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U.S. COMPETITIVENESS: THE INNOVATION CHALLENGE

HEARING

BEFORE THE

COMMITTEE ON SCIENCE
HOUSE OF REPRESENTATIVES

ONE HUNDRED NINTH CONGRESS

FIRST SESSION

JULY 21, 2005

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U.S. COMPETITIVENESS: THE INNOVATION CHALLENGE

THURSDAY, JULY 21, 2005

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE,
Washington, DC.

The Committee met, pursuant to call, at 10:05 a.m., in Room 2318 of the Rayburn House Office Building, Hon. Sherwood L. Boehlert [Chairman of the Committee] presiding.

COMMITTEE ON SCIENCE
U.S. HOUSE OF REPRESENTATIVES

U.S. Competitiveness: The Innovation Challenge

Thursday, July 21, 2005
10:00 a.m. – 12:00 p.m.
2318 Rayburn House Office Building (WEBCAST)

Witness List

Mr. Nicholas Donofrio
Executive Vice President for Innovation and Technology
IBM Corporation

Mr. John Morgridge
Chairman
Cisco Systems, Incorporated

Dr. William Brody
President
The Johns Hopkins University

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HEARING CHARTER

COMMITTEE ON SCIENCE
U.S. HOUSE OF REPRESENTATIVES

U.S. Competitiveness: The Innovation Challenge

THURSDAY, JULY 21, 2005
10:00 A.M.—12:00 P.M.
2318 RAYBURN HOUSE OFFICE BUILDING

1. Purpose

On Thursday, July 21, 2005, the House Science Committee will hold a hearing to examine the relationship between federal science and engineering research and education investments and U.S. economic competitiveness.

2. Witnesses

Mr. Nicholas Donofrio is Senior Vice President for Technology and Manufacturing at IBM Corporation.

Mr. John Morgridge is Chairman of Cisco Systems, Incorporated, and part-time Professor at Stanford University's Graduate School of Business. From 1988 to 1995, Mr. Morgridge was CEO and President of Cisco.

Dr. William Brody is the President of The Johns Hopkins University. He has previously served as Director of the Department of Radiology, Professor of Electrical and Computer Engineering, and Professor of Biomedical Engineering at Johns Hopkins, and Radiologist-in-Chief at The Johns Hopkins Hospital. He is also Co-chair of the Council on Competitiveness National Innovation Initiative.

3. Overarching Questions

- How do federal science and engineering research and education programs foster innovation and contribute to U.S. economic competitiveness?
- How is the global competitive landscape changing, particularly with regard to innovation capacity, and what does this mean for future U.S. economic performance? What are the principal innovation-related challenges U.S. businesses face in terms of competing in the global economy?
- How can research and development (R&D) and math, science, and engineering education and training better contribute to the Nation's innovation system and the U.S. competitive position? What specific steps should the Federal Government take to ensure that the U.S. remains the world leader in innovation?

4. Brief Overview

- The importance of a strong scientific and technological enterprise as a primary factor in driving economic growth is well-established. Substantial and sustained U.S. investments in research and education over the last 50 years spawned an abundance of technological breakthroughs that transformed American society and helped the U.S. to become the world's dominant economy. Economists estimate that these technological advances have been responsible for up to half of U.S. economic growth since the end of World War II. The relationship between innovation and economic growth has only grown in recent years as the world shifts to an increasingly knowledge-based economy.
- While the U.S. continues to lead the world in innovation capacity—R&D spending, number of scientists and engineers, scientific output, etc.—recent indicators of the level of U.S. support for research relative to other countries show that this lead may be slipping. Overall U.S. federal funding for R&D as a percentage of gross domestic product (GDP) has declined significantly since its peak in 1965, and the focus of this R&D has shifted away from the

physical sciences, mathematics, and engineering—the areas of R&D historically most closely correlated with innovation and economic growth.

- At the same time, other nations—particularly emergent nations such as China and India—have recognized the importance of innovation to economic growth, and are pouring resources into their scientific and technological infrastructure, rapidly building their innovation capacity and dramatically increasing their ability to compete with U.S. businesses on the world stage.
- It has become increasingly apparent that the growing innovation capacity of foreign competitors, combined with the rise of the global economy and a relative erosion of federal support for innovation in the U.S., could present a long-term challenge to U.S. economic competitiveness.
- As a result, some industry and academic leaders have raised concerns that U.S. Government policy has been slow to react to the rapidly changing competitive landscape. In particular, calls from U.S. industry for a revitalization of the U.S. innovation system have become louder and more frequent. Numerous business associations representing nearly every industry sector are now calling on the Federal Government to respond to the competitiveness challenge by increasing investments in the science and engineering research and education.

5. Background

History of U.S. R&D Funding

Prior to World War II, the private sector funded most research and development activity in the U.S. Federal Government support was uncoordinated and targeted toward solving a small number of specific problems. The onset of the war led to a substantial (and successful) investment and effort to harness science and technology to meet the challenges of the war. In 1945, President Roosevelt's science advisor, Vannevar Bush, published a seminal report entitled *Science: the Endless Frontier,* which argued that continued and expanded public support for long-term, fundamental scientific research was as an important of investment in peacetime as it was in wartime, noting that building the knowledge base would ultimately lead to accelerated innovation and greater future economic growth.

In response to the report, Congress made support for civilian fundamental research a national priority, creating the National Science Foundation (NSF) in 1950. The Soviet launch of Sputnik in 1957 further broadened federal support for science and technology, resulting in the creation of the National Aeronautics and Space Administration (NASA) and significant spending increases on R&D and math, science, and engineering education. Another important response to Sputnik was passage of the *National Defense Education Act* in 1958, which provided unprecedented resources for math and science education at the elementary, secondary, and post-secondary levels. Together these events led to a dramatic shift in the Federal Government's approach to funding research and education. In 1935, the Federal Government support for R&D comprised only 13 percent of overall U.S. expenditures. By 1962, the federal portion had risen to 70 percent. Today, the federal portion has declined to roughly 30 percent, in part because of increased development funding by the private sector.

Role of R&D in Innovation

These efforts placed the U.S. at the forefront of innovation by building a massive U.S. R&D enterprise and educating the next generation of scientists and engineers. Ultimately, this paid significant dividends for the Nation. While economists are not able to precisely determine the economic impact of federal support for R&D, the advancements resulting from such support have undeniably transformed every aspect of American life. Computers, the Internet, lasers, jet aircraft and modern telecommunications are just a few examples of products made possible by federal R&D investments since World War II.

6. Issues

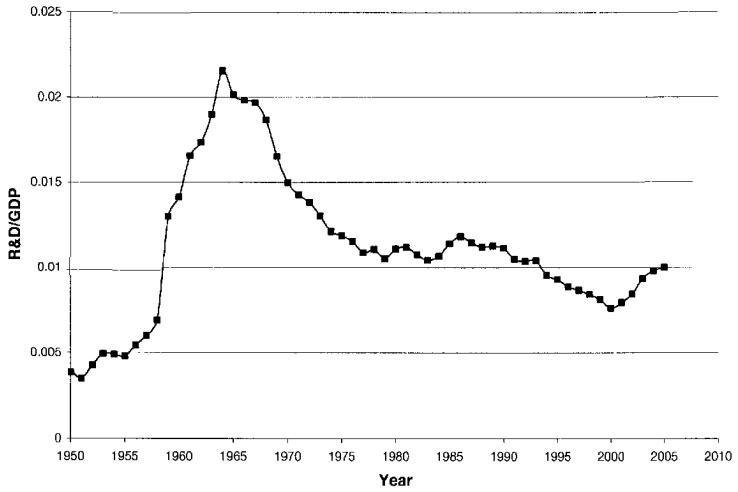
Overall Federal Support for R&D

The amount of the country's overall wealth devoted to federal R&D has declined significantly since the post-Sputnik surge in support for R&D. According to Office of Management and Budget statistics, in 1965, funding for R&D as a percentage of GDP (measured as outlays), also known as R&D intensity, was slightly over two percent (Chart 1). In 2005, it is estimated to be 1.07 percent.

While this ratio has recently begun to increase again, turning upward over the last five years, the majority of those increases have gone toward short-term defense

development and homeland security applications. For example, the Department of Defense (DOD) R&D increases alone—most of which have supported development projects that have very little impact on innovation or broader economic development—has accounted for almost 70 percent of the overall R&D increases of the last five years. Of the remaining increases, 75 percent has gone to the National Institutes of Health (NIH) and the Department of Homeland Security (DHS). At $71 billion and $29 billion, respectively, the R&D budgets of DOD and NIH now account for over 75 percent of all federal R&D. Meanwhile, funding for the physical sciences and engineering—the areas historically most closely associated with innovation and economic growth—have been flat or declining for the last 30 years.

Chart 1. Federal Spending (Outlays) on Research and Development as a Percentage of GDP, FY1950-FY2005. (Source: Office of Management and Budget Historical Tables, Fiscal Year 2006.)



The increased emphasis on short-term development at the expense of longer-term basic and applied research, as well as the emphasis on defense and biomedical R&D spending, has led many in industry and academia (as well as the Science Committee) to question whether federal R&D priorities are appropriately balanced to maximize innovation and ensure long-term economic competitiveness.

Compounding these concerns, the long-term outlook for the federal budget does not favor future increases in discretionary spending (through which almost all R&D is funded). Absent major policy changes, the growth in mandatory federal spending—primarily for health and retirement benefits and payments on the national debt interest—will demand a significantly greater share of the government's resources.

Shift of Private Sector R&D

During the heyday of the corporate research laboratory in the middle decades of the 20th century, U.S. corporate laboratories supported all stages of R&D, from knowledge creation to applied research to product development, and were quite successful in their efforts to nurture innovation. The most notable example of this was AT&T's Bell Laboratories, which grew to be one of the world premier research organizations of the last century, developing numerous breakthrough technologies that changed American life, including transistors, lasers, fiber-optics, and communications satellites. Researchers at Bell Labs and other corporate laboratories were eligible for, and received, grants from federal research agencies such as NSF and DOD, but they received core support from the parent company and they conducted basic and applied research directed toward developing technology relevant to the company's business.

While overall growth of industry-funded R&D has remained strong in recent years, the focus of this R&D has shifted significantly away from longer-term basic research in favor of applied research and development more closely tied to product development. Because of market demands from investors to capitalize on R&D quickly, large corporate laboratories of the Bell Labs model are increasingly rare (notable exceptions include companies such as IBM and GE). Instead, corporations now focus research projects almost exclusively on lower-risk, late-stage R&D projects with commercial benefits, leaving the Federal Government as the predominant supporter of long-term basic research.

Increasing Competitiveness of Foreign Countries

While trends of support for the innovation system in the U.S. have showed signs of slowing and even eroding, other nations are committing significant new resources to building their science and technology enterprises. More than one-third of OECD (Organization for Economic Cooperation and Development) countries have increased government support for R&D by an average rate of over five percent annually since 1995. The European Union has recently established a target to achieve EU-wide R&D intensity of three percent of the EU economy by 2010. (By comparison, the current U.S. R&D intensity, public and private sector combined, is 2.6 percent of GDP.) Similarly, individual nations, including South Korea, Germany, the U.K. and Canada, have recently pledged to increase R&D spending as a percentage of GDP.

However, no nation has increased its support for innovation as dramatically as China. It has doubled its R&D intensity from 0.6 percent of its GDP in 1995 to 1.2 percent in 2002 (this during a time of rapid GDP growth). R&D investments in China by foreign corporations have also grown dramatically, with U.S. investments alone increasing from just $7 million in 1994 to over $500 million in 2000. China is now the third-largest performer of R&D in the world, behind only the U.S. and Japan.

The increased innovation capacity of other countries is also becoming evident in output-based R&D benchmarks. For example, the U.S. share of science and engineering publications published worldwide declined from 38 percent in 1988 to 31 percent in 2001, while Western Europe and Asia's share increased from 31 to 36 percent and 11 to 17 percent, respectively. Similar trends have occurred in the area of U.S. patent applications and citations in scientific journals.

Education and Workforce Issues

While the supply and demand of future scientists and engineers is notoriously difficult to predict, most experts believe that the transition to a knowledge-based economy will demand an increased quality and quantity of the world's scientific and technical workforce. As is the case with R&D figures, trends in the distribution of the world's science and engineering workforce are also unfavorable to long-term U.S. competitiveness.

The world is catching up and even surpassing the U.S. in higher education and the production of science and engineering specialists. China now graduates four times as many engineering students as the U.S., and South Korea, which has one-sixth the population of the U.S., graduates nearly the same number of engineers as the U.S. Moreover, most Western European and Asian countries graduate a significantly higher percentage of students in science and engineering. At the graduate level, the statistics are even more pronounced. In 1966, U.S. students accounted for approximately 76 percent of world's science and engineering Ph.D.s. In 2000, they accounted for only 36 percent. In contrast, China went from producing almost no science and engineering Ph.D.s in 1975 to granting 13,000 Ph.D.s in 2002, of which an estimated 70 percent were in science and engineering.

Meanwhile, the achievement and interest levels of U.S. students in science and engineering are quite low. According to the most recent international assessment, U.S. twelfth graders scored below average and among the lowest of participating nations in math and science general knowledge, and the comparative data of math and science assessment revealed a near-monopoly by Asia in the top scoring group for students in grades four and eight. These students are not on track to study college level science and engineering and, in fact, are unlikely ever to do so. Of the 25–30 percent of entering college freshmen with an interest in a science or engineering field, less than half complete a science or engineering degree in five years.

All of this is happening as the U.S. scientific and technical workforce is about to experience a high rate of retirement. One quarter of the current science and engineering workforce is over 50 years old. At the same time, the U.S. Department of Labor projects that new jobs requiring science, engineering and technical training will increase four times higher than the average national job growth rate.

Industry Concerns and Reports

As a result of the aforementioned trends, U.S. businesses have become increasingly vocal about concerns that the U.S. is in danger of losing its competitive advantage. In an effort to call attention to these concerns, several industry organizations have independently produced reports specifically examining the new competitiveness challenge and recommending possible courses of action to address it. Prominent among these efforts is the National Innovation Initiative (NII), a comprehensive undertaking by industry and university leaders (including those representing IBM, Cisco, and The Johns Hopkins University) to identify the origins of America's innovation challenges and prepare a call to action for U.S. companies to "innovate or abdicate." The December 2004 NII final report, *Innovate America: Thriving in a World of Challenge and Change,* intends to serve as a roadmap for policy-makers, industry leaders, and others working to help America remain competitive in the world economy.

Other industry associations that have also produced recent reports include AeA (formerly the American Electronics Association), the Business Roundtable, Electronic Industries Alliance, National Association of Manufacturers, and TechNet. While the companies and industry sectors represented by these organizations varies widely, one general recommendation was common to all of the reports: the Federal Government needs to strengthen and re-energize investments in R&D and science and engineering education.

7. Witnesses Questions

The witnesses were asked to address the following questions in their testimony:

Questions for Mr. Donofrio

- What role does innovation play in bolstering U.S. competitiveness?
- What principal innovation challenges do your company and its industry sector face in terms of competing in the global economy?
- How can research and development and math, science, and engineering education and training better contribute to the strength of the Nation's innovation system and to the U.S. competitive position?
- What should the Federal Government be doing to strengthen the Nation's innovation system, particularly with regard to federal programs to support research and technical workforce development?

Questions for Mr. Morgridge

- What role does innovation play in bolstering U.S. competitiveness?
- What principal innovation challenges do your company and its industry sector face in terms of competing in the global economy?
- How can research and development and math, science, and engineering education and training better contribute to the strength of the Nation's innovation system and to the U.S. competitive position?
- What should the Federal Government be doing to strengthen the Nation's innovation system, particularly with regard to federal programs to support research and technical workforce development?

Questions for Dr. Brody

- What role does innovation play in bolstering U.S. competitiveness?
- What principal innovation challenges does the U.S. face in terms of competing in the global economy?
- How can research and development and math, science, and engineering education and training better contribute to the strength of the Nation's innovation system and to the U.S. competitive position?
- What should the Federal Government be doing to strengthen the Nation's innovation system, particularly with regard to federal programs to support research and technical workforce development?

Chairman BOEHLERT. The hearing will come to order. I want to welcome everyone here today to hear from our witnesses, who are true captains of industry and intellectual leaders.

The reason for this hearing should be clear. We want to send a message. If we don't invest today in science, technology, and education, then our economy simply will not continue to thrive. Happily, we have some key allies in Congress promoting this message, such as Chairman Frank Wolf on the Appropriations Committee, the Chairman of the subcommittee of jurisdiction, and his fellow appropriator, John Culberson, but we have more work to do to ensure that all of Washington understands what is at stake.

We used to be so far ahead of everyone else that when we looked around, we couldn't find the people in second place. Guess what? They are breathing down our neck now. I like being preeminent. I like being number one. We have got our work cut out for us to maintain that position. We live in financially constrained times in Washington. The jockeying for federal funds gets more intense each year, and most of us have scars to prove it. We need more forceful and more vocal advocates, both inside and especially outside of government, if research and education are to get the attention they need.

Today's hearing is just one effort among many to raise the profile of these issues. Many associations have gone into high gear, and I want to draw particular attention to the National Innovation Initiative of the Council on Competitiveness, which is now moving into a legislative stage. Also, we hope the Innovation Summit this fall, which Dr. Vern Ehlers, our distinguished colleague on the Committee, and a scientist in his own right, we are working on this together, to put together with industry groups, thanks to Chairman Wolf, that will galvanize the type of support we need for this most important and most urgent mission we are upon.

This is a critical time for research and education, as Congress and the Administration are working on both the Fiscal 2006 and 2007 budgets. We need to act now if future generations are to enjoy the standard of living that leaders like our witnesses today have brought to the United States. And I remind people all the time of so-called glory days of the '90s. Ten consecutive years, quarter after quarter, year after year, growth in our economy. More Americans employed than ever before. Guess what? That was a technology-driven era, and we have got to replicate that in this generation and in the next generations to come. And we are going to succeed if we do it right, and we are going to fail if we fail to recognize the importance of the basics, like K–12 math and science education. Like federal investment in the science enterprise.

And I remind everybody of this saying right up here on the wall: "Where there is no vision, the people perish." We are not going to perish, because of the work that we are doing on this committee, and because of the outstanding leadership we enjoy from people like our distinguished panel of witnesses today.

With that, let me give the microphone to another very distinguished American, my colleague from Illinois, Mr. Costello.

[The prepared statement of Chairman Boehlert follows:]

PREPARED STATEMENT OF CHAIRMAN SHERWOOD L. BOEHLERT

I want to welcome everyone here today to hear from our witnesses who are true captains of industry and intellectual leaders.

The reason for this hearing should be clear; we want to send a message; if we don't invest today in science, technology, and education then our economy simply will not continue to thrive. Happily, we have some key allies in Congress in promoting this message such as Chairman Frank Wolf and his fellow appropriator John Culberson. But we have more work to do to ensure that all of Washington understands what's at stake.

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This is a critical time for research and education as Congress and the Administration are working on both the fiscal 2006 and 2007 budgets. We need to act now if future generations are to enjoy the standard of living that leaders like our witnesses today have brought to the United States.

Mr. COSTELLO. Mr. Chairman, thank you, Mr. Chairman. I have a full statement that I will enter into the record. I do have brief comments that I would like to make.

First, let me thank you for calling this hearing, and let me join you in welcoming our witnesses here this morning, to explore the Nation's innovation capabilities and its competitiveness in the global economy.

There are many examples of how the excellence of our science and technology enterprise has played a central role in our economic competitiveness. To stay in the lead, as you indicated in your opening statement, as the rest of the world makes increasing strides to catch up, we must make the appropriate investments in research and development, and in the education of new generations of scientists and engineers.

