--said they would avoid long-term investments that might result in falling short of the current quarterly targets.

Admittedly, it will be difficult to change Wall Street’s attitudes and habits. But it is terribly important to this country that we begin to try to do so. We can use the tax code to reward the behavior of companies that make significant research investments and take significant risks, just as we can find disincentives to short-term, bottom-line-only thinking. In doing so, we will make holding stock of innovative companies over the long term a more desirable investment, and our national economy more competitive.

Conclusion

The legacy America bequeaths to its children will depend on the creativity and commitment of our nation to build a new era of prosperity at home and abroad. The generation of new knowledge through research, and the transmission of existing knowledge in a world-leading educational system are the two essential elements of a productive and innovative society. Since World War II America has led the world in science and technology innovations largely because it was willing to make the considerable investments in both its educational systems and its research and development infrastructure that have enabled the natural creative genius of the American people (and visitors to our shores from all over the world) to flourish. If imitation is the sincerest form of flattery, we should be very, very flattered that so many other nations seek to emulate the methods of our success. But we also must be aware that today, as in no other time in our recent past, we are challenged by other nations equally determined to succeed. As Americans, we wish them ever success--except the kind that would come at our own expense. The race belongs to the swiftest. We must keep running. Thank you for giving me this opportunity to appear before you.

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