Unfortunately, the Administration has not placed a high priority on research investments, particularly for non-defense research. The best measure of federal support for the research that underpins innovation and creation of advanced technology is the federal science and technology budget. The Administration proposed a 1.4 percent spending reduction in its budget for Fiscal Year 2006. While the House passed the appropriation bills increasing this funding level, the increase is still below the inflation level. If we continue to chip away at the research base, we jeopardize our economic strength and technological competitiveness for the long-term.

Of perhaps even greater concern for the long-term is whether the correct policies are in place to ensure that we have the type of scientists and engineers needed in the future. Ranking Member Gordon and myself have recently organized and held in this very room a roundtable discussion to look at supply and demand of science and technology workforce, including the effects of offshoring.

Several things became apparent as a result of that roundtable discussion. First, there is no straightforward answer on whether there is a shortage or a surplus now, and there is no accurate way to predict future demand in this country. It is also very clear that we have entered a new era of international competition, in which

our economic competitors are producing increasing numbers of well-trained scientists and engineers, and that the U.S. companies are going offshore for their low-cost technical talent.

The question then is what kind of skills will enable U.S. scientists and engineers to differentiate themselves from, and thereby command higher salaries than, foreign scientists and engineers. With unemployment levels in engineering at historic highs and U.S. companies announcing that they are reducing their professional workforce, it is difficult to see how these careers will attract the most talented young people, our American students, who have other career options.

These are difficult issues that go beyond simple solutions, such as more funding for R&D, or training more scientists and engineers. We need more information on the factors that lead to the offshoring of science and engineering jobs, and on the impact of this trend on the career choices of our students.

It does little good to invent new technologies if the manufacturing and production is done offshore, yet we are hearing that in venture capital invested high tech firms, that this is exactly what is happening. Developing successful policies to address these issues will require a frank and open discussion between industry, government, and universities.

Mr. Chairman, I look forward to hearing the testimony of the witnesses here today, in particular, as to how they think that innovation will create more jobs in the United States, as well as other important issues. And again, I thank you for calling this hearing this morning, and look forward to hearing our witnesses.

[The prepared statement of Mr. Costello follows:]

PREPARED STATEMENT OF REPRESENTATIVE JERRY F. COSTELLO

Mr. Chairman, I am pleased to join you in welcoming our witnesses this morning to this hearing to explore the Nation's innovation capabilities and its competitiveness in the global economy.

No one serving on the Science Committee can fail to appreciate the relationship between innovation economic strength and security.

We have had many opportunities to review through the Committee's hearings how the excellence of our science and technology enterprise has played a central role in our economic competitiveness.

To stay in the lead in competitiveness, as the rest of the world makes increasingly greater strides to catch up, requires that we progress even faster. That means making appropriate investments in research and development and in the education of new generations of scientists and engineers.

And I want to stress the word appropriate, we can't expect to re-cycle the policies of twenty years ago and expect them to work today.

Unfortunately, this Administration has not placed a high priority on research investments, particularly for non-defense research.

The best measure of federal support for the research that underpins innovation and creation of advanced technology is the Federal Science and Technology budget.

The Administration proposed a 1.4 percent spending reduction in its budget for fiscal year 2006. While the House-passed appropriation bills have turned this into an equivalent increase—even so, the increase will trail the inflation level.

If we continue to chip away at the research base, we jeopardize our economic strength and technological competitiveness for the long-term.

Of perhaps even greater concern for the long-term is whether the correct policies are in place to ensure we have the type of scientists and engineers needed in the future.

Ranking Member Gordon and I recently organized a roundtable discussion to look at supply and demand for the science and technology workforce, including the effects of off-shoring.

Several things became clear from that event. First, there is no straightforward answer on whether a shortage or surplus now exists, and there is no accurate way to predict future demand. Indeed, one of the witnesses pointed out that past predictions of shortages of scientists and engineers have been notoriously wrong.

It is also clear we have entered a new era of international competition in which our economic competitors are producing increasing numbers of well trained scientists and engineers and that U.S. companies are going off-shore to avail themselves of this low-cost technical talent.

The question then is what kinds of skills will enable U.S. scientists and engineers to differentiate themselves from, and thereby command higher salaries than, foreign scientists and engineers. With unemployment levels in engineering at historic highs and U.S. companies announcing that they are reducing their professional work force it is difficult to see how such careers will attract the most talented American students, who have other career options.

These are difficult issues that go beyond simple solutions, such as fund more R&D or train more scientists and engineers. For instance, we need more information on the underlying factors that lead to the off-shoring of science and engineering jobs and on the impact of this trend on the career choices of our students.

It is timely to explore what policy options are available to ensure the Nation maintains its current prominence in technology and innovation. In addition, we need to address how innovation will create more jobs in the U.S.

It does no good to invent new technologies if the manufacture and production is done off-shore. Yet we are hearing that in venture capital invested high-tech firms that this is exactly what is happening.

Developing successful polices to address these issues will require a frank and open discussion between industry, government and universities.

I look forward to discussing these matters with our distinguished panel, and I thank the Chairman for convening this hearing.

[The prepared statement of Mr. Ehlers follows:]

PREPARED STATEMENT OF REPRESENTATIVE VERNON J. EHLERS

As a firm believer that innovation is the key to U.S. economic growth, vitality, and national security, I am pleased that the Science Committee is holding this important hearing. One of my top priorities in Congress has been to educate other Members about innovation and foster policies that enhance it. The United States is on the cutting edge of global competition because of our past investments in science and technology. Whether we remain in that position depends on how well we understand the drivers of innovation and how we choose to respond.

There are many ways we can foster innovation and competitiveness at the national level, but some are less obvious than others. I have consistently advocated for two main goals: increased funding across the federal agencies that support fundamental research; and strengthening math and science education in our current and future workforce. Economists attribute more than half the economic growth in the past 50 years to technological innovation. Federally funded basic research has been responsible for groundbreaking technologies, such as magnetic resonance imaging (MRI), the global positioning system (GPS), human genome mapping, fiber optics, lasers, and the Internet. Bolstering our workforce requires improving current training programs and strengthening core math and science teaching and curricula throughout our K–12 system. In the House I co-chair the Science, Technology, Engineering and Math (STEM) Education Caucus, a member organization that works to support STEM Education at all levels. Improving the science literacy of our current and future workforce will ensure the quality of our intellectual infrastructure. In addition to the ways I have mentioned, we must continue to be aware of other areas that impact the innovation process and maintain Congressional awareness and support of those areas.

I have been working on these issues for some time now. In 2002, as Chairman of the Science Committee's Subcommittee on Environment, Technology and Standards, I held a hearing about innovation in manufacturing. Following that hearing I developed the *Manufacturing Technology Competitiveness Act,* which passed the House overwhelmingly in the 108th Congress. Unfortunately the Senate did not have time to take it up last year, but we are at it again even stronger this time around and expect this year's bill, H.R. 250, to be on the House Floor soon. The *Manufacturing Technology Competitiveness Act* authorizes the highly successful Manufacturing Extension Partnership program. This federal-State partnership program, run by the National Institute of Standards and Technology (NIST), provides expert advice to small and medium-sized manufacturers who want to improve their

processes to remain competitive. My manufacturing bill also establishes collaborative research programs at NIST that would foster partnerships between small and large manufacturers, academic researchers, and other partners to do manufacturing-specific research.

I know that today's witnesses will share personal experiences and creative ideas on ways we can promote an environment of innovation to maintain U.S. competitiveness across all sectors of the economy. I am happy to see the Committee has invited representatives of both the business and the academic communities, because there are no "islands of innovation" and I believe new partnerships between traditionally separate communities will be important for future innovation. I look forward to learning from all of our witnesses how we might make government, industry, academia and others work together as a team for creative innovation.

[The prepared statement of Mr. Honda follows:]

PREPARED STATEMENT OF REPRESENTATIVE MICHAEL M. HONDA

Chairman Boehlert and Ranking Member Gordon, thank you for holding this hearing today with these distinguished witnesses to address the vitally important issue of U.S. competitiveness in the global economy and the role of innovation in maintaining the U.S. preeminence.

I represent from Silicon Valley, where tens of thousands of high tech workers have lost their jobs over the last few years. Many of these jobs have moved overseas, a fate formerly only associated with unskilled jobs. These are highly skilled jobs, though, held by highly educated people. We can't just "retrain" them to move up into higher skilled jobs these jobs are at the top rungs of the engineering ladder. This aspect of the problem makes it a very difficult one to tackle.

One thing that has troubled me about the debate over out-sourcing is that it has been portrayed as an "us vs. them" confrontation, pitting the U.S. against other nations, usually Asian ones such as India, China, or Taiwan. I disagree with this notion, however, because the truth is that American executives running American companies are making decisions to move jobs to other countries. They are not coming in and "stealing our jobs," we are giving those jobs away.

Why are we doing that? It seems to be a complex question. Simple business sense tells us that there must be something about the demands placed on companies by American consumers that is driving this out-sourcing. And there must be some benefit that companies see to making the move.

Until we can identify those factors, we will not be able to figure out what needs to be done. We will be left to flail about, trying stopgap measures that do not really address the root of the problem.

In the end, it looks like either we need to stop the jobs from moving out of the country, become resigned to the fact that these top tier technology jobs going away and accept a workforce shift to the service sector, or maybe create whole new high tech fields in which the U.S. leads the rest of the world, so that the jobs need to stay here.

I am not sure how we are going to do that, since I do not know the underlying factors that have led to the problem. I hope that our expert witnesses can help us understand some of the causes behind the trends and then develop some policies to address some of these questions.

[The prepared statement of Mr. Davis follows:]

PREPARED STATEMENT OF REPRESENTATIVE LINCOLN DAVIS

Thank you, Mr. Chairman and Ranking Member, for holding today's hearing. Many say the U.S. is losing its competitive edge when it comes to technology and innovation. In Tennessee's Fourth Congressional District, I see jobs being lost or jobs going overseas, where labor is cheaper. At the same time, I see other nations investing more heavily in research and technology than we are. Other countries are surpassing the U.S. when it comes to certain areas of technology like computer chip manufacturing or technology customer service.

How can the U.S. regain its competitive edge? I believe that the Federal Government should support math and science education in our public schools to encourage more children to pursue science and technology careers.

I also believe we should look carefully at our national budget and find a way to maintain balance, providing cost-effective health care and Social Security, while also giving adequate funding to science and technology research.

Most federal research dollars go to university scientists, who are training tomorrow's generation of innovators. We must fund federal research in a balanced way

so that the physical sciences receive the same level of support as the biomedical sciences did a few years ago.

I am interested in hearing ideas from today's witnesses on how the U.S. can regain its competitiveness. Thank you, Mr. Chairman. I yield back the balance of my time.

[The prepared statement of Mr. Carnahan follows:]

PREPARED STATEMENT OF REPRESENTATIVE RUSS CARNAHAN

Mr. Chairman and Mr. Ranking Member, thank you for hosting this very important hearing today.

Many have noted recently that manufacturing plants are shifting off-shore, but we must also recognize that high-end engineering jobs are being moved off-shore. Additionally, U.S. companies are moving to establish industrial research labs abroad.

Like many other Members sitting here today, I believe strongly in promoting science and engineering education. We have a tremendous responsibility as legislators to recognize that our nation is no longer leading the pack in STEM (science, technology, engineering and math) performance and that related job markets are shifting overseas. Deciding if and how we will remedy this situation is our greatest challenge.

Mr. Donofrio, Mr. Morgridge, and Dr. Brody, thank you for your willingness to join us. I am eager to hear your testimony and your recommendations.

Chairman BOEHLERT. Thank you very much, Mr. Costello, and our panel today is composed of three very distinguished people in their own right, and I want to thank each of you for serving as instructors for this committee. And we do something on this committee that some people might find a little bit rare. We sort of sit back and listen. We invite people like you, who have distinguished records in the real world, if you will. We have Nobel laureates. And we sit back and we listen, and we hope to learn, and we respect you for your willingness to serve as guides for us, and to help inform us.

In the final analysis, Congress is going to be a success or failure based upon the direction in which we take this country, and we are not going to do it in the dark of the night, on the back of an envelope, in some lobby. We are going to do it in open hearings, where we get the best guidance we can get.

And with that, let me present to my colleagues and to the audience our distinguished witnesses: Mr. Nicholas Donofrio, Executive Vice President for Innovation and Technology for the IBM Corporation; Mr. John Morgridge, Chairman of Cisco Systems, Incorporated; and Dr. William Brody, President of The Johns Hopkins University.

Thank you very much, gentlemen, for appearing here. And we would ask you to summarize your statements as much as you can, which would provide greater opportunity for the interaction here. We ask the obvious questions, and then we sit back and say, hmm. You will notice we have a timer there, and Mr. Morgridge, in front of you, you are all veterans. You have been through this drill before. The chair is not arbitrary. I am not going to cut you off in mid-sentence or even mid-thought or mid-paragraph, but we would try to summarize it, so that we can get to the exchange here.

With that, Mr. Donofrio, you are up first.

STATEMENT OF NICHOLAS M. DONOFRIO, EXECUTIVE VICE PRESIDENT FOR INNOVATION AND TECHNOLOGY, IBM CORPORATION

Mr. DONOFRIO. Good morning, Mr. Chairman, and distinguished Members of the Committee. My name is Nick Donofrio, and it is my pleasure to be with you today. At the outset, I extend my most sincere gratitude to Chairman Boehlert for his personal leadership, and to the committee for its longstanding support of science, technology and innovation.

My testimony this morning is focused on the principal innovation challenges we faced in IBM and within the information technology industry, and I will also share my views on the role innovation plays in the competitiveness of the United States of America.

IBM's transformation over the past few years has been driven by new global marketplace realities and opportunities which, taken together, have shifted our focus from the development and manufacturing of products and technologies to the robust application and integration of technology. The shift is enabling us to deliver new value to our clients around the world as we align around a single business model—innovation. Innovation that is collaborative, open, multi-disciplined, and global.

For the information technology industry and for the United States of America's economy, a new era of growth is beginning, due in large part to the emergence of a new computing architecture and the new business models it enables.

The change is fundamentally driven by the convergence of three historic developments. The first is network ubiquity, as evidenced by the Internet, which is fast becoming the world's operational infrastructure. The second is by open standards, widely adopted technical and transactional specifications that are spurring the creation of new kinds of products and services. And the third, the emergence of the network ubiquity and open standards has been enabled by a new business design that allows for the enablement of institutions to integrate their business operations horizontally, and respond rapidly to business challenges, responding in a way that we at IBM call on-demand.

Implementing these fundamental concepts enables businesses, governments, and institutions of higher learning to innovate in new and entirely different ways, and it is affording new growth opportunities in both economic and societal activity. Seizing the opportunities demands unique foresights and capability, and nations must choose carefully. Investment, talent, and infrastructure are increasing everywhere, making the world more tightly integrated. For companies in a broad range of industries, as well as governments, the choice is either innovation or commoditization. Institutions may choose to be innovative by investing in managing, leveraging intellectual capital, or they can be commodity players, by differentiating themselves through low price, economies of scale, and efficient distribution of other parties' intellectual capacity and capability.

The choice will impact nations as well as industries. Only by understanding, anticipating, and managing the forces of innovation and commoditization can we properly address the challenges to national economic prosperity. So, how do we, as a nation, capitalize on the most important developments in technology, infrastructure,

and business organization? How do we translate those developments into the differentiators and distinguishers for American prosperity. In short, how do we optimize for innovation?

Today, innovation is the arbiter of national competitiveness. We must recognize innovation as a national priority, and adopt innovation as a core strategy for the 21st century knowledge-based economy. Reaching higher levels of innovation is complex, and since the basic idea is to transform ideas and intellectual property into new value, the private sector is the primary agent.

Still, the Federal Government has enormous influence. That is because innovation no longer is driven solely by investments in research and development. It must be viewed from both the supply and demand sides. Policy and infrastructure create a national platform that can accelerate or impede the pace and quality of innovation. The Council on Competitiveness National Innovation Initiative calls for the United States to develop an integrated, coherent approach to innovation across a number of policy areas. The vitality of the ecosystem will stimulate innovation.

We cannot focus only on the discrete components, but on the entire ecosystem. A proper mix of policy measures will make the United States a more attractive and fertile environment for innovation investment. And I have included in my formal, written statement a number of policies I believe will have the greatest potential for national innovation success. Allow me just to cite a few.

Our country needs the world's deepest collection of business and technological innovators, able to create and apply intellectual capital; that is what defines competitive advantage. Workforce skills must include both technology and strategic expertise. Equally important, our nation's structural transition to a services economy needs to be supported by a deepened understanding of how services can support and interact with manufacturing and other, more traditional activities. The services sector today accounts for the bulk of employment in the United States, and in other high wage economies. More than 75 percent of the United States gross domestic product is services-based, and with the exception of India and China, at least half the workforce in every high wage country is concentrated in the services sectors.

Students also must be prepared to become innovators. Education must be transformed and realigned, and reform must start with the curriculum. For example, creative and integrative instruction can be achieved through the development of problem-based learning, which is particularly helpful in the development of scientific, mathematical, and technical talent. Our nation benefits greatly from a diversity of talent, a diversity of culture, and a diversity of thought and insight from all over the world. Innovation does not happen in isolation. It is a multi-disciplined and multicultural event. We need national immigration policies that enable the United States to attract and retain the best minds in the world.

Unlocking innovation demands that we rethink our ideas also about intellectual property. While the ownership of intellectual property is an essential driver of innovation, technology advances are often dependent on shared knowledge, open standards, and collaborative innovation. The best intellectual property framework balances both proprietary and open approaches.

I will close now with these brief thoughts. Economies around the world are replicating the characteristics that have given Western nations such an advantage. Many companies in rapidly developing nations, such as China, Indian, Brazil, and Russia, are leapfrogging to new computing architectures and business designs, and those countries are developing very specific innovation strategies and higher levels of skill. As the United States considers its next steps, I urge that any dialogue on innovation be made in a global context.

The forces of the global economy of integration and advances in technology are presenting complex challenges. The status quo simply cannot be an option. Government, business, academia and labor must work together to create a climate and a culture to facilitate cross-border, cross-organizational, and cross-disciplinary collaboration. That is the only environment for innovation to thrive in.

America has a long and proud history of recognizing when change is required, and seizing upon that opportunity, and rising to the challenge. We are at such an inflection point today. I am very enthusiastic about our opportunities, and about our outlook for prosperity, and I thank you very much for listening.

[The prepared statement of Mr. Donofrio follows:]

PREPARED STATEMENT OF NICHOLAS M. DONOFRIO

Good morning, Mr. Chairman and Members of the Committee. Thank you for inviting me to join you today. My name is Nicholas Donofrio and I am the executive vice president for Innovation and Technology in the IBM Corporation. I appreciate the opportunity to offer IBM's views on U.S. competitiveness and the innovation challenge. Given the fundamental role of innovation in underpinning American economic growth and national security, I believe this hearing is more important now than ever.

I also wish to thank Chairman Boehlert for his longstanding support of science, technology and innovation. Under his leadership, this committee has been an outstanding proponent for the pillars of growth in our society—namely, research, technology and skills development.

I will focus my testimony today on the principal innovation challenges we face—both inside IBM and within the information technology industry—as we compete in the global economy. You also have asked me to provide my views on the role innovation plays in driving the competitiveness of the United States.

With regard to IBM, no longer are we focused exclusively on the development, manufacture and delivery of information technology, but rather on the application and integration of technology to deliver new and lasting value to our clients around the world. We have conducted an end-to-end transformation of our business, driven by major new global marketplace realities and opportunities. As a company with $96 billion in revenue, and which operates in 174 countries, we believe we bring unique insight to global trends and a solid base from which to make national recommendations. IBM is aligned around a single, focused business model—innovation. Innovation that is collaborative, open and multi-disciplined.

TRENDS

History suggests that a sustained period of growth is about to begin for the $1.4 trillion information technology industry. At the same time, new markets are opening up on its borders. We believe that the drivers of growth are very different today and will remain so for the foreseeable future; they are propelling information technology and business services, and they are affecting not only IBM and the IT industry, but also the American economy as a whole. Further, a major factor in the accelerated growth of the American economy in the post-1995 period has been the increase in productivity gained by the application of information technology to business processes.

The rewards of that growth will not be shared equally; they will, as in the past, flow to those enterprises and nations that can innovate and turn disruptive shifts to their advantage. Such conviction is what sharpens our focus on innovation in IBM, for the benefit of our clients and the nations where we conduct business.

Our economy today is moving into a new era, underpinned by cyber-infrastructure, a new architecture of computing and the new business models they enable. The essential ideas about the networked organization and global economy are clearly taking hold. Those changes are driven by the convergence of three historic developments:

Network Ubiquity: In less than a decade, the Internet—the most visible evidence of an increasingly networked world—has reached some 800 million people, and is projected by some analysts to reach more than a billion people by 2007. The Internet has not only connected people and opened up access to the world's information, it is rapidly becoming the planet's operational infrastructure. It is linking people, businesses and institutions, as well as billions—ultimately trillions—of devices. It is facilitating and transforming transactions of all kinds—from commerce, government services, education and health care, to entertainment, conversation and public discourse.

Open Standards: Technical and transaction specifications underpin all industries. When they become standards—that is, when they are widely adopted—they enable growth by spurring the creation of many new kinds of products and services. Standards made possible electrical, telephone and TV networks, CDs, DVDs, credit and debit cards and global financial markets—and by extension, all the other business and public services those systems enabled. Today, standards are truly taking hold in information technology. They determine how computers operate and software applications are developed, how digital content is produced, processed, distributed and stored, and how transactions of all types are managed. These standards are "open"—that is, not owned or controlled by any one company or entity. (The Internet itself, for example, is built on open standards.) This is common in other industries, but a radical departure for the information technology industry.

New Business Designs: The simultaneous emergence of the networked world and open standards is enabling entirely new business designs, giving CEOs and other decision-makers options that were not feasible before. Companies can now be far more flexible and responsive to changes in the economy, buyer behavior, supply, distribution networks, consumer tastes, geopolitical realities—even the weather. That is because their business operations can be integrated horizontally, from the point of contact with customers through the extended supply chain. And because vital information is captured and managed enterprise-wide, networked companies can anticipate and respond much faster, or, in other words, on demand.

The fundamental shifts I have described are creating significant competitive advantages for institutions around the world, particularly in the management and integration of their business processes. Companies are innovating in new areas, such as supply chain management, engineering design services, human resource management, after-sales services and customer care. Governments are transforming their legacy agencies to organize around missions rather than departments. Academic institutions are delivering their course ware through the Internet in addition to the traditional classroom. Institutions are radically innovating in their business operations and processes using information technology and the services and expertise associated with business process transformation. This new organizational structure and marketplace are growing dramatically, and American industry is at the forefront. We see global opportunity in excess of $500 billion that can be addressed by both information technology and non-information technology companies.

Enterprises around the world are innovating through the transformation of their businesses because they recognize that new and integrated processes result in genuine competitive advantage.

INDUSTRY CHANGE

Like other major structural shifts before it, the new era—networked, built on standards and with wholly new business and institutional models—is opening up new possibilities for profit and growth for business, while also affecting other realms of societal and economic activity—from government, to health care, to education.

Seizing the opportunities presented by that shift, as always, requires unique foresight and capabilities. Despite the turmoil in the economy in recent years, some nations have managed to increase their prosperity, advance the frontiers of science and learning, and build multiple kinds of new expertise. For them, the result today is an economy poised for sustained growth in traditional markets and robust growth in the new markets. But, as I mentioned, the growth will not be shared equally. In the years ahead, choosing wisely will prove important. Significant rewards will accrue to those who are up to the challenge.

Capabilities, investments and infrastructure are increasing everywhere. Global interconnections make it possible for people to work from virtually anywhere. The

world is indeed becoming more tightly integrated. For American companies in a broad range of industries—as well as governments—the choice is either innovation or commoditization.

Companies that create new, high-demand technologies and services enjoy, for a time, barriers to entry, as well as superior margins and pricing power, since there are few other providers of that technology or service. However, alternative technologies or capabilities inevitably emerge, decreasing the innovator's advantages. In short, that segment of the industry "commoditizes." There are still attractive opportunities to be pursued, but with much less profit potential.

The global innovation-commoditization cycle has never been more pronounced than it is today, and it forces distinct choices. Winners can be the innovators—those with the capacity to invest, manage and leverage the creation of intellectual capital—or the commodity players, who differentiate through low price, economies of scale and efficient distribution of other parties' intellectual capital.

Perhaps the greatest risk is to get squeezed in the middle—being attacked by low-price competitors, while lacking the expertise and intellectual capital to keep up with the most aggressive innovators.

GLOBAL TRENDS AND OPPORTUNITY

The dilemma affects nations, as well as industries. Understanding, anticipating and managing the forces of innovation and commoditization can address many of the challenges to national economic success. Today, companies and organizations are coming to a new way of conceptualizing and managing business activity. Essentially, they are choosing to move to a higher value space in the overall national economic picture. A networked, interconnected model enables them to achieve higher levels of responsiveness, flexibility and efficiency than legacy, Industrial-Age business models. This new flexibility offers great potential for growth, by increasing productivity and by creating entirely new capabilities.

There are many examples of new capabilities. In health care, for instance, we now see personalized medicine on the horizon—as the integration of patient histories and genomic data is changing the nature of diagnosis and patient care. In insurance, we see products and services tailored to the driving habits of individual policyholders.

So, how do we, as a nation, enable that transformation? How do we capitalize on the most important developments in technology, infrastructure and business organization in which we currently have global leadership? How do we translate those developments into differentiators for American prosperity? How do we strategically align ourselves to innovate and leverage the networked world, based on a combination of expertise, advanced technology, and business insight, for productivity gains and economic success? In short, how do we optimize for innovation?

MOVING TO THE FUTURE

Innovation has become the new arbiter of national competitiveness. We must recognize innovation as a national priority. For the United States to thrive in the hyper-competitive world economy we must, with urgency, mobilize business, government, educators and researchers to adopt innovation as a core strategy to build the foundation for a 21st Century knowledge-based economy.

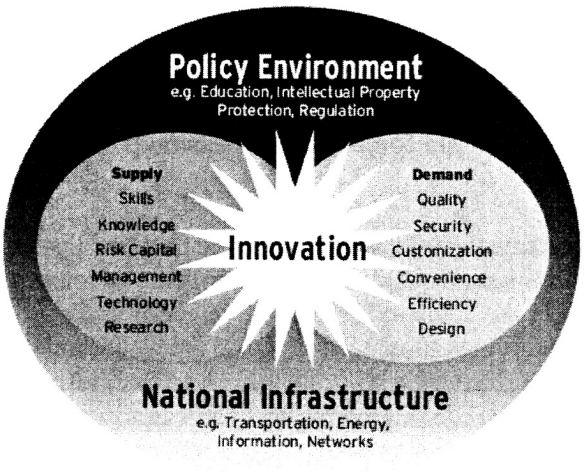
Innovation success will be a product of many stakeholders collaborating and sharing the risk of change. To facilitate the process, our nation's policy architecture must be modernized to address the changing nature of innovation, the new opportunities I have described and the new global competitors. The redesign of our nation's innovation policies must be balanced, consistent and coordinated, and focused on crucial challenges.

INNOVATION ECOSYSTEM: A KEY CONCEPT

Achieving national innovation success is complex. It requires far more than the management of ideas, technology transfer and research and development. The challenge is not only to generate fresh ideas and intellectual property, but to transform ideas and intellectual property into new value. As such, they become commercially successful. The private sector is the primary agent for innovation. The Federal Government, however, has enormous influence over the pace of fundamental knowledge advances, the incentive for private enterprises to invest in innovation and the conditions under which innovation may thrive.

Innovation is not just R&D driven. It needs to be viewed on both the supply and demand side, and in a global perspective. A basic prerequisite for the next generation of innovation policies is to move toward a thoughtful integration with all the dynamics of the *National Innovation Ecosystem,* as illustrated in the following chart:

THE NATIONAL INNOVATION ECOSYSTEM



The push and pull of supply and demand do not occur in a vacuum. They are strongly influenced by public policy and the overall infrastructure for innovation offered by our society.

Public policies related to education and training, research funding, regulation, fiscal and monetary tools, intellectual property and market access demonstrably affect our ability to generate innovation inputs and respond to innovation demands.

The same can be said of infrastructure—be it transportation, energy, health care, information technology networks or communications. Taken together, the policy and infrastructure environments create a national platform that can accelerate—or impede—the pace and quality of innovation. [Excerpted from: InnovateAmerica, Report of the National Innovation Initiative, December 2004]

AN INTEGRATED POLICY APPROACH REQUIRED

In 2004, IBM Chairman and Chief Executive Officer Sam Palmisano co-chaired the National Innovation Initiative of the Council on Competitiveness. One of the central findings of its report is that the United States needs an *integrated,* coherent approach across a number of policy arenas to maintain global economic leadership. The total mix and composition of federal policies affect private sector innovation behavior.

Many of the critical choices lie outside the traditional sphere of research and development and innovation supply policies. Policies which influence the supply of talent, risk capital, the demand for innovative goods and services and the robustness of regional innovation networks also are important. A higher level of national innovation performance will result from an integrated end-to-end *(idea to market)* approach by the Federal Government. The vitality of the ecosystem will stimulate innovation. Focusing only on the discrete components—investing in schools or sector-specific initiatives—is not enough. We must find ways to address the entire ecosystem.

The National Innovation Initiative report presents recommendations under three broad themes: talent, investment and infrastructure. They represent a new approach to drive U.S. competitiveness—making clear that innovation is not a checkpoint on the economic agenda, but rather the organizing principle of the agenda. If the U.S. seeks to remain the most attractive and fertile environment for innovation in the world, such policy measures must be pursued as a coherent and clearly-articulated strategy.

COMPONENTS OF A NATIONAL INNOVATION POLICY

The highest-leverage policy choices for consideration in a national innovation policy include:

1. *Establishing an innovation focal point within the Executive Office of the President to frame, assess and coordinate strategically the future direction of the Nation's innovation policies.*
2. *Creating new metrics for the national innovation ecosystem to drive performance and monitor results. New metrics of the knowledge-based economy should include knowledge indicators, contractual agreements like strategic partnerships, IP licensing, and conditions for innovation, such as economic demand, public policy environment and infrastructure readiness.*
3. *Implementing new tax incentives to provide scholarships for the next generation of scientists, engineers and innovators and changing immigration policies to attract and retain the brightest talent from around the world.*
4. *Accelerating innovation oriented learning environments at the K–12 level, enhancing careers options and the adaptability of workers through portable learning benefits.*
5. *Modifying the long-term Federal R&D investment portfolio by a new priority on the physical and engineering sciences, setting aside an increased proportion of research funding to basic, novel, high-risk and exploratory research, establishing a research program for the services sciences, encouraging multidisciplinary research, and making permanent a restructured R&D tax credit including university-industry collaborations.*
6. *Coordinating and focusing federal economic development programs on regional innovation hotspots and creating more dynamic innovative industry clusters.*
7. *Implementing a legal and regulatory framework that encourages voluntary and more complete disclosure of business intellectual ("intangible") assets and longer-term innovation strategies.*
8. *Supporting a new U.S. production capability in emerging technologies through creation of world class Centers for Production Excellence, strengthening DOD's historic role in advanced manufacturing research, reorganizing the Manufacturing Extension System toward innovation services for small to medium sized enterprises and supporting an open systems approach to customer relationship, product design, supply chain, manufacturing and logistics systems.*
9. *Capitalizing on innovation opportunities in hydrogen fuel cells, nanotechnology, new materials, micro-machining, advanced semi-conductor technology, broadband deployment and applications, next generation wireless devices, digital medical records and health care, pervasive computing, modeling and simulation.*

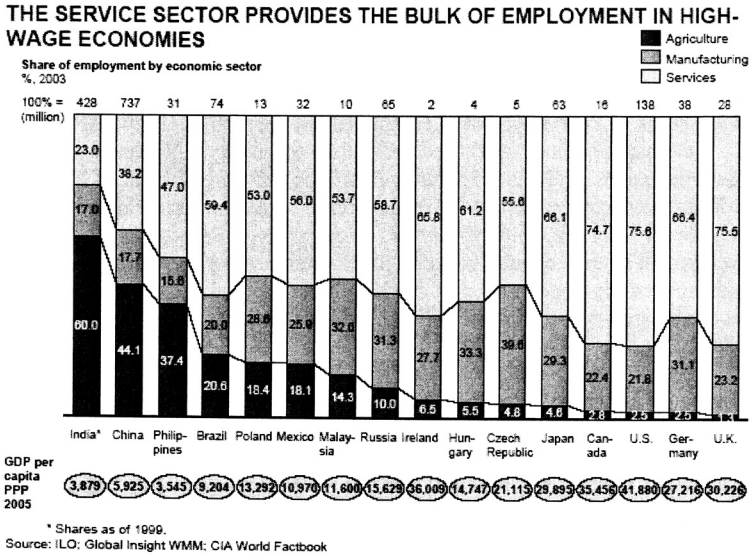
EDUCATION, TRAINING AND WORKFORCE

I will now comment on several areas of education, training and workforce development which contribute to our nation's innovation system and competitive position.

Competitive advantage today comes from expertise—and expertise is not static. The United States needs the world's deepest, most diverse collection of business and technology innovators, supported by advanced collaboration systems and a culture that enables continuous learning. In the Agricultural Age, land and farm production defined competitive advantage. In the Industrial Age, it was raw materials and manufacturing capability. Today, it is the ability to create and apply intellectual capital based on multi-dimensional expertise.

Workforce skills must include both technology and strategic expertise. An understanding of technology—its current capabilities as well as its future potential—is now integral to business decision-making. Business leaders need innovation partners who are at the frontiers of research and deeply steeped in the issues and dynamics of specific industries.

To advance strategic expertise, the Nation's structural transition to a services economy needs to be supported by a deepened understanding of how services support and interact with manufacturing and other more traditional activities. In fact, in today's global economy, the services sector provides the bulk of employment in high-wage economies. See attached chart:



A wide community is beginning to discuss the technical and social effects of new developments in global connectivity, automation, technology integration and Web services and a new scientific discipline is being opened. Leading universities are beginning to work with IBM to better understand the social and technical issues involved in collaborating across global enterprises. For example, the University of California at Berkeley is considering the implementation of a Services Science curriculum in conjunction with IBM Research—much in the way the first Computer Science department was initiated at Columbia University. Federal research investment and collaboration could significantly accelerate learning in this area.

To advance technology expertise, I am convinced that education must be transformed and realigned to prepare students to become innovators. Reform must start with curriculum. Creative and integrative instruction can be achieved through the development of Problem-Based Learning (PBL)—a methodology that is sure to enhance the development of much-needed skills—especially in the engineering and technical professions. PBL is specifically helpful in the development of scientific, mathematical and technical talent. It focuses on ill-structured problem-solving, and provides deeper meaning, applicability and relevancy to classroom materials and the development of crucial analysis skills that are required in the workplace. An education system designed to support curriculum focused on acquiring discreet skills and memorizing information will not produce the leaders and innovators the world needs.

In my own industry, these needs are particularly acute. The information technology sector is experiencing a pronounced shift in demand for specialized skills that fuse industry-specific knowledge, information technology capability and business process expertise. These skills enable the business transformations described earlier. Organizations seek more integrated and customized technology and services solutions that create competitive advantage and enable innovation. New information technology jobs are mushrooming in areas like business analysis, security analysis, vendor management, service management, system integration, and others. IBM's clients seek business acumen, project management and leadership skills along with specific IT skills linked to open standards, networking and e-commerce. These emerging occupations require higher skills and they are well paid.

Finally, we must realize that we benefit greatly from a diversity of talent, a diversity of culture, a diversity of thought and insight from all over the world—intra-national and international. Innovation does not happen in isolation. It happens through collaboration across the diverse communities required to sustain economic

leadership in the 21st century. We need national immigration policies that enable the United States to attract and retain the best minds in the world.

In an expertise-based, global marketplace, the expansion of business into more diverse services is forcing us to rethink the types of skills and educational degrees that are needed to drive America forward. In fact, the whole services paradigm is enabling us to be more innovative in our approach to talent development.

Applied more broadly, our experience drives me to conclude that America needs a culture of learning, skill building and collaboration. Specifically, it means that technologists and business experts need to work closely together, not simply to share insights, but to create entirely new intellectual capital for competitive advantage. We must build the capacity to apply new intellectual property to nurture and launch new high-value businesses.

Unlocking innovation also demands that we rethink our ideas about intellectual property. Some believe the best way to provide incentives for innovation is by fiercely protecting the inventor's proprietary interest. Others argue that we should open the doors and give full access to intellectual assets. I believe we need a new path forward, an approach that offers a balance of those two extremes.

While IP ownership is an essential driver of innovation, technological advances are often dependent on shared knowledge, standards, and collaborative innovation. The IP framework must enable both. We must protect truly new, novel and useful inventions. And we need to recognize that open standards can accelerate the interoperability and expansion of the global infrastructure. Because collaborative innovation is relatively new, the structure and processes to accommodate ownership, openness and access are evolving, and new creative models are emerging. This is an area of tremendous promise and is currently being addressed in patent legislation in the Judiciary Committee.

SUMMARY

Economies around the world are replicating the characteristics that have given Western nations such an advantage—open markets, R&D investment and highly-trained workers. Many companies in rapidly developing nations such as China, India, Brazil and Russia are leapfrogging to new computing architectures and business designs. Emerging nations with limited legacy infrastructures are developing specific innovation strategies. They plan to drive economic growth by leapfrogging in infrastructure development. These approaches are creating a highly competitive global economy.

As the United States considers its next steps, I urge that any dialogue on innovation must be made in the global context. The forces of global economic integration—and advances in technology—are presenting complex challenges that can only be addressed by embracing opportunities for change and future prosperity. The status quo simply cannot be an option.

Governments, business, academia and labor must work together to create a climate and a culture that facilitates cross-border, cross-organizational and cross-disciplinary collaboration. That is the only environment in which innovation will thrive.

America has a long and proud track record of recognizing when change is required, and then rising to the challenge. We are at such an inflection point today. I am very enthusiastic about seizing the opportunities before us and prospering in the decades ahead.

Thank you for the opportunity to be with you today.

BIOGRAPHY FOR NICHOLAS M. DONOFRIO

Nick Donofrio is the leader of IBM's technology strategy and a champion for innovation across IBM and its global ecosystem. His responsibilities include IBM Research, Governmental Programs Quality, Environmental Health and Product Safety, and Mr. Donofrio is Vice Chairman of the IBM International Foundation. Also reporting to Mr. Donofrio are the senior executives responsible for IBM's enterprise on demand transformation internal information-technology organization and IBM's initiatives for open industry standards and intellectual property. He is a member of IBM's Executive Technology and Strategy teams. In addition to his strategic business mission, Mr. Donofrio leads the development and retention of IBM's technical population and strives to enrich that community with a diversity of culture and thought.

Mr. Donofrio joined IBM in 1967 and spent the early part of his career in integrated circuit and chip development as a designer of logic and memory chips. He held numerous technical management positions and, later, executive positions in several of IBM's product divisions. He has led many of IBM's major development

and manufacturing teams—from semiconductor and storage technologies, to microprocessors and personal computers, to IBM's entire family of servers.

He earned a Bachelor of Science degree in Electrical Engineering from Rensselaer Polytechnic Institute in 1967 and a Master of Science in the same discipline from Syracuse University in 1971. In 1999 he was awarded an honorary doctorate in Engineering from Polytechnic University, in 2002 he received an honorary doctorate in Sciences from the University of Warwick in the United Kingdom, and in 2005 he was awarded an honorary doctorate in Technology from Marist College.

Mr. Donofrio is a strong advocate of education and vigorously promotes mathematics and science as the keys to economic competitiveness. He is particularly focused on advancing education, employment and career opportunities for under-represented minorities and women. He served for many years on the Board of Directors for the National Action Council for Minorities in Engineering (NACME) and was NACME's Board Chair from 1997 through 2002. He also serves on the national Board of Directors for INROADS, a non-profit organization that trains and develops talented minority youth for professional careers in business and industry.

He is the holder of seven technology patents and is a member of numerous technical and science honor societies. He is a Fellow of the Institute for Electrical and Electronics Engineers, a Fellow of the U.K.-based Royal Academy of Engineering, a member of the U.S.-based National Academy of Engineering, a member of the Board of Directors for the Bank of New York, and he serves on the Board of Trustees at Rensselaer Polytechnic Institute.

In 2002, Mr. Donofrio was recognized by Europe's Institution of Electrical Engineers with the Mensforth International Gold Medal for outstanding contributions to the advancement of manufacturing engineering. In 2003 he was named *Industry Week* magazine's Technology Leader of the Year, the University of Arizona's Technical Executive of the Year, and was presented with the Rodney D. Chipp Memorial Award by the Society of Women Engineers for his outstanding contributions to the advancement of women in the engineering field. In 2005, Mr. Donofrio was elected a member of the American Academy of Arts and Sciences and was presented with Syracuse University's highest alumni honor—the George Arents Pioneer Medal.

Office of the Executive Vice President
Innovation and Technology

New Orchard Road
Armonk, NY 10504

November 29, 2005

The Honorable Sherwood Boehlert
Chairman, Science Committee
2320 Rayburn Office Building
Washington, DC 20515

Dear Chairman Boehlert:

Thank you for inviting me to testify July 21 before the House Science Committee at the hearing entitled ***U.S. Competitiveness: The Innovation Challenge***. In accordance with the Rules Governing Testimony, please be advised of the following:

IBM is a vendor – competing for information technology business – across the Federal Government, including the Legislative, Executive and Judicial branches, as well as independent establishments and government corporations such as the U.S. Postal Service, Amtrak and quasi-governmental organizations. Our contracts are numerous and they vary at any given time.

IBM's annual revenue from Federal business in 2004 was approximately 2.8 percent of IBM's total 2004 revenue of $96.3 billion. The IBM Research Division also engages in a range of activity under federal contracts and/or grants. During 2005 to date, IBM's Research Division has been awarded approximately $60 million in federal contracts and grants, with a variety of government agencies, including the Department of Defense, Department of Homeland Security, Department of Energy, National Science Foundation, National Institutes of Health, and NASA.

Sincerely,

Nicholas M. Donofrio

Chairman BOEHLERT. And thank you for that very positive close. Mr. Morgridge.

STATEMENT OF JOHN P. MORGRIDGE, CHAIRMAN OF THE BOARD, CISCO SYSTEMS, INC.

Mr. MORGRIDGE. Good morning. I am John Morgridge, Chairman of Cisco Systems, the worldwide leader in networking for the Internet. This year, Cisco celebrates its twentieth anniversary. I am honored to offer this testimony before this committee.

Today's hearing comes at an important and challenging time in our country. It is clear that the United States can no longer take for granted our place as the global economic technology and innovation leader. There is much that government, education, and industry can do to address the challenge, but we cannot be complacent in our response. We must recognize the challenge, and take it head on, if we hope to be successful.

Like my colleagues, I will briefly focus on three areas today: education, the appropriate physical infrastructure, and the proper legal and policy framework. First, and most important, is a sound primary and secondary education system, with a focus on math and science. Education is the foundation. All innovation comes from it, and it is the engine for economic growth. We have the finest post-secondary education institutions in the world, bar none, but we are not producing anywhere near enough ready high school graduates to capitalize on this national asset, and particularly in math, science, and engineering.

There are no easy answers, but technology may help. Ten years ago, our industry faced a shortage of well-trained, network savvy technical personnel, people who understood the fundamentals of networking and could design, install, and maintain networks. To address the challenge, we launched the Cisco Networking Academy Program. High schools, community—technical and community colleges, universities, provided the teachers, students, and classrooms. Cisco provides the online curriculum, currently 16 semesters worth, a distribution network, a teacher training and support system, and in some cases, equipment. Some eight years later, this partnership of some 10,000 institutions, in over 160 countries, has provided basic networking training to 1.2 million individuals. Currently, almost a half million students are involved in the programs. If any of you would like to visit an academy, I would be delighted to join you. There is at least one institution in each Congressional district who is our partner in this program. More recently, based on our academy experience, Cisco has joined others in developing a pilot program in the Kingdom of Jordan to deliver K–12 math curriculum in this blended classroom Internet model. If successful, a science curriculum will follow. We hope to capitalize on this pilot here in the United States and in other countries as well.

We clearly want to have U.S. students studying and excelling at the masters and Ph.D. level in math, science, and engineering, but we must also continue to attract the best and brightest from around the world to our universities, and encourage them to stay after their studies. The positive impact that foreign-born students have had on our innovation economy cannot be underestimated.

Upwards of one third of Cisco's technical personnel are foreign-born.

Lastly, in the area of education, we must continue to fund basic research projects in our universities. They are the major innovation factories. Cisco, like many other countries, was born and incubated at a great research university. NSF and other government agency funding is critical to maintaining this unique U.S. asset.

The second area is having appropriate and proper legal and—I am sorry. The second area is having the appropriate physical infrastructure necessary to support the innovation ecosystem, namely and most specifically, having real, ubiquitous broadband available to all Americans, either a wire line or a wireless. I applaud President Bush's stated goal of having universal broadband connectivity in the United States by 2007, and we are looking forward to the FCC's leadership in making this goal a reality.

Lastly, we must foster innovation by having proper legal and policy framework, particularly in the area of intellectual property and in the patent systems. Patents ensure that inventors have the incentive to invest in further innovation, while at the same time, promoting public access to new inventions. The threat of patent litigation, however, is becoming a drag on innovation, while the current patent system is creating incentives for frivolous lawsuits. Legislation is necessary to reduce the disruptions caused by litigation, and improve the quality of our patents.

At Cisco, our most important asset walks out the door every night. We understand the vital importance of intellectual property to business development, and strong intellectual property protection is necessary. The most effective role of government is to ensure adherence to existing laws, and enforce penalties against transgressors.

In summary, there is a lot that business, government, and education can do to focus on innovation and our national overall competitiveness. In order to innovate and remain competitive in the increasingly global marketplace, we must have the national trained workforce necessary to produce the products and services that the global markets require.

A national focus on science, math, and engineering training is vital for the U.S. to continue leading the innovation economy. We must have the appropriate physical infrastructure, in the form of a ubiquitous true broadband. We must have a date certain for the transition to digital television to free up the spectrum for public safety uses, as well as rural broadband. Finally, we must have a legal framework that incents innovation and a patent system that protects the inventors, while not creating a system that is overly litigious. Patent legislation before the Congress should be passed this session.

Thank you. I will be happy to take any questions.

[The prepared statement of Mr. Morgridge follows:]

PREPARED STATEMENT OF JOHN P. MORGRIDGE

I am John Morgridge, Chairman of the Board of Cisco Systems, the worldwide leader in networking for the Internet. This year, Cisco celebrates 20 years of commitment to technology innovation, industry leadership and corporate social responsibility and I am honored to offer this testimony on innovation and U.S. competitiveness before this committee.

Today's hearing comes at an important and challenging time for our country. It is becoming very clear that the United States can no longer take for granted our place as the global economic, technology, and innovation leader. There is much that government and industry can do to address this challenge, but we cannot be complacent in our response. We must recognize the challenge and take it head on if we hope to be successful.

I will focus on three areas today. The first area, and in my mind, the most important to ensure global competitiveness and continued innovation is a sound education system, including sufficient basic research and development funding as well as a focus on science and math. The second area is having the appropriate physical infrastructure necessary to support the innovation ecosystem, namely, and most specifically, having real, ubiquitous broadband available to all Americans—whether wireline or wireless. Last, we must foster innovation by having a proper legal and policy framework, particularly in intellectual property, security and in the patent system.

I. IMPORTANCE OF EDUCATION TO INNOVATION AND U.S. COMPETITIVENESS

Education is the foundation to all innovation and the engine to economic growth. We must advocate policies that will create an educated workforce to match America's future employment needs, specifically an educated workforce trained in math and science which is critical to the innovation economy. In order for America's high tech industry to stay competitive throughout the 21st Century and beyond, we need to invest in our workforce of tomorrow by giving them the tools necessary to compete for post-secondary education programs or careers in science, math or engineering. We need to make America's educational system the best in the world by making math and science teaching a priority for our children and support efforts on the State and federal levels to accomplish this objective. I applaud what this committee has done to recognize the finest math and science teachers in this country—their work is vital to our future competitiveness.

A domestic workforce educated in science, math or engineering will ensure that the American high tech industry continues to lead the world in terms of innovation and entrepreneurship. Moreover, an educated workforce will enable Cisco and other job producing innovative companies to meet our human resource needs by attracting domestic talent, unencumbered by immigration restrictions.

Unfortunately, America's children are not receiving the necessary training in math and science to compete for high-paying technology jobs of the future. For example, only 24 states require secondary students to take at least three years of math, and only 21 states require students to take at least three years of science.

Because math and science education is lacking, young Americans will miss out on job opportunities, or will lack the necessary skills for post-secondary study. Nationally, out of 100 ninth-graders, only 67 will graduate from high school on time, only 38 will directly enter college, only 26 are still enrolled their sophomore year, and only 18 will end up graduating from college. U.S. 12th graders performed among the lowest of the 21 countries assessed in both math and science on the Third International Mathematics and Science Study.

Improving education worldwide is a top goal of Cisco Systems, Inc. Since 1997, the Cisco Networking Academy Program has leveraged the Internet to improve education around the world. The Cisco Networking Academy Program has enabled Cisco to facilitate public and private partnerships for education and become a leading innovator in e-learning. Since its inception, over 1.6 million students have enrolled at more than 10,000 Academies located in high schools, technical schools, colleges, universities, and community-based organizations in over 150 countries. For more information on this program, please visit: *www.cisco.com/go/netacad.*

We have to be innovative in our approach to education. We are in the 21st century and must use the tools and methods of today to train our future workforce. With an e-learning model such as the Cisco Network Academy Program we have learned that curriculum can be altered based on how well students are performing on the tests based on that curriculum. We have also found that students in East Palo Alto, California, an underprivileged area, perform as well as the richest school districts in America. Given the opportunity and the tools, students can perform and become excited about technology. Students in the Chairman's district are currently becoming certified as Cisco Network Associates at SUNY Institute of Technology and Mohawk Valley Community College, as well as at Broome-Tioga Board of Cooperative Educational Services, serving 15 school districts in Broome and Tioga counties.

Additionally, Cisco has helped develop a pilot program in the Hashemite Kingdom of Jordan to deliver math and science curriculum via the Internet. Partnering with the government of Jordan, the World Economic Forum, U.S. Agency for Inter-

national Development (USAID), and many other corporate partners, the Jordan Education Initiative (JEI) is using the Internet to deliver curriculum of math, Information and Communication Technology (ICT), Arabic and Science (January 2005). Taking the knowledge from this pilot program, we hope to expand to other nations and bring this method of curriculum delivery to the United States as well.

Cisco supports increasing innovation in public schools, establishing high standards, promoting the use of education technology in the classroom and ensuring accountability of schools, teachers, districts and programs. We also support efforts to ensure that all children—and all Americans—share in the information age through access to technology and its benefits. However, we also need to put a renewed focus on math and science in the schools, much like in the 1960's, so that it is the United States producing the innovative technologies and the job centers of tomorrow, rather then our counterparts in Europe or Asia.

The positive impact that foreign-born students have had on our innovation economy cannot be discounted. We clearly want to have U.S. students studying and excelling at the masters and Ph.D. levels in math, science and engineering, but we also must continue to attract the best and the brightest from around the world to our universities and encourage them to stay in the U.S. after their studies. Foreign-born math, science and engineering students have been and continue to be a boon to our economy and we should support their continued success in academia and industry in this nation.

Recognizing the technology industry's responsibility to contribute to an improved education system, TechNet has established an Education Task Force to develop a new private-sector initiative to increase America's math, science and engineering talent. TechNet is a technology policy trade association of CEO's of which Cisco is a founder and active member. The Task Force will examine science and math preparedness in primary and secondary education as well as barriers to science and engineering degree attainment in post-secondary and graduate education. One of the goals of the Task Force is to impact the goal of doubling the number of STEM (Science, Technology, Engineering and Math) majors by 2015. I serve on this Task Force and we will be offering our full report this fall.

Last, but certainly not least, in order to stimulate high-tech research and give companies certainty, the R&D tax credit should be updated and expanded to maximize its impact in incentivizing companies to conduct R&D in the United States. Additionally, funding should be increased for basic R&D at government, university and private labs. It pleases me to no end that Chairman Boehlert is a self-professed "unabashed cheerleader" for the National Science Foundation (NSF) and hope that the increased funding for the NSF he and his colleagues were able to get this year will be built upon.

The House Science Committee, with its deep understanding of the importance of math and science to our overall standing in the world, should continue to use its leadership role, with hearings such as this one, to bring attention to this vital area for U.S. competitiveness and innovation and press for increased funding for math and science education, basic R&D and the National Science Foundation.

II. APPROPRIATE PHYSICAL INFRASTRUCTURE FOR INNOVATION

Broadband Deployment

The Internet, as we know it, was developed with government funds under the direction of the U.S. Advanced Research Projects Agency and, in 1969, became a reality with the interconnection of four university computers. From those humble beginnings, the Internet has now become the basis for efficiencies and productivity never thought possible.

Broadband is always-on, high-speed connectivity to the Internet and it is the foundation of all future information connectivity. Its import to innovation, collaboration and a nation's overall competitiveness cannot be understated. The deployment of broadband infrastructure is a key measure of success for a country and is crucial to the future growth of the innovation economy. I applaud President Bush's stated goal of having universal broadband connectivity in the United States by 2007 and we are looking forward to the FCC's leadership to making this goal a reality.

Although a few countries such as Korea and Japan have achieved significant broadband penetration, most countries lag far behind. The United States has fallen from fourth to 16th in broadband penetration and stands to fall even further. Moreover, with few exceptions, most of the broadband infrastructure available today consists of relative slow connections in the 500kpbs to 3Mbps range, not in the 10Mbps to 100Mbps that will needed to support the development of future innovative applications.

Because telecommunications is one of the most intensely regulated industries and has a legacy of decades of government involvement, regulatory policy significantly affects broadband infrastructure investment. Regulators and government can affect investment in myriad ways, some negative and some positive: through the application of legacy regulation to new technologies, through attempts to artificially create competition, through spectrum allocation, through subsidy systems, and through direct government investment and tax incentives.

Cisco believes that deployment of next generation broadband infrastructure should take priority over most competing interests when deciding regulatory policy. In Cisco's opinion, any national broadband plan should include policies to:

- Incent private sector investment in broadband infrastructure
- Promote market-driven deployment of new technologies and applications
- Encourage innovation and entrepreneurship through clear, concise, minimally intrusive rules that create as much market certainty as is possible
- Make spectrum available for wireless broadband services

Key regulatory policies to implement these goals include removing regulatory requirements to unbundle new networks and new infrastructure investment; keeping onerous telecommunications regulation from being imposed on competitive broadband providers such as cable, wireless, and powerline; avoiding legacy regulation being imposed on new technologies and applications such as VoIP, IP video, and other Internet applications; ensuring sufficient spectrum for high speed broadband access applications; and migrating programs to support infrastructure investment in low density rural areas from a traditional circuit switched voice focus to broadband connectivity.

Digital Television Transition

In order for additional wireless spectrum to be made available for public safety uses, as well as to bring broadband to rural and under-served areas in the Nation, Cisco has advocated a "date certain" to end analog television broadcasting in the 700 MHz band in the U.S.

Current federal law provides that analog television broadcasting will cease by the end of 2006 or when 85 percent of households can receive digital TV signals. It is clear that the 2006 date will not be met, given projected market conditions. Key officials at the FCC, and in the U.S. House of Representatives, have indicated an interest in selecting a date certain of no later than January 1, 2009, and Cisco, along with other high technology companies, including consumer electronics companies, rural interests, and the public safety community, are urging policy-makers to adopt a hard date. Once the transition is complete, 24 MHz of spectrum will be turned over to public safety licensees, and the lion's share would be devoted to commercial wireless service, including broadband access, as the directed by Congress.

Cisco has no "technology religion" with respect to licensed wireless broadband technology. Cisco is a member of the WiMax inter-operability forum, and has also closely followed developments around the 802.20 standard, but we believe it is the market that will best decide what technologies will flourish. As fits our overall philosophy, we do not believe that the government should pick technology winners or losers.

The basic benefits that will be available to the American public as soon as broadcasters give back their second channel will be numerous. According to the Information Technology Industry Council (ITI), of which Cisco is an active member, benefits will include:

1. **Public Safety—**On 9/11 and every day across the country, first responders from police and fire departments cannot speak to each other because their radios operate on different frequencies. The 9/11 Commission Report recommended in 2004 that Congress approve legislation to clear these channels for public safety. Congress was aware of this problem in 1997 and designated more spectrum for use by first responders, but it can't take effect until broadcasters release their currently held spectrum.
2. **Rural Broadband—**Rural areas are one of the major parts of the country that still lack high-speed broadband Internet access. Using the additional spectrum, companies would be able to offer wireless broadband to areas that are not served by current broadband technologies.
3. **Economic Growth—**A definitive digital TV transition date would give high-tech companies enough certainty to invest R&D into innovative wireless broadband networks for use in the newly available spectrum. That would in turn spark growth in the U.S. high-tech sector, provide new high-quality jobs

for American workers, and add to the global competitiveness of U.S. technology.

4. **Telecom Competition—**Today, consumers receive most of their telecommunications services—phone, television, and Internet service—through either their phone line or their cable line. Because spectrum in the 700 megahertz band is of high quality and capable of advanced uses, it could one day become a "third pipe" into consumers' homes that could provide phone, television and Internet services, which would have the effect of increasing competition and reducing prices for consumers.

III. PROPER LEGAL AND POLICY FRAMEWORK FOR INNOVATION

Patent Reform

Patents ensure that inventors have the incentive to invest in further innovation, while at the same time promoting public access to new inventions. The threat of patent litigation, however, is becoming a drag on innovation while the current patent system is creating incentives for frivolous litigation. Legislation is necessary to reduce the disruptions caused by litigation and improve the quality of patents.

Certain factors in the current patent system have resulted in disruptions for Cisco and other leading innovation companies. First, the playing field in the patent legal system has become increasingly tilted towards plaintiffs, making even weak claims problematic for litigation targets. Second, the U.S. Patent and Trademark Office (PTO) is currently overburdened and lacks procedures necessary to avoid issuing poor quality patents on which plaintiffs can stake a claim. Third, some opportunistic trial lawyers and investment funds are buying up patents to use as offensive litigation tools. These so-called "patent trolls" accumulate patent portfolios not to further innovation and development of new products, but to compel others to license technologies from them under threat of litigation. In many instances, these patents are used for strictly tactical purposes, never intended for commercialization of inventions.

Cisco supports efforts to pass common sense patent reform legislation to reduce the disruptions caused by litigation and improve the quality of patents. We are working with other companies and industry groups to craft legislative recommendations to address this issue.

Intellectual Property

At Cisco, we believe our most important assets walk out the door every night. However, as we produce and own intellectual property and understand the vital importance of intellectual property to business development, strong intellectual property protection is necessary. Mandatory or legislated standards are not the answer, however. Technical standards developed and mandated by the government would freeze technological innovation and hurt development of digital technologies. This concept is true for digital rights management, security and other issues where some have asked government to step in and mandate a solution. If history and Moore's Law are any indicators, by the time a technology industry standard is developed and adopted, there is usually one in the pipeline that is better and in the marketplace eighteen months later.

The most effective role of government is to ensure adherence to existing laws and enforce penalties against transgressors.

Security

We all recognize how important security is to our economy, national security, and national competitiveness. Over the years, this committee has been a leader in promoting cyber security research and development, including it's authorship of the 2002 *Cyber Security Research and Development Act* (P.L. 107–305), which brought an important focus to the benefits from additional basic cyber security research at the NSF and the ongoing security work at the National Institute of Standards and Technology. The proper policy framework is also vitally important for continued advances in security.

Innovation sits at the heart of the security challenge. There is tremendous innovation in security technologies. Information security systems are moving from passive to active, and from point products to self-defending networks using an adaptive, and interconnected, architecture-based approach. We will enhance security through innovation and effective law enforcement. As the nature of security continues to change, public policy has to continue recognize the centrality of innovation, and continue to avoid technology mandates or regulation, which at the end of the day will always trail innovation, and make us less, not more, secure.

CONCLUSION

In summary, there is a lot that the government can be doing to focus on innovation and our national overall competitiveness.

In order to innovate and remain competitive in the increasingly global marketplace we must have the national, trained workforce necessary to produce the products and services that the global market requires. If we do not produce them, they will be produced elsewhere. A national, laser focus on science, math and engineering training is vital for the U.S. to continue leading the innovation economy. Further, we must also have the tools to incent the future workforce to go into science, math and engineering. The Financial Accounting Standards Board (FASB), overseen by the Securities and Exchange Commission (SEC), has issued a final rule to require companies to expense stock options—a vital component of what helped build Cisco Systems and other innovative companies around the Nation. Without the appropriate tools to build companies in the U.S., it becomes increasingly difficult to compete.

We also must have the appropriate physical infrastructure in the form of ubiquitous, true broadband. We must have a date certain for the transition to digital television to free up the spectrum for public safety uses as well as for rural broadband.

Finally, we must have a legal framework that incents innovation and a patent system that protects the work of inventors while not creating a system that is so overly litigious to the point of being fruitless to innovation. Patent legislation before the Congress should be passed this session.

Thank you.

BIOGRAPHY FOR JOHN P. MORGRIDGE

John P. Morgridge joined Cisco Systems in 1988 as President and CEO, and grew the company from $5 million to more than $1 billion in sales, and from 34 to more than 2,250 employees. In 1990 he took Cisco public, and in 1995 was appointed Chairman. During his tenure, Cisco has become the leading supplier of high-performance inter-networking products, with more than $20 billion in revenues, and some 34,000 employees in 65 countries.

As Chairman, Morgridge continues to champion a range of education, philanthropy, and corporate citizenship initiatives, and is a guiding force behind the company's long-term commitment to focusing on basic human needs, responsible citizenship, and access to education.

Morgridge speaks frequently to audiences worldwide about productivity, strategic management, entrepreneurialism, and how education and technology can fuel economic development in developing nations. He teaches management at Stanford University's Graduate School of Business, and serves on its School of Business Advisory Council. In 1996, he received Stanford's Arbuckle Award for excellence in management leadership.

Prior to Cisco, Morgridge was President and CEO of GRiD Systems, and before that held senior positions with Stratus Computer and Honeywell Information Systems. He earned a BBA from the University of Wisconsin and an MBA from Stanford.

Morgridge and his wife, Tashia, actively support a range of education, conservation, and human services initiatives, and he serves on the boards of CARE, the Nature Conservancy, Business Executives for National Security, the Wisconsin Alumni Research Foundation, the Cisco Foundation, and the Cisco Learning Institute. Morgridge is also a Trustee of Stanford University.

CISCO SYSTEMS

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July 14, 2005

The Honorable Sherwood Boehlert
Chairman, Science Committee
2320 Rayburn Office Building
Washington, DC 20515

Dear Congressman Boehlert:

Thank you for the invitation to testify before the Committee on Science of the U.S. House of Representatives on July 21, 2005 for the hearing entitled ***"The Future of Computer Science Research in the U.S.."*** In accordance with the Rules Governing Testimony, this letter serves as formal notice of the federal funding I currently receive related to the hearing topic.

Cisco Systems, Inc:

The only funding I am aware of are funds received by University of California Santa Barbara (UCSB) who subcontracts to Cisco Systems, Inc.

Lasor Project for 519,488.80 for FY05 from DARPA/DoD on contract let by DARPA and administered by U.S. Army Research Laboratory Contract W911NF-04-9-0001. Note the funds are actually to UC Santa Barbara (UCSB) who subcontracts to Cisco (not sure if this qualifies given that we do not receive the funds directly from DARPA).

On a personal level:

I received no federal funding directly supporting the subject matter on which I testified, in the current fiscal year or either of the two proceeding fiscal years.

Sincerely,

John P. Morgridge
Chairman of the Board
Cisco Systems, Inc.

Chairman BOEHLERT. I suspected something before I came to today's hearing, because I knew of the witnesses, and Mr. Donofrio and Mr. Morgridge, and I suspect and know Dr. Brody will confirm, this is going to be a love-in. This is people who agree with each other.

The challenge before us is to get other people to pay attention when they are dealing with issues of the moment in other committees, and on the other side of the Capitol, got to deal with this right now, because the moment is here.

Dr. Brody.

STATEMENT OF DR. WILLIAM R. BRODY, PRESIDENT, THE JOHNS HOPKINS UNIVERSITY

Dr. BRODY. Thank you, Mr. Chairman, and Members of the Committee. It is a both an honor and a pleasure to be here today.

Johns Hopkins University, the university of which I am President, was founded in 1876 as the first research university in America. 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 terms of expenditures in science, medical, and engineering research.

But I am also here today as a member of the Council on Competitiveness, and now, co-chair of the Committee's National Innovation Initiative, or NII, which I believe you are all familiar. The Council, of course, brings together labor, business, government, and academic leaders to address issues of importance at this time, of course, being the focus on innovation.

Since you, Mr. Chairman, said this was a learning experience, I am going to teach you introductory calculus, and the calculus is what I call the calculus of innovation, which I have learned from my role on the NII. And it is very simple, this is no homework required. Knowledge drives innovation; innovation drives productivity; productivity drives economic growth. It couldn't be simpler. It is what made America what it is today. And in order to do that, as you have heard, we need talent, we need investment in basic research, and we need infrastructure in order to enable that to happen. And knowledge is key.

What I would like to do is to tell a little story, an example. In the 1960s, I was a graduate student at Stanford University, studying both medicine and electrical engineering. And I had the opportunity to work on a computer system—actually, the computers were made by IBM—on a project to tie computers together. These computers were—it wasn't clear what you would do tying computers together, but the Defense Department, through the Defense Advanced Research Project Agency, DARPA, funded this project, and it was called the DARPANet, and my colleague, John Morgridge, knows about this very well. And of course, in the '60s, we were playing around with this, doing all sorts of things, none of them particularly useful at the beginning. It wasn't clear where it ended. Fast forward 15 years, a graduate student working at Stanford on the DARPANet makes some small computers that he calls workstations, and forms a company called Sun Microsystems.

Sun, if you don't know it, stands for Stanford University Network, and is a multi-billion dollar company today.

Another pair of students, I believe a husband and a wife team, made little devices that move traffic around on this network, and that became the foundation for Cisco Systems, and of course, the DARPANet became the Internet, and not only do we have Cisco and Sun today, but we have got Yahoo! and Google and thousands of other companies, hundreds of thousands of jobs, and tens of billions of dollars.

I use this as an example for two reasons. One, it talks about the investment in sort of blue sky research that has no short-term or foreseeable value, but ends up being extraordinarily valuable. Secondly, it provides a vehicle in which young, talented students can come to a university and learn a new field, in the process of undertaking the research. And also, it illustrates the importance of taking risks, and I think as a nation, we have become extraordinarily risk averse.

You have heard things about education, and certainly, access to talent is critical. And although we have had the best and the brightest coming to the United States, as you know, that is no longer happening in our universities, and we need, I think, very quickly to address what has become a global talent search. In 2002, the House passed the NSF Tech Talent bill, which created incentives for universities to increase the fraction of students receiving degrees in science and engineering majors, but these NSF programs were not funded as authorized. Scholarship money is a critical choice of majors for students, and providing incentives, I think, is a way to fund, to get students, more students into science and engineering by funding scholarships.

We should also augment programs to reach out to underserved, especially under-represented populations, women and minorities, because we are excluding a large potential fraction of the labor pool to access homegrown talent. And universities should be encouraged to bolster science and math teacher training. After all, we have lots of people who are expert in science and math. We should find ways to leverage our expertise into the school system.

We have two urgent priorities before us, I think. The first is to greatly increase government and private funding in basic research, as opposed to applied research, and emphasize the far out research, like the DARPANet that was going on. I use DARPA as an example, because I had a conversation with one of my computer science faculty who recently was telling me that DARPA was becoming very short-term focused. I had, then, a conversation with a president of a major research university, who told me that the DARPA research now was so short-term focused that they were no longer accepting DARPA grants in certain fields, because with a short-term focus, they couldn't put a graduate student on the project for fear that the project funding would end before the graduate student completed the dissertation. This is a huge issue, I think, to turn around, but take a long-term focus.

And we need to fulfill our commitment to double the National Science Foundation budget in the next five years, significantly increasing our basic research efforts in the physical sciences and mathematics and information sciences, as we have through the

doubling of the NIH budget. The NSF budget costs $18 per person, scarcely more than a couple of six packs of your favorite brew or cola, and I think we can't afford not to make this kind of commitment.

I would just like to close by saying that since World War II, America has led the world in science and technology innovations, largely because it was willing to make considerable investments in both its education systems and its research and development infrastructure, that has enabled natural creative genius of the American people to flourish. But today, as at no time in the recent past, we are challenged by other nations equally determined to succeed. As Americans, we wish them every success, except the kind that would come at our own expense. The race belongs to the swiftest, and we must keep running.

Thank you very much for the opportunity to speak today.

[The prepared statement of Dr. Brody follows:]

PREPARED STATEMENT OF WILLIAM R. BRODY

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 Ph.D.s.

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 seven 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 4th grade, U.S. students score above the international average in math and near first in science. At 8th grade, they score below average in math, and only slightly above average in science. By 12th 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 21st 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 home grown 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 home grown 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 six 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 multidisciplinary 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 discernible 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 21st 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 eight 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 drum beat 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.

BIOGRAPHY FOR WILLIAM R. BRODY

William R. Brody became the 13th President of The Johns Hopkins University on September 1, 1996. Immediately prior to assuming the position, Dr. Brody was the Provost of the Academic Health Center at the University of Minnesota. From 1987 to 1994, he was the Martin Donner Professor and Director of the Department of Radiology, Professor of Electrical and Computer Engineering, and Professor of Biomedical Engineering at Johns Hopkins, and Radiologist-in-Chief of The Johns Hopkins Hospital.

A native of Stockton, California, Dr. Brody received his B.S. and M.S. degrees in electrical engineering from the Massachusetts Institute of Technology, and his M.D. and Ph.D., also in electrical engineering, from Stanford University. Following postgraduate training in cardiovascular surgery and radiology at Stanford, the National Institutes of Health and the University of California, San Francisco, Dr. Brody was professor of radiology and electrical engineering at Stanford University (1977–1986). He has been a co-founder of three medical device companies, and served as the President and Chief Executive Officer of Resonex, Inc. from 1984 to 1987. He has over 100 publications and one U.S. patent in the field of medical imaging and has made contributions in medical acoustics, computed tomography, digital radiography and magnetic resonance imaging.

Dr. Brody serves as a trustee of The Commonwealth Fund and of the Baltimore Community Foundation, and sits on the governing committee of the Whitaker Foundation. He serves on the Board of Directors of the following public companies: Medtronic Inc. and Mercantile Bankshares. He is a member of the executive committee of the Council on Competitiveness; the International Academic Advisory Committee, Singapore; and the selection committee of the Goldseker Foundation. He formerly served on the President's Foreign Intelligence Advisory Board, on the Board of the Minnesota Orchestra Association, and on the Corporation of the Massachusetts Institute of Technology. Dr. Brody is a member of the Institute of Medicine, and a fellow of the Institute of Electrical and Electronic Engineers, the American College of Radiology, the American College of Cardiology, the American Heart Association, the International Society of Magnetic Resonance in Medicine, the American Institute of Biomedical Engineering, and the American Academy of Arts and Sciences.

Dr. Brody and his wife, Wendy, have two grown children and reside at Nichols House on the Johns Hopkins Homewood campus.

July 18, 2005

The Honorable Sherwood Boehlert
Chairman, Science Committee
2320 Rayburn House Office Building
Washington, D.C. 20515

Dear Congressman Boehlert:

Thank you for the invitation to testify before the Committee on Science of the U.S. House of Representatives on July 21st for the hearing entitled "U.S. Competitiveness: The Innovation Challenge." I received no federal funding directly supporting the subject matter on which I testified, in the current fiscal year or either of the two proceeding fiscal year or either of the two proceeding fiscal years. However, I am attaching the 2003 and 2004 Federal Awards to Johns Hopkins Institutions.

Sincerely,

William R. Brody

William R. Brody, M.D.
President
The Johns Hopkins University

JOHNS HOPKINS UNIVERSITY

Notes to Schedule of Expenditures of Federal Awards

Year ended June 30, 2003

Expenditures for other federal awards of the University's academic and other divisions and JHPIEGO Corporation are determined using the cost accounting principles and procedures set forth in OMB Circular A-21, *Cost Principles for Educational Institutions*. Under these cost principles, certain expenditures are not allowable or are limited as to reimbursement.

Expenditures for nonfinancial aid awards include facilities and administrative (F&A) costs, relating primarily to facilities operation and maintenance and general, divisional and departmental administration services, which are allocated to direct cost objectives (including federal awards) based on negotiated percentages of direct expenditures, with certain exclusions. F&A costs allocated to such awards for the year ended June 30, 2003 were based on predetermined fixed rates negotiated with DHHS, the University's cognizant federal agency.

(3) Summary of Sponsoring Agencies

The full names of the sponsoring agencies included in the Schedule are as follows:

Defense	–	Department of Defense (DOD), including Defense agencies
DHHS	–	Department of Health and Human Services
AID	–	Agency for International Development
NSF	–	National Science Foundation
NASA	–	National Aeronautics and Space Administration
Energy	–	Department of Energy
Education	–	Department Education
Transportation	–	Department of Transportation

For purposes of the Schedule, agencies which provided less than $3,500,000 of federal awards expended by the University have been combined as "Other." These agencies are detailed in note 7 to the Schedule.

(4) Summary of Facilities and Administrative Costs

Facilities and administrative cost recoveries for the University's academic and other divisions and JHPIEGO Corporation (excluding APL) for the year ended June 30, 2003 are summarized as follows (in thousands):

Research and development	$	171,702
Cooperative agreements:		
JHPIEGO Corporation		5,052
Other		9,228
Training and other similar programs		3,176
Total	$	189,158

(Continued)

JOHNS HOPKINS UNIVERSITY

Notes to Schedule of Expenditures of Federal Awards

Year ended June 30, 2003

(5) Expenditures Under Awards from the Department of Defense

Federal award expenditures for research and development under agreements with agencies of DOD for the year ended June 30, 2003 are summarized as follows (in thousands):

APL		Total
Defense Advanced Research Project Agency	$	11,800
Navy and Office of Naval Research		315,138
Army		15,705
Air Force		5,996
Other sources		38,716
Total APL		387,355
Other divisions		
Air Force		2,909
Army		3,882
Defense Advanced Research Project Agency		1,056
Defense Electronics Supply Center		2,809
Navy and Office of Naval Research		6,051
National Security Agency		960
Other sources		5,547
Total other divisions		23,214
	$	410,569

Other sources consist primarily of expenditures incurred on awards passed through to the University by other nonfederal government and private organizations for which the specific funding source within DOD has not been provided to the University.

(Continued)

JOHNS HOPKINS UNIVERSITY

Notes to Schedule of Expenditures of Federal Awards

Year ended June 30, 2003

(6) Expenditures Under Awards from the Department of Health and Human Services

Federal awards from DHHS for research and development and training and other similar programs include awards from various centers, divisions and institutes of DHHS. Federal award expenditures by funding source within DHHS for the year ended June 30, 2003 are summarized as follows (in thousands):

DHHS funding source	Research and development	Training and other similar programs	Total
Agency for Healthcare Research and Quality	$ 4,078	40	4,118
Maternal and Child Health Bureau	189	111	300
Centers for Disease Control and Prevention	15,457	79	15,536
John E. Fogarty International Center	349	4,107	4,456
Food and Drug Administration	409	—	409
Health Resources and Services Administration	6,548	3,670	10,218
National Cancer Institute	60,061	4,862	64,923
National Center for Complementary and Alternative Medicine	1,686	38	1,724
National Human Genome Research Institute	1,046	23	1,069
National Center for Research Resources	5,496	644	6,140
National Eye Institute	21,679	2,394	24,073
National Heart, Lung and Blood Institute	54,766	6,146	60,912
National Institute of Allergy and Infectious Diseases	57,160	3,120	60,280
National Institute of Arthritis and Musculoskeletal and Skin Diseases	3,999	115	4,114
National Institute of Child Health and Human Development	9,678	357	10,035
National Institute on Deafness and Other Communication Disorders	5,416	1,042	6,458
National Institute of Dental and Craniofacial Research	5,653	188	5,841
National Institute of Diabetes and Digestive and Kidney Diseases	18,548	2,614	21,162
National Institute of Environmental Health Sciences	14,724	946	15,670
National Institute of General Medical Sciences	20,102	6,684	26,786
National Institute of Health	53,778	3,647	57,425
National Institute of Mental Health	18,375	3,613	21,988
National Institute of Neurological Disorders and Stroke	28,885	2,538	31,423
National Institute of Nursing Research	3,495	318	3,813
National Institute for Occupational Safety and Health	194	1,147	1,341
National Institute on Aging	16,028	933	16,961
National Institute on Alcohol Abuse and Alcoholism	5,092	454	5,546
National Institute on Drug Abuse	34,622	2,082	36,704
National Library of Medicine	2,698	283	2,981
Substance Abuse and Mental Health Services Administration	1,156	—	1,156
Other sources	14,519	658	15,177
	$ 485,886	52,853	538,739

(Continued)

JOHNS HOPKINS UNIVERSITY

Notes to Schedule of Expenditures of Federal Awards

Year ended June 30, 2003

Other sources consist primarily of expenditures incurred on awards passed through to the University by other nonfederal government and private organizations for which the specific funding source within DHHS has not been provided to the University.

(7) Expenditures Under Awards from Other Federal Agencies

Federal award expenditures under agreements with other federal agencies by funding source for the year ended June 30, 2003 are summarized as follows (in thousands):

Department of Agriculture	$	2,158
Department of Justice		1,048
Department of Labor		275
Department of Treasury		2,160
Environmental Protection Agency		3,342
National Institute of Standards and Technology		803
Other sources		8,078
Total	$	17,864

Other sources consist primarily of expenditures incurred on awards passed through to the University and APL by other nonfederal government and private organizations for which the specific funding source has not been provided to the University.

(8) Federal Student Loan Programs and Related Matters

The Federal Perkins (Perkins), Health Professions (HPSL) and Nursing Student Loan (NSL) Programs are administered directly by the University and balances and transactions relating to these programs are included in the University's financial statements. The balances of loans outstanding under the Perkins, HPSL and NSL programs were approximately $25,423,600, $1,745,000 and $215,000, respectively, at June 30, 2003.

The University is responsible only for the performance of certain administrative duties with respect to the federally-guaranteed student loan programs and, accordingly, these loans are not included in its financial statements and it is not practical to determine the balance of loans outstanding to students and former students of the University under these programs at June 30, 2003.

JOHNS HOPKINS UNIVERSITY

Notes to Schedule of Expenditures of Federal Awards

Year ended June 30, 2004

Expenditures for other federal awards of the University's academic and other divisions and JHPIEGO Corporation are determined using the cost accounting principles and procedures set forth in OMB Circular A-21, *Cost Principles for Educational Institutions*. Under these cost principles, certain expenditures are not allowable or are limited as to reimbursement.

Expenditures for nonfinancial aid awards include facilities and administrative (F&A) costs, relating primarily to facilities operation and maintenance and general, divisional and departmental administration services, which are allocated to direct cost objectives (including federal awards) based on negotiated percentages of direct expenditures, with certain exclusions. F&A costs allocated to such awards for the year ended June 30, 2004 were based on provisional rates established with DHHS, the University's cognizant federal agency. The University and DHHS completed negotiation of fixed rates for the year ended June 30, 2004 in September 2004. Because the provisional rates exceeded the negotiated fixed rates, the University repaid approximately $11,200,000 to DHHS.

(3) Summary of Sponsoring Agencies

The full names of the sponsoring agencies included in the Schedule are as follows:

Defense	–	Department of Defense (DOD), including Defense agencies
DHHS	–	Department of Health and Human Services
AID	–	Agency for International Development
NSF	–	National Science Foundation
NASA	–	National Aeronautics and Space Administration
Energy	–	Department of Energy
Education	–	Department Education
Transportation	–	Department of Transportation

For purposes of the Schedule, agencies which provide less than $4,000,000 of federal awards expended by the University have been combined as "Other." These agencies are detailed in note 7 to the Schedule.

(4) Summary of Facilities and Administrative Costs

F&A cost recoveries for the University's academic and other divisions and JHPIEGO Corporation (excluding APL) for the year ended June 30, 2004 are summarized as follows (in thousands):

Research and development	$	191,970
Cooperative agreements:		
JHPIEGO Corporation		3,319
Other		8,559
Training and other similar programs		3,478
Total	$	207,326

(Continued)

JOHNS HOPKINS UNIVERSITY

Notes to Schedule of Expenditures of Federal Awards

Year ended June 30, 2004

(5) Expenditures Under Awards from the Department of Defense

Federal award expenditures for research and development under agreements with agencies of the DOD for the year ended June 30, 2004 are summarized as follows (in thousands):

APL		Total
Defense Advanced Research Project Agency	$	10,716
Navy and Office of Naval Research		339,870
Army		17,462
Air Force		8,221
Other sources		78,951
Total APL		455,220
Other divisions		
Air Force		2,220
Army		6,537
Defense Advanced Research Project Agency		3,247
Defense Electronics Supply Center		2,600
Navy and Office of Naval Research		2,851
National Security Agency		1,370
Other sources		3,227
Total other divisions		22,052
	$	477,272

Other sources consist primarily of expenditures incurred on awards passed through to the University by other nonfederal government and private organizations for which the specific funding source within the DOD has not been provided to the University.

(Continued)

JOHNS HOPKINS UNIVERSITY

Notes to Schedule of Expenditures of Federal Awards

Year ended June 30, 2004

(6) Expenditures Under Awards from the Department of Health and Human Services

Federal awards from DHHS for research and development and training include awards from various centers, divisions and institutes of DHHS. Federal award expenditures by funding source within DHHS for the year ended June 30, 2004 are summarized as follows (in thousands):

DHHS funding source	Research and development	Training and other similar programs	Total
Agency for Healthcare Research and Quality	$ 6,018	385	6,403
Maternal and Child Health Bureau	399	448	847
Centers for Disease Control and Prevention	14,572	103	14,675
John E. Fogarty International Center	567	4,011	4,578
Food and Drug Administration	604	—	604
Health Resources and Services Administration	6,059	4,210	10,269
National Cancel Institute	72,455	5,798	78,253
National Center for Complementary and Alternative Medicine	2,699	32	2,731
National Human Genome Research Institute	1,569	46	1,615
National Center for Research Resources	9,583	1,025	10,608
National Eye Institute	26,712	2,592	29,304
National Heart, Lung and Blood Institute	74,112	7,567	81,679
National institute of Allergy and Infectious Diseases	69,319	3,487	72,806
National Institute of Arthritis and Musculoskeletal and Skin Diseases	4,228	463	4,691
National Institute of Child Health and Human Development	15,611	1,086	16,697
National Institute on Deafness and Other Communication Disorders	9,450	1,335	10,785
National Institute of Dental and Craniofacial Research	6,431	138	6,569
National Institute of Diabetes and Digestive and Kidney Diseases	24,599	3,197	27,796
National Institute of Environmental Health Sciences	17,743	1,323	19,066
National Institute of General Medical Sciences	25,741	7,678	33,419
National Institute of Health	18,330	994	19,324
National Institute of Mental Health	27,979	4,123	32,102
National Institute of Neurological Disorders and Stroke	34,592	2,317	36,909
National Institute of Nursing Research	3,418	295	3,713
National Institute for Occupational Safety and Health	52	1,239	1,291
National Institute on Aging	20,907	1,036	21,943
National Institute on Alcohol Abuse and Alcoholism	5,447	527	5,974
National Institute on Drug Abuse	37,773	2,772	40,545
National Library of Medicine	2,140	558	2,698
Substance Abuse and Mental Health Services Administration	468	—	468
Other sources	16,172	2	16,174
	$ 555,749	58,787	614,536

Other sources consist primarily of expenditures incurred on awards passed through to the University by other nonfederal government and private organizations for which the specific funding source within DHHS has not been provided to the University.

(Continued)

JOHNS HOPKINS UNIVERSITY

Notes to Schedule of Expenditures of Federal Awards

Year ended June 30, 2004

(7) Expenditures Under Awards from Other Federal Agencies

Federal award expenditures under agreements with other federal agencies by funding source for the year ended June 30, 2004 are summarized as follows (in thousands):

Department of Agriculture	$	2,302
Department of Justice		1,218
Department of the Treasury		1,861
Environmental Protection Agency		3,676
National Institute of Standards and Technology		348
National Institute of Justice		380
Other sources		10,406
Total	$	20,191

Other sources consist primarily of expenditures incurred on awards passed through to the University and APL by other nonfederal government and private organizations for which the specific funding source has not been provided to the University.

(8) Federal Student Loan Programs and Related Matters

The Federal Perkins (Perkins), Health Professions (HPSL) and Nursing Student Loan (NSL) Programs are administered directly by the University and balances and transactions relating to these programs are included in the University's financial statements. The balances of loans outstanding under the Perkins, HPSL and NSL programs were approximately $26,123,000, $1,408,000 and $246,000, respectively, at June 30, 2004.

The University is responsible only for the performance of certain administrative duties with respect to the federally-guaranteed student loan programs and, accordingly, these loans are not included in its financial statements and it is not practical to determine the balance of loans outstanding to students and former students of the University under these programs at June 30, 2004.

DISCUSSION

Chairman BOEHLERT. I liked the statement in your testimony when you refer to a great American, Dale Earnhardt, Jr.

Dr. BRODY. Yeah.

Chairman BOEHLERT.—and you say his quote, "When the race gets tough, you step on the gas."

Dr. BRODY. Yes.

Chairman BOEHLERT. So, we have got to step on the gas. Speaking about stepping on the gas, a guy that has already got his foot on the pedal, we are pleased to invite him, and to participate in today's deliberations, our distinguished colleague, Mr. Culberson, from Texas, who is a member of the Appropriations Committee, and I want more people to have the same insight that he has, who are appropriators.

Mr. Culberson, I ask unanimous consent that you be permitted to participate in today's proceedings, and welcome. And thank you for your interest. You are sitting, on your right, next to two very distinguished scientists in their own right, Dr. Ehlers, Vern Ehlers, and Dr. Bartlett, Roscoe Bartlett, two very distinguished scientists.

Let me tell you something. Once again, it is music to our ears what you are telling us. Our challenge is how do we get the other Members of Congress to focus more on this, and how do we get people to say you know, that is right. We should invest more in the National Science Foundation, and you know, it is just—they have more money in the coffee fund over at the Pentagon across the river——

Dr. BRODY. Yeah.

Chairman BOEHLERT.—than we have in the annual budget for the National Science Foundation, and it is——

Dr. BRODY. Yeah.

Chairman BOEHLERT.—so vitally important, not just to our present, to our future. And you are so right when you mention DARPA, and we have had Tony Tether over here before us, and say hey, look, you are getting too short-term in your thinking. You have got to think about the immediate problems, but you can't abandon the long range thinking.

But one of the things I say to all the captains of industry, when they come before us, you have got to step up the lobbying effort. When a budget comes out, I don't care if it is this Administration or the previous Administration, and you see the figures for the National Science Foundation or the Office of Science in the Department of Energy, or the National Institute of Standards and Technology, and you shake your head and say, gee, that is not adequate, but your lobbyists don't come up and beat on the doors of all the Congresspeople, and say that is not adequate, and for Cisco and for IBM, you have got to invest more, and that is a message from IBM and Cisco, you have got to invest more in this, because your lobbyists come up, and talk to us about the most current tweaking of trade policy, or the necessity for adjusting tax policy to encourage innovation, and there is nothing wrong with that, but they never get to the rest of the story, and the rest of the story deals with adequate funding for science on the part of the Federal Government.

And we wouldn't have the Internet today if it weren't for DARPA and NSF, and the Internet has changed the world. And so people who say, but too many people expect from us, you know, when we invest in research, they expect guaranteed results. You don't have guaranteed results with research. You are going to have more failures than successes, and you hope and pray that you get one out of a hundred ideas that you can follow through to a logical conclusion. But if we don't do a better job of building the foundation to the structure, and Mr. Morgridge, you are so right, and I praise Cisco for what you are doing with the academies and the thousands of people you are introducing to the new technology. But if we don't do a better job of K–12 science and math education, that is a national security issue. That is not just a bunch of people who agree that we all want better education for our kids and grandkids. It is a national security issue, and we are failing.

In international comparisons, with youngsters around the world, our kids in K–12 don't measure up. By the fourth grade, they are about on par. By the eighth grade, they are slightly behind, and by the twelfth grade, they are way behind. Boy, that doesn't guarantee us anything in the future but more agita. You know, I get all exercised about this, but I just hope that other companies in corporate America will follow the lead of your two great institutions, and I am not just, you know, currying favor with you because you are here. But I know the IBM record. I know the Cisco record. But I would like every company to replicate that.

I have got a company in my district, a small company, called Dolphin Technology. They have got 100 employees. You know what the president of that company, a guy named Mike Miravalle, who I wish I could clone. I don't believe in human cloning, but I wish I could clone this guy. If I—he takes promising high school sophomores and juniors. He goes to the schools and gets the recommendation of their teachers, and then he employs them in the summer at his company, pays them 10 bucks an hour. Can you imagine a 15-year-old kid getting 10 bucks an hour? And assigns them to a mentor, and the mentor works with that kid, and they are only there for 10 or 12 weeks, and they get a few bucks in their pocket. They get some discipline in the job market, and they get excited about the promise of their future, and he called me up one day this spring, and he was so proud. One of the kids that participated in this mentoring program was from the inner city. He happened to be a star athlete, a great quarterback, and he called me up, and he said hey, remember the kid I told you about? He just got a full scholarship, full scholarship, to a very distinguished university. Guess what? It was an academic scholarship, not a sports scholarship. He had a lot of offers, so when I speak to the NAM or the Chamber of Commerce, and all the businesspeople start complaining to me, you know, these high school graduates, we have to retrain them. We can't even employ them right away. We have got to retrain them. I listen to them. I say quit moaning and groaning and start doing something about it. Go back and survey your company, and then come back and report to me, how many of your employees have run for school board. Everybody says education should operate like a business. How many businesspeople do we have on boards of education? Oh, I can't get involved. I am too busy in my

business. You better damn well get involved, because there is a lot at stake.

So, excuse this monologue, but in the form of thanking for you for what you are doing, it reminds me of my parish priest. Once a year, I am convinced from on high the bishop sends down an order, and he says I want you to give your homily this week on a sense of reverence and church attendance, and boy, he is good at it. And he gets wound up, and about halfway through, I feel like saying time out, but Father, we are here. So, you are here, and just thank you so much for what you are doing. And I want, and I know I can expect a renewed commitment for you to continue that.

I have got some very specific questions, but the red light is on for me, so I will go to Mr. Costello, and I will be at the end. Mr. Costello.

Mr. COSTELLO. Mr. Chairman, thank you, and I would like to associate myself with your remarks concerning the innovations that both IBM and Cisco have made, and contributions that they have made not only to the economy here in the United States, but the global economy as well. Also with your remarks to encourage those who are here today and others in the private sector to become engaged and do a better job of lobbying on behalf of research and development, and lobbying both the White House and the Congress. We need your help. You are kind of singing to the choir here. We are all in this together, and we understand the importance of R&D and investment, unfortunately, as the Chairman pointed out, there are others, other challenges, and because of budget deficits, but we need you to help us convince our colleagues, and those in the Administration that we need to make those investments.

I think we can all agree, as the Chairman pointed out, and I think the three of you pointed out, the importance of education, in particular K–12 in math and science. I think we can all agree that we have a responsibility, and that we should aggressively be investing more in research and development.

My concern, frankly, and the reason that we held the roundtable discussion, and the reason that I have brought up the issue several times in various hearings of this committee, is the issue of outsourcing. I think, Dr. Brody, in particular, in your testimony, you point out the discrepancy between the percentage of U.S. college graduates obtaining degrees in science and engineering, and in comparison to the world average, and especially, relative to the percentages in Korea and China. And you point out that the quality of the graduates, essentially is equivalent to us here in the United States in U.S. institutions. In fact, many of our institutions are affiliating with educational institutions in China, Asia, and other parts of the world. You point out that high speed communications now link us together, where you are based is really not an issue any longer, and as a result, many of the U.S. companies are outsourcing, and we are competing with low wages.

So, I guess my question to you is, in particular, is the—if we simply just increase the number of U.S. science and engineering graduates, how does that address the problem of outsourcing, number one. Number two, what do we tell young people today that are in K–12, that we need more engineers, we need more scientists, but the prospects of you entering these careers, if you in fact become

graduates, and you become a scientist or an engineer, that the wages that you are looking at today have not increased in several years in the United States, and number two, that many U.S. companies are now, because of the low wages, and the quality of education, as you point out in your testimony, is equivalent to U.S. graduates. How does that all shake out?

Dr. BRODY. Congressman Costello, you ask a question that probably exceeds my capability to answer in components. I would like just to address one issue. One critical factor that nobody seems to be talking about, one reason that the United States needs to train more scientists and engineers, is we have a large number of jobs in the defense and security infrastructure that require security clearances. And for example, we at the Applied Physics Lab, it is in Congressman Bartlett's district, 2000 scientists and engineers. They need clearance. If we bring students from other parts of the world in, it is very hard to get clearance. And we have a large number on that workforce that is going to be retiring, and we do not have the people coming up to replace them. So, this is a critical security issue, irrespective of anything else that we have talked about. I will leave the outsourcing question to my colleagues. I think they are more expert. But I suspect that one of the things that is happening is the wages may come down a little bit in the U.S., but my prediction is that the wages for scientists and engineers in other countries are going to rise much more rapidly and equilibrate, that you know, there are still only a number of really exceedingly bright people, and they are going to command a premium in the workforce.

And the other thing that we need to do that we haven't done, and I think this is a university responsibility, is to sell why careers in science and engineering are useful. A technical background, even if you go off and become a manager, you move into other fields, a technical background is really important, and I think we need to sell those careers, not just an issue of well, if I go to work for IBM as an engineer, I am going to make, you know, less than if I go to Wall Street and work for Goldman Sachs.

Mr. COSTELLO. Mr. Morgridge.

Mr. MORGRIDGE. Over the past year, Cisco has added about 3,000 positions. Currently, about two-thirds of our employees, and we have about 37,000, 38,000, are in the United States. The positions that we have added have been principally in engineering and sales, and sales support. From an engineering standpoint, the vast majority of those jobs are here, either in San Jose, California, which is our headquarters, or in one of our three other campuses. The sales jobs, as you might expect, are all over the globe, because only 45 percent of our total revenue is generated here in the U.S., so a large portion of our business is outside the United States, and the technical support for that business, and the sales, of course, are located in country.

So, as long as we are able to get the best and the brightest, our real preference is to hire at these campuses. We have invested a lot of money in developing them. That is, the Internet is a powerful collaboration tool, but it is not the same, it is not the same as being geographically and physically related. There is magic to that that you don't quite get in the Internet.

Mr. COSTELLO. When you mention that as long as we can get the best and the brightest, our preference, and of course, we understand that, but you have a responsibility to stockholders, you have a responsibility to others, as far as from a competitiveness standpoint. And if you have an equivalent elsewhere, an engineer or scientist that is making one third of the wages of someone in the United States that can perform the job, don't you have a responsibility to take a look at that, and isn't that what is going on in manufacturing today in other sectors, because there is an equivalent, where the only call is money? Many of the jobs are being outsourced.

Mr. MORGRIDGE. Well, it actually goes beyond money. You know, it is yet to be demonstrated conclusively that creativity is going to be as transferable geographically as some would think. And certainly, our experience to date is that the best work, the most creative work, is to get the best and the brightest, and situate them in our environment here in the United States, and certainly, I see that continuing. The only exception to that rule is that all markets don't develop at the same pace, and some of them differentiate themselves, and to be successful in those markets, you have to have on the ground contact to understand, and I think we are seeing some of that. That is not a zero sum game. That is, we would hope that there is actual considerable upside, and I would cite just the use of the cell phone as a kind of a broad base platform. That is different around the world. And it is important to be in those countries where they have used it differently, and understand why and how, so that we can develop those solutions.

Mr. COSTELLO. Briefly, Mr. Donofrio.

Mr. DONOFRIO. Thank you. Thank you, Congressman. It is a complex problem. It is a complex situation. I will try to simply my views on this, IBM's views on this.

Everything is changing, and we are naïve to think that it is not. It is not just technology. It is the entire business environment. Value is migrating. That is the fundamental issue. Value that creates real wealth. Everything will flow from that. For us, we had a near death experience in order to appreciate and understand that value had migrated. In our business, there are systems, there is software, and there is services. And they always existed, it is interesting, for 100 years more or less that we have been around as the wonderful IBM company, but what customers want, what clients want, and what they are willing to pay you for changes. It changes because of market forces. This is where we need to look. This is where we need to start, as we have these discussions and these debates, about what innovation is like in the 21st century. What is the role of science, engineering, technology, and mathematics?

It is critically important, but it is not the necessary and sufficient condition. It is critically important that we build on the bona fides that we have established here in the United States, and that we continue to worry about why we are not producing more science, scientists, technologists, engineers, and mathematicians. And what is wrong with the K–12 education system, and why have we left behind an incredible percentage of the population, the Hispanic population. I mean, if you really want to worry, look at the number of Hispanics in terms of how many of them are entering the STEM

disciplines. They are the fundamental reason this country is growing. They will be 25 if not 30 percent of the population in the next foreseeable future.

That aside, will not get us to where we want to be, a leader in the world economy. We will not be the leader by sheer numbers. That is probably a preordained and destined fact in the next 10 or 15 years, but that does not mean that the United States of America cannot lead the world from an economic perspective. It needs to lead it from an innovation perspective. We have always thought better than anyone else in the world. We have always found value. That is how John created Cisco, that value. All of the examples that Bill talked about. They are all innovative examples that found real business value or societal value, based on technology.

This is the fundamental issue. We need to educate ourselves, and we need to make this a national platform. We need to find a way to rally around this, not just government, but we need you leading us too. Us, the academic institutions, labor, this is the only way that real leadership is going to be found on this topic.

So, you worry about the whole issue of outsourcing and globalization. We are in 174 countries around the world. It is a simple thought for us. The right task, with the right skills, in the right place. That is what determines where things get moved. But in the end, we have more employment in the United States for the last year, for the year before, and for this year, than we have had before.

So, our employment is not going down. It is the kind of people that we are employing. It is the thought process that we are employing. It is this whole idea of services that we keep forgetting about. We have 195,000, 195,000 engineers, scientists, technologists, and mathematicians in the IBM company, Congressman, around the world. Half of them are in services. Half of them are applying all of that incredible educational capability at this whole issue of what is the business issue, what is the societal issue, and how do I put technology to work to solve that problem faster.

That is the key for our success.

Chairman BOEHLERT. The gentleman's time has expired. Dr. Bartlett.

Mr. BARTLETT. Thank you, Doctor. I feel very comfortable at this hearing, having spent 24 years in a former life teaching, five years working for Johns Hopkins University Applied Physics Lab and eight years working for IBM. Gentlemen, thank you very much.

Chairman BOEHLERT. Is that a commercial?

Mr. BARTLETT. Yeah, I have a longer view of life than most Members of Congress, having been born in 1926. Mr. Donofrio, you mentioned that 90—I am sorry, that 75 percent of our economy was service-based. Now, if you push this service-based economy to an absurdity, if all we do is cut each other's hair and take in each other's laundry, that is clearly not a very good prescription for prosperity, is it? Do you think this may have something to do with the fact that we had last year, about a $700 billion trade deficit?

Mr. DONOFRIO. Well, Congressman, that is part of the problem, is we actually don't understand what the metrics are that should lead us in the 21st century. We continue to apply, in all due respect, Industrial Age views to the evolving economies of the 21st

century. Services, for instance, that category, it includes all of the things you just said, and it includes about 90,000 of our wonderful engineers and scientists from around the world working in our services sector as well. We need a better understanding of what the real value driver is in services, instead of just homogenizing everything.

I would argue that yes, our services-based people and others, you know, others in the industry, the communications industry and the IT industry, they are generating real value. They are generating real wealth. They are generating real jobs, but most importantly, they are creating real business and societal value. We need to start to understand, how do we educate people to do that? So, let us take services apart into its various categories and constituencies, let us start treating at least services in information technology and communications technology, let us start treating it with a different thought process. Let us treat it as a science, as an engineering discipline.

You do remember, it wasn't so long ago, you could not get a computer science degree. In fact, when I went to school, 41 years ago, when I graduated from school, I had to hide away in the EE department, take as many computer courses as I could, and then came out to go to work for a computer company. It is only 25 or 30 years that we have reformed our view of yeah, these computers will be around for a while. They are not going to go away. I think we are at a very similar tipping point on this whole issue of services. It is a science. It is a discipline. It may be where the real value is, and it is not just cutting your hair, polishing your shoes, and changing your oil.

Mr. BARTLETT. Mr. Donofrio, don't you think that maybe this information technology is to the world of economy, manufacturing, mining, and agriculture, like mathematics is to science and engineering? If all you trained were mathematicians, and they never applied their skills to manufacturing and science and so forth, you know, I think we are kind of obsessed with moving these little electrons around and storing them and coughing them up and doing it faster and faster.

Mr. Morgridge, you mentioned that we needed to attract the best and the brightest from around the world. Don't you think this is a cop-out, because we aren't able to turn out good graduates from our secondary schools?

Mr. MORGRIDGE. In a global, competitive world, I don't think so.

Mr. BARTLETT. But you know, if we are going to do this, and if every country is going to do that, you know, why should we have to drain brains from other countries? Don't you think we have enough in our country, if we shaped up our secondary education system, so that we were turning out adequate numbers of prepared young people to enter our graduate schools?

Mr. MORGRIDGE. I think that is an awfully broad assumption, but I still think that——

Mr. BARTLETT. Do you think that the students from other parts of the world are inherently brighter than ours, that we have to go there?

Mr. MORGRIDGE. No.

Mr. BARTLETT. I don't for a minute think that. I think you are going there because we are failing at K–12. Mr. Donofrio mentioned that our graduate schools were the envy of the world. But they are having some pretty darn good ones other places in the world, and we are now having trouble attracting the brightest and the best in the world. But that is only a very recent phenomenon.

Mr. MORGRIDGE. Right.

Mr. BARTLETT. And I just don't think we need to go outside our country, if we had adequate K–12 education. I think that is where the challenge is. Mr. Chairman, if you would indulge me just one quick question to Dr. Brody.

Dr. Brody, I think that our intense focus on this information technology is a bit like gilding the lily. It is already pretty darn good, thank you. And I wonder if we shouldn't now be using the skills that we have developed there to apply to some real world challenges, like maybe energy.

Dr. BRODY. Well, I am not an expert. Clearly, energy is going to be the looming issue for all of us, and if we don't get on that, as a critical number one priority for our country, we are all going to be reading with the lights out, and that is probably not a good way to read. It might be good for the Hopkins Ophthalmology Clinic, but otherwise—I will go back, just if I might, the other—we are in a global competition for talent, and I use the analogy of the NBA. You know, for many years, the NBA had only American players. Now, you look at the NBA roster, it is worldwide, including Yao Ming from China. It is a global search for talent, and wherever the best and brightest are, if there is a large talent pool, you know, companies and universities are going to want to get the very best and brightest.

That does not forgive us for failing at K–12, which is failing, and we need to do something about that, as a major priority as well.

Mr. BARTLETT. Thank you for recognizing that. Thank you, Mr. Chairman.

Chairman BOEHLERT. The gentleman's time has expired. But what I am hearing the panel say is that we don't have to just serve as a magnet to attract the brightest minds from all around the world. We have got to do both. We have got to produce them here, but we have got to attract them from wherever we can attract them. In other words, we need a good mix. That is the greatness of America.

Mr. Lipinski.

Mr. LIPINSKI. Thank you, Mr. Chairman. I can't really top Dr. Bartlett there, or we also—with his background, but I do have a unique background, in that I am an engineer. I have a background in engineering, and one of only 11 Members of the House and Senate, I am told, that does. But then again, you could say that I got a couple degrees in engineering, then I went and got a Ph.D. in political science, so I am not sure what that says, and I am not sure. I was sitting here thinking about how do we encourage people to go in for these higher degrees in engineering, and I think well, what happened to me. But I also, you know, share something with Mr. Morgridge and Brody, that I have a degree from Stanford also. So, I do have that going.

I look at this from many different angles, as someone who taught political science at a university, someone with an engineering background. But it really, to me, comes down to how do we do the best job we can here in Washington, so that we can employ more Americans? And that is where I am coming at this from, and I realize that if you are running a company, though, you need to take care of the stockholders, and—that is an inherent tension there that I think we don't deal with, we don't talk about enough, but I think we need to work together as the government, companies, to help try and employ more Americans. So, we talk about a lot of different things here, and I sort of wonder, I know they are all important, but I want to know, what do you think is most important? We see these other countries producing more Ph.D.s in science and engineering. We see students doing better, say, at eighth grade level, or the eighth grade level here, students are doing better in science and math in other countries.

We also talk about the problem with short-term, too much short-term emphasis on research and development. What is most important? Is it most important that we bring all our students up, or is it more important that we have a select few that are really interested in going for advanced degrees, science, engineering, other fields where we can innovate, and then, that will create the jobs? Or is it the focus of our companies in being too short-term, or having too much of a short-term focus? Well, that doesn't seem to make a difference there. Why are other countries doing better than we are doing?

So, what is the one step each of you would say that we should take here in Washington to help have a brighter future to employ more Americans? Nice easy question, right?

Dr. BRODY. I don't want to disagree with you, but I don't think there is one step. I think a better way to think about it is there are some things you can do over the short-term that will have a short-term impact. There are some things over the intermediate-term, and there are longer-term things. The short-term, we can increase funding for basic research in math and physical sciences, through the NSF budget, as we have with the NIH. Clearly, I think, in time, DARPA, hopefully, will get back to their original longer focus mission.

I think K–12, our educational system, didn't get into the state it is in overnight, and it is not going to get out of the state it is overnight. So, although we can do individual things to help individual students, turning around the system has to be viewed as an important priority, but one that will take probably many, many years to turn around.

Mr. LIPINSKI. Do you think, is it in the system, or is it in society?

Dr. BRODY. It is both. It is both. Turn on the television and see what we value. That is part of it. But also, then, you—and the way we manifest that is the way we invest in our local school boards. It is about nobody taking the time to join the school boards. It is, it is society's values, and we will have to turn that around over time. But there are things that we can do. Incentives always work, if you get the right incentives in there, if we could incent some students into science and engineering careers, one way or another,

through scholarships and the like, it will have an impact over the short-term.

Mr. LIPINSKI. Well, what do you think those incentives, good incentives would be from the government?

Dr. BRODY. Well, I think scholarships, forgiving loans, for example, for students who go on to college and major in science and engineering. Loans are a huge burden for college students, and that would be a big incentive for students, to think about it. The fact that you went on to get a Ph.D. in another field is not a bad thing. I think these cross-disciplinary people who become leaders in whatever field, including Congress, who have the broad disciplines, including a scientific training or engineering, is a good thing. So, the fact that we lose people is not bad, but getting more people trained. You go to other countries in Asia, and most of the senior government officials all have technical training at their undergraduate level. Some of them then have Ph.D.s. Some of them go to business school or law school. But it is amazing how many of the leaders of those countries have engineering or science training.

Chairman BOEHLERT. The gentleman's time has expired, and we go to a Ph.D., a very distinguished one in his own right, Dr. Vern Ehlers.

Mr. EHLERS. Thank you, Mr. Chairman, and thank you for the monologue you gave. I am going to do something, and not just because you did, but I will copy you in one respect. That is quoting a racing figure. I am reminded of Mario Andretti's comment that if you are in control, you are going too slow. That, in a sense, describes the creative process as well. I believe that the most important phrase in science is not "Eureka, I found it," but "that is funny, I never saw that before. I wonder what is causing it?"

The creative process is hard to—for us to control, but we have to plough the ground and provide the fertilizer for it to take place, and we are not doing that. I think—I believe this is the most important hearing on the Hill this week, maybe this year. And that may seem like an outrageous statement, in view of the lack of extensive media coverage and so forth, but just think back 30, 35 years. This committee was talking about the DARPANet, and look what happened. What happened, what came out of that, has affected the world much more than anything that happened in the Defense Committee or other major committees. When Alan Greenspan comes and testifies, all the media are there. What we are talking about here today is going to have a greater effect on the economy of this nation than anything that the Fed decides this week, and we have to get that word out. We have to emphasize how important it is for the future of this country that the ideas you are presenting are the basis for our next 30 to 40 years of success as a nation. And that is our job, but it is also your job, as the chairman said. We have to get the scientific and engineering community out there helping us and lobbying. We have to improve our educational system.

Just one bright spot you can go home with. Today, I am on the Education and Workforce Committee. Right now, we are marking up the Higher Education Bill, and Congressman McKeon and I are offering a scholarship amendment to offer 1,000 scholarships each year to the 1,000 brightest students we identify, to go forward and

study in the sciences, engineering, mathematics, and so forth. And the problem is going to be getting funding for it. I think we will get it passed. I suspect the House will pass it, and you can help us get the Senate to pass it, but then, where is the money coming from? And that is where you and your colleagues are going to have to lobby every year to get sufficient funds to keep that program going.

Also, there is a cultural attitude that I am very concerned about, a cultural attitude that says women are no good at science and math. It is unique to this nation. I believe we have to reverse that. It is happening, but we have to work more diligently at that. I give many speeches in the schools, and I always tell the students in high schools. I said when you get out of this place, you are either going to be a nerd or be working for a nerd, and the choices you make now in high school are going to determine which. And I also assure them that I am a nerd, and they never believe it until I show them my plastic pocket protector. That is my badge of my identity.

A few questions. First of all, Mr. Donofrio, I appreciate your comments about intellectual property protection. I have been pushing that really hard with—especially with respect to China, and just yesterday, talked to both our trade representative and our Secretary of Treasury on that issue, and encouraged them, once again, to pursue it. But you made an interesting comment, Mr. Donofrio, not in your spoken testimony, but in your written testimony. You called for new performance metrics to measure innovation. I think that is very important, but I wonder if you could expand on that, as to just how you would do that. We are planning, by the way, an important conference in October on innovation and creativity. I see Deborah Wince-Smith in the audience. She is part of the planning group as well. And I think that is one issue we have to work on, and how we can apply this to manufacturing. So, I am interested in your detailed thoughts on that.

Mr. DONOFRIO. It would be good, by the way, I thank you for the comments and for the question, maybe that conference that you are going to hold in October, maybe we can do more on this whole issue of the right performance metrics for innovation in the 21st century.

I think most of you recognize that the current system we have, the current view we have of innovation, is fundamentally determined by the Industrial Revolution, and I mean, I am not saying there is anything wrong with that, but it is 20th, at best, 20th century thought. We are in a 21st century environment, and again, I will sound a little repetitive here, things are moving. Value is moving one more time. And if you are not watching value, you end up, as we did, in an almost near death experience.

So, the way you look at innovation in the 21st century, and these metrics that you are looking for, it is a very complex set of issues. You can measure piece parts. You can measure things that will contribute, and we have described an environment, for instance, in the NII report, that we think make sense, to support an innovative economy and an innovative growth opportunity for the United States of America. And look, we are all Americans here, so I mean, we would like the United States of America to continue to succeed and lead, but to your point, if we don't, someone else will. You

know, it is a very interesting world that we live in, and by the way, the United States isn't the only country that doesn't do so well with women in STEM disciplines. Almost every other country, with the notable exception of China. China does incredibly well with women in the STEM disciplines. Just another reason to worry about whether or not we can continue to lead here if we leave half the population behind, more or less.

So, to your point, specifically, we could do a better job of looking at how research and development is funded. The reports suggest we should be doing a better job of more complete research and development funding, not piece by piece, not a piece of a solution, but the totality of a solution. President Brody has already indicated we should be doing a better job of funding the physical sciences. I mean, this is on the government side. Not take away from the life sciences, but I mean, have you seen the budgets for physical sciences over the last 25 years? They are flatlined. They are flatlined. I mean, we are, thank God, they are at least flat, but that is not the way you get ahead in the physical sciences. We could do a lot more on education. We agree with you, curriculum reform at the higher education level, as well as a more concentrated set of thoughts on K–12. Outcomes and the value migration is a very complex issue that we do need to find a set of metrics to work on. We are committed to do that, by the way, with the National Innovation Initiative and the follow-on work. We would welcome the opportunity to either participate in your conference in October, or perhaps we should have another hearing on this very topic, because I will tell you, no one else in the world has figured this out either. So, we are not—it is not like we are being way left behind here. If we can get it right, if we can find the measurements, and then from the measurements, we can therefore find the right things to incent, to get the right behavior, to be the leader in innovation in the 21st century. It is in front of us, to be able to see, to understand, and to grab.

I hope that helps you a bit.

Mr. EHLERS. Thank you. And Mr. Chairman, if I may have just 15 seconds, I want to compliment Mr. Morgridge on his statement that creativity is not necessarily geographically transferable, and I criticized American culture vis á vis science and math education, but I will compliment American culture on the creativity that is intrinsic to the thinking of this nation, and that is one of our biggest aces in the hole to overcome the advantage other countries have in wages.

Thank you.

Chairman BOEHLERT. Thank you, Dr. Ehlers. Mr. Carnahan.

Mr. CARNAHAN. Thank you, Mr. Chairman, and I want to say, in particular, to you that I agree with you, that K–12 education is a national security issue. I also want to thank the panel, and also, specifically, mention to Mr. Morgridge, your comment about education being the foundation for innovation, absolutely is true. I agree wholeheartedly. The quandary that I think I see here is that we have seen education policy, at the Federal Government level, and then many states, has really been one of devolution of education funding. At the Federal Government level, we have seen, you know, arguments over whether we can fully fund No Child Left

Behind. Many state governments, from elementary and secondary and higher education, they have been cutting those budgets, where most of our state education funding comes from. In particular, higher education. We have seen those costs passed on to students in higher tuition. Students are racking up higher debt than ever before.

When I was in the state legislature and served on our Education Appropriations Committee, the one thing that struck me is we didn't have business leaders showing up at our hearings, and none of them were weighing in on the questions of how important the funding of education was. That is why I am so heartened to see you here today engaged in that discussion. We have also seen, at the local level, the burden land on these local school boards with regard to how to properly fund their schools.

We can't pass everything down, and pass everything off to the local school boards. I guess you can tell from the nature of my comments that I would like to know what you think about that—our overall education policy in the country, and what you are doing, or can do, to really weigh in on that debate as we have it here, and as we have it at the state level. And—well, I would ask that of the panel.

Mr. MORGRIDGE. Well, certainly in California, and particularly in Silicon Valley, there have been kind of continuous efforts focused on primary and secondary education. Currently, TechNet, which is a collaboration of high tech companies in Silicon Valley, is putting forth a proposal on education, primary and secondary education, and on post-secondary education. So, there is not only an increased awareness, but also, increased activity, in terms of carrying that forward.

You know, one of the things we forget, we do have excellent elementary and secondary schools. I am very proud of the high school that I went to. I have gone back and visited it numerous times. I would love to go back there and go to school. And I am sure in your districts, there are outstanding primary and secondary schools. The key is, we don't have enough of them. And more critically, we have a third of them that are almost total failures, and that third is addressing a very important piece of our future population and of our national asset. And we can't afford to have two thirds of them not participate and develop. And you know, to your question, we have got to solve that problem if, indeed, we want some level of independence, relative to the source of key technical and engineering personnel.

So, I think there certainly has been an ongoing interest on the part of business. I think it has heightened—I think there is greater recognition, as there is in this body, of the criticality of it, and so, I think that business is prepared to work collaboratively, and to push State governments and local governments on the issue of education funding.

Mr. CARNAHAN. Thank you.

Mr. DONOFRIO. Could I add something to that, if there is time.

Mr. BOEHLERT. By all means, yes, please.

Mr. DONOFRIO. So, I agree with everything John said. I would just simply add, the real issue here that I think you are trying to talk about and deal with is math and science, and why are we for-

saking ourselves here. You realize this problem that we are talking about starts in the third, the fourth, and the fifth grade. This problem is too late by the time we get to high school, let alone college.

There is enough research done on this matter that suggests that the problem lies with the fact that we don't have adequately capable teachers. It is true that in the fourth and the fifth grade, young women get deprogrammed from math and science. They get frustrated. Under-represented minorities get frustrated, and they become channeled to go do other things. So, if you were really looking for one thing to do, from my perspective, having spent 20 years trying to figure out this problem, it is teachers. We need better math and science teachers. That is how we will get more and more people through the system into our college programs, because the other countries that we are all worried about, it is what they do. It is how they major in this stuff.

Chairman BOEHLERT. The gentleman's time has expired. To follow through on that, just let me point out—the reality of something. About half of the kids in K–12 in America are taking science and math courses from teachers who didn't major in a science or math discipline. That doesn't mean they are not dedicated educators, but quite frankly, I don't want a French major teaching my grandkids calculus, because they will end up with the same result, where their grandfather still doesn't understand it, but that is part of the problem.

And then secondly, they will say, well, why don't we get the best and the brightest in science and math majors to go into teaching? Because we are stupid about the way we do it. Here is what happens. You got people in undergraduate work majoring in science and math, excelling, and they say, you know what? I would love to teach. What a rewarding profession that is. But then they graduate, and it is gee, I got $28,000 in student loans to pay back, and Johnny and Susie want to get married, and begin to start their family, and they say, boy, IBM and Cisco, they have got this offer to me for double what the local high school or grade school is offering, and I really want to teach, but I can't afford to teach. I will do it later, and later never comes about. So they make a practical decision.

So, one of the things this committee has done is start out the Science and Math Scholarship Program. And it took us five years after we got it authorized to get a buck for it, and we give stipends, $10,000, to juniors and seniors in college, science, math, or engineering majors, who will agree, for each year of the stipend, to teach two years in public education, help solve their problem of income, and it helps solve our problem of getting them in the classroom. But I don't want anyone to go from this hearing to think that America's schools, even the ones that are failing, aren't peopled by dedicated educators. There is a lot to be lacking in the administrators, quite frankly, and the fact of the matter is, the most dedicated French major or history major is probably not going to be the best calculus teacher or chemistry teacher, understandably, but they have to take their assignment. So, we are getting on with the job, but help us lobbying for more money for the scholarship programs.

And I want to welcome, to show you the interest we have, another appropriator—we like to curry favor with appropriators, you

know—Todd Tiahrt. He is an individual who is vitally interested in innovation and what we are discussing here today. And in his busy schedule, he is not on this committee, but he wants to be here. So, without objection, I ask unanimous consent that he be allowed to sit in on the proceedings, and we welcome you, Mr. Tiahrt.

Mr. TIAHRT. Thank you, Mr. Chairman, and let me thank you for having this hearing. This is a real challenge that we are facing. How do we prepare for the future economy? What do we need to do in our government to assist that, and I think your vision with the scholarship program and with this hearing is commendable, and I am glad you are going down that path. I have a statement I would like to include in the record of this hearing.

Chairman BOEHLERT. Without objection, so ordered.

[The prepared statement of Mr. Tiahrt follows:]

PREPARED STATEMENT OF REPRESENTATIVE TODD TIAHRT

First, I thank Chairman Boehlert for inviting me to this hearing. I commend the Chairman for his hard work on this committee and especially his foresight in focusing the Committee's work not only on the immediate needs of our nation but also on long-term goals and finding the steps to reach those goals. I am especially interested in the topic of today's hearing "U.S. Competitiveness: The Innovation Challenge." The innovation challenge is one of the most important ones for us to meet in order to ensure America's economic competitiveness—however it is also one of the hardest to define. I am pleased that Chairman Boehlert has assembled these witnesses from various backgrounds to help Congress better define the innovation challenge and propose solutions.

As you may know, for the last two years I have been working with my colleagues to address the issue of economic competitiveness. The United States has the #1 economy in the world. For almost two centuries, we have been the envy of the world—a dynamic economy, a hardworking, motivated workforce, truly the land of opportunity where innovation has thrived. That status is changing, however. We are running a $670 billion annual trade deficit, that is contributing to our budget deficit and slowed economy over the past few years.

This development is not a temporary blip on the radar screen. It is the culmination of a generation of *increased regulation, unsound tax policies, languishing emphasis on math and science education, unchecked health care costs, rampant lawsuit abuse, unfocused research and development funds, and weak trade policy enforcement.* In short, our government has made it difficult and undesirable to do business in the United States. We have put up roadblocks to keeping and creating jobs in the America. And we have done this to ourselves. If these current trends continue, our economy will continue to lag and we will no longer remain the most dynamic economy in the world.

Meanwhile, China, India and other nations are preparing for the future. They are educating their students in math, science and technology and pumping out record numbers of engineers. They are reducing tax rates and other economic barriers to entice investment in their nation. They are pursuing aggressive trade policies to reduce America's dominance in world trade.

Without attention to these matters, the United States is headed towards a third rate economy.

That is why we need to take this issue seriously. Last year we began the competitiveness legislative agenda on the Floor and over a period of eight weeks discussed and voted on issues relating to keeping and creating jobs in America. Beginning last week the Jobs Action Team is again bringing legislation to the floor to combat this problem. But we need to take a longer-term vision. For this reason, I have established the House Economic Competitiveness Caucus. The Caucus will carefully examine the issues facing our ability to compete economically in the coming years. We will work to focus Congressional efforts on removing the barriers to American economic competitiveness, and develop economic goals for the future and find the paths to get there.

I am most interested in hearing the testimony of the witnesses. I am especially interested in the first two questions they will address:

- What role does innovation play in bolstering U.S. competitiveness?

- What principal innovation challenges do your company and its industry sector face in terms of competing in the global economy?

Americans are known for their ingenuity, a trait fostered by our society since the Pilgrims found a way to survive the harsh New England winter and develop into a thriving community that eventually became a great nation. Knowledge and ideas are our most important raw materials.

The American economy has led the world because our system rewards innovation. From Benjamin Franklin through Eli Whitney, Thomas Edison, George Washington Carver, the Wright Brothers, Henry Ford, Jonas Salk, and Spaceship One promoter Burt Rutan, our entrepreneurs, scientists and skilled workers create and apply the technologies that have changed and will continue to change our world.

Our leaders have realized that while they shouldn't tell people what to think or how to do things, there is a vital national interest in helping the best ideas come forward. America's strength has been in encouraging thought and exploration, and providing the resources to bringing those dreams to life.

The Republican Congress has made great strides in funding research and development. We have met and exceeded our goal of doubling the National Institutes of Health (NIH) medical research funding, we have made necessary reforms to streamline the Patent and Trademark Office and FDA processes, and we have promoted nanotechnology, broadband dissemination, and a myriad of other important high tech investment. Similarly President Bush has focused on evaluating the scale, quality, and effectiveness of the federal effort in science and technology.

Research and development investments are still the keys to our nation's future competitiveness, and thus we must increase our efforts to spur innovation. I look forward to working with my colleagues to find ways to guarantee a vibrant, internationally competitive American economy now, five, 10, 15, and 20 years down the road.

Chairman BOEHLERT. Just let me tell you, this has been a love-in so far, because we are on the same wavelength. What we are trying to do is overcome the obstacles out there, and try to figure out how we can, you know, serve as collective missionaries, and convince other people in this Congress not to be just concerned with CAFTA or who our Supreme Court nominee is going to be, and all of that. Those are all important, but be concerned with this, too. This is very important.

And speaking about something very important, it is very important that I recognize Mr. Rohrabacher.

Mr. ROHRABACHER. Thank you, Mr. Chairman. I certainly agree with the idea of providing scholarships for our young people.

Chairman BOEHLERT. And you have been a leader in that regard, and we have the Scholarship for Service program. Give scholarships, and for a scholarship, you serve.

Mr. ROHRABACHER. Okay. I—let me note also, perhaps, just taking care of the college funds for students might not be enough. Maybe we need to pay, if we are going to get the best, or at least some very adequate teachers in science and mathematics, because of the competition with the private sector, maybe we need to pay those teachers more money, as compared to teachers who teach poetry or more of the other things that, perhaps, aren't involved with competitiveness but involved with happiness. And so, I think that is a major problem, that all teachers in high school have to be paid the same amount of money. We don't differentiate that, and I think that differentiation is needed if we are going to remain competitive.

However, I have another line of questioning, that I would like to go into, and very quickly, I would like to ask each member of the panel, in just one or two words, literally, one or two words, how much credit would you give to the federal spending on long-term research to the success of America's high tech industries? What would you say, a lot, medium, or not very much credit?

Dr. BRODY. A lot.

Mr. MORGRIDGE. The same.

Mr. DONOFRIO. A lot.

Mr. ROHRABACHER. Okay. And I take it from our industrial leaders that that means that in their own companies, they have taken advantage of this long-term research, the product of long-term research. Now, I want to ask something a little bit more aggressively, and that is what should we expect from American companies, if they are the recipients of such largesse? IBM, for example, just sold off, I don't know, I think that the deal was consummated, selling off a major division to America's greatest economic adversary. Should we expect that America's long-term research that we invest so much money in should be going to help you create companies like your companies, set up manufacturing units in China, to put our people out of work? Where does the benefit of the American people who pay for those tax dollars play a role in the decision-making of American industrialists like yourself?

Mr. DONOFRIO. Well, Congressman, in order for IBM to be the asset you would like it to be here in the United States and the world, of course, it needs to be competitive. The government does, indeed, help us with certain research, but I would remind you that we probably have the world's largest and singularly distinguished private research laboratory in the world. Our research division, headquartered in the T.J. Watson Research Center. We have over 3,000 researchers, 2,000 of them here in the United States, and 1,000 of them spread across the globe. That research organization is what is the spark plug for IBM's growth. So, nobody invests more in science and technology——

Mr. ROHRABACHER. Right.

Mr. DONOFRIO.—on their own than the IBM company does.

Mr. ROHRABACHER. Right. But you just gave a lot of credit to the American taxpayer for your success.

Mr. DONOFRIO. Doesn't necessarily mean—no, I—you said overall success when you asked that question.

Mr. ROHRABACHER. Of America's high tech industries.

Mr. DONOFRIO. Right. That may not be——

Mr. ROHRABACHER. IBM is different than that, I think.

Mr. DONOFRIO. Well, a little bit——

Mr. ROHRABACHER. You have done it on your own.

Mr. DONOFRIO. Not completely on our own, and we participate now in these programs much more aggressively, and we have also provided a considerable amount of technological prowess and capability to the United States of America, and we continue to do that, in the defense industry, as well as in the intelligence community.

Mr. ROHRABACHER. And that is an excuse for going overseas to America's greatest potential enemy and investing in their country?

Mr. DONOFRIO. That is not an excuse for doing anything of that matter at all. This is all about being globally competitive.

Mr. ROHRABACHER. That is right. It is not all about globally competitive. It is about what this gentleman down here said, it is about the benefit and the wellness of the American people.

Mr. DONOFRIO. How can we——

Mr. ROHRABACHER. You can divorce yourself about what the benefit to the American people are all you want, but the fact is, we

represent the people of this country. We don't represent a global interest, especially if that global interest puts our people out of work.

Mr. DONOFRIO. A healthy IBM helps us become healthy in the United States. It is what has allowed us to continue to increase our employment in this country for the last three to four years. Without that, you are faced with the near death experience that IBM went through at the end of the '80s and the beginning of the '90s. So, the consequences are severe, and they are important to the United States of America, for us to be globally competitive.

Mr. ROHRABACHER. I guess, does Cisco go along with this? Is that——

Mr. MORGRIDGE. Cisco does 55 percent of its business outside the United States. We employ over two-thirds of our people in the United States. We spend a billion, over a billion dollars a year on research. The vast majority of that is done here. This past year, we increased our employment from about 35,000——

Mr. ROHRABACHER. If the Chairman would indulge me just one more minute to follow up, because I know this is——

Chairman BOEHLERT. Is this going to be poetry or prose?

Mr. ROHRABACHER. It is not part of the love fest, anyway, let me put it that way. Is Cisco——

Mr. MORGRIDGE. So, I think we are——

Mr. ROHRABACHER. Have you——

Mr. MORGRIDGE. We are returning——

Mr. ROHRABACHER. Have you invested—yeah, certainly you are returning jobs to the United States, but have you also invested dramatically in China?

Mr. MORGRIDGE. We have not invested——

Mr. ROHRABACHER. Okay.

Mr. MORGRIDGE. Most of our investment——

Mr. ROHRABACHER. So——

Mr. MORGRIDGE.—in China has been in sales and marketing, in order——

Mr. ROHRABACHER. Okay. Right, but——

Mr. MORGRIDGE.—to get share of that market.

Mr. ROHRABACHER.—not in manufacturing. But not in manufacturing.

Mr. MORGRIDGE. We are not an integrated——

Mr. ROHRABACHER. And not——

Mr. MORGRIDGE.—manufacturer.

Mr. ROHRABACHER.—in transferring technology that was developed here over to our greatest potential enemy.

Mr. MORGRIDGE. If you mean from a research standpoint, no.

Mr. ROHRABACHER. Right. So, you are competitiveness in your company wasn't dependent on that, but the IBM company was, huh?

Mr. MORGRIDGE. I can't——

Mr. ROHRABACHER. Totally confuse——

Mr. MORGRIDGE. I can't answer for the IBM company.

Chairman BOEHLERT. In all fairness, let us have——

Mr. ROHRABACHER. All right.

Chairman BOEHLERT.—the witness from IBM, Mr. Donofrio, respond to that.

Mr. ROHRABACHER. Sure.

Mr. DONOFRIO. The technology that you are referring to and I didn't know this was going to be this type of a hearing, but that is fine, you know, that PC technology, have you been studying it? I mean, do you understand how much value there is in that technology? There are no secrets there. There is nothing at risk in being able to transfer this around the world. And by the way, do you realize that 90 percent of most of the insides of all of those computers come from somewhere else other than the United States already today, and that the real value is in the way you apply these things? This is the whole——

Mr. ROHRABACHER. Do you differentiate——

Mr. DONOFRIO.—issue that we have been talking about.

Mr. ROHRABACHER. Do you differentiate in something—other than the United States versus some country like Red China, that might be an enemy of the United States——

Mr. DONOFRIO. We comply with every rule, law, and enforcement in the United States of America——

Mr. ROHRABACHER. But your company also participates in helping us create that law, create those regulations. I am sorry, Mr. Chairman, if I have to be the skunk at the lawn party, but I find the globalist view of big business not to be comforting to someone who is basically looking out for the interests of the American people, and not some global concept of the future.

If IBM isn't healthy, we are talking about U.S. competitiveness here. We are not talking about, you know, IBM's health, if it not basically an American company.

Mr. DONOFRIO. Mr. Rohrabacher, we co-chaired this report. That is how much we care about the competitiveness of the United States of America.

Chairman BOEHLERT. Thank you very much. The gentleman's time has expired, and thank you for that report.

Mr. Green.

Mr. GREEN. Thank you, Mr. Chairman. Mr. Chairman, if I may, I would like to thank you for the wonderful sermon that you gave us earlier. I think those of us who did not have religion acquired it, and quite frankly, we were ready to pass the collection plate. Thank you so much.

I would like to talk just a little bit, if I may, friends, about the problem. There is an indication that the problem starts in the fourth grade, thereabout. I think there is some truth to this. However, I contend that it really starts in the home. I really do think that we do have some cultural attitudes that we have to adjust. I have actually witnessed persons pay good money to go and sit in the rain and watch a football game, while missing an opportunity to attend a PTA or PTO meeting that was free.

It has been my experience that we seem to be placing athletics above and beyond academics, and that attitude has got to change, because as long as we are willing to pay athletes millions to play, and have millions of teachers underpaid, we have a problem. I think that teachers are the molders and sculptors of humankind, and that they mold and shape the human mind. They take the essence of mental clay, and they mold it and shape it into the quintessential manifestation of intellectual cloisonné.

We have got to have the best and brightest teachers, and one of the ways that you get the best and brightest teachers is to pay them more. Teachers are underpaid. We pay athletes hundreds of millions in their profession, and teachers are making thousands in their professions. Friends, and some don't make thousands, one of my colleagues has commented. So, I am appealing to us to understand that if we truly want to leave no child behind, we ought to leave no teacher behind, and we ought to pay them more.

Having said this, how do you propose that we deal with this vote that is coming up, and continue this hearing.

But we do have, we do have this problem of adjusting our attitudes about academics versus athletics, and I would just like to, given that you have studied so many things, get some of your comments about how we will make this cultural change. I heard on the news this morning there is some game out, Mr. Chairman, called Grand Theft Auto, has some sort of sexually explicit scene in it. There is a cultural problem here that is deeply rooted that we have got to deal with, and I am interested in your comments on how do we deal with the culture that promulgates a lot of what we are seeing at the fourth grade, fifth grade, sixth grade levels and above, and I also would, as I close, Mr. Chairman, like to thank my good colleague and friend, Mr. Culberson from Texas. I would like to extend a personal welcome to you to our committee.

Thank you so much, my good friend. And I welcome your comments.

Dr. BRODY. I do, Mr. Chairman, I don't have an answer, Congressman Green. I do believe that this is—there are manifest problems, obviously, and money drives a lot of what is going on in our society, but nonetheless, universities of the margin can make a difference through outreach to schools, and providing role models, and I think of my distinguished faculty member, a famous neurosurgeon, world famous neurosurgeon, Ben Carson, who grew up in the projects and became a world famous neurosurgeon. He volunteers his time, has created a foundation to mentor young kids in the inner cities, and to teach them about role models——

Mr. GREEN. Would you yield for just a moment? We don't ask the CEOs of, oh, well, shouldn't use Enron, of IBM, major corporations, to volunteer their time, to run these corporations. They do it for money, and they do a good job. Why do we tend to assume that if you are an educator, you do it simply because you love it? I think they do. They do. They love it, but you can do what you love, and still be properly compensated. That is my point.

Dr. BRODY. You certainly have no objection from me on that topic.

Mr. DONOFRIO. No, so I would agree with that, Congressman. And I think you are right. We do need to find a way to pay teachers more, because that is what will get the better and the brighter teachers to show up, and that will help this whole issue of math and science, which we spoke about earlier. And your comments are also very well made about the home and the environment and the culture that our young are exposed to. And it is complementary. I mean, you can get both of these things to synergistically work together. There have been many attempts, and we need to continue to work on improving our education system's efficiency, to deliver

more taxpayer dollars, you know, to the classroom, to the teacher, to allow what you are talking about to occur, because it is always hard to generate new funds to be able to do this.

And on top of that, I do think that Dr. Brody has a good idea. We do volunteerism, more outreach, a mixture of that could help take off some of the burden of the cost of the education system. There are many wonderful efforts that go on around the calendar year. One that I know of, that I participate in, is this National Engineers Week effort that many of us are all founders, if not sponsors of, where thousands and thousands and thousands of engineers and scientists show up in the fourth or fifth or sixth grades, so that hundreds of thousands, if not millions of children actually get to understand what an engineer or scientist or a mathematician or a technologist do. They don't know what they do. They have never even heard of it, because of their background, their home life, their at-risk, you know, environment. And it is just powerful to see their eyes lighten up, and to see their whole thought process start to change about what could be possible.

Chairman BOEHLERT. Here is the problem. You see, we have got bells. We are going to have a series of two votes. That means about a half-hour. So, Mr. Reichert next, and we are not going to ask you to hang around here, while we go over and play Congresspeople.

So, Mr. Reichert.

Mr. REICHERT. Yes, sir. Thank you, Mr. Chairman. I am one of the few Members that don't have a doctorate, and/or an engineering degree. I come from a law enforcement background. I was the sheriff in Seattle, and as we sit here and talk about technology and science, I think back to my days as a homicide detective, and I made a list of, you know, innovative technology that has come along. DNA, when I was a homicide detective, archaeology, anthropology, entomology, all of those things come together in the world that I worked in. We need scientists in those areas, too. So, I also am a member of the Jobs Action Team. It is a team here put together, in Congress, to focus on jobs, and so, I kind of want to follow up on some questioning that came earlier, and a little bit, as was described, a hostile way, but coming from a jobs point of view.

Just one question. What factors do IBM and Cisco consider when locating a major manufacturing facility in another country? What are the major factors that you consider?

Mr. MORGRIDGE. We have a virtual manufacturing model, which means that we really don't have a large number of factories. We have a large number of factories that support our products, but we don't choose those locations. They are chosen by our suppliers. The factories, the few factories that we do have are in San Jose, California, and we use them principally to do early prototype and first run, before we have someone else actually build the product.

What I would say is that all of our major research facilities, which is really the value add of our company, are located here in the United States, with the exception of one in Canada and one in Israel.

Mr. DONOFRIO. So, Congressman, the way we do it is quite straightforward. Number one, of course, we have a history, given we have been around for almost 100 years, but we have an integrated supply chain, meaning everything that deals with the whole

issue of building something is handled by the same group, whether we are building it ourselves, or whether we are taking parts from other people, and adding value to them, and putting them together. But for the pieces where we actually have factories, and we have many of them around the world, I would have to simply say it is the right tasks, the right skills, and the right places, and we let that determine in the bottom line, in the final analysis, you know, where we have to put a factory, or where a manufacturing facility should be, as part of the whole global, you know, integrated supply chain network that we build.

Mr. REICHERT. Thank you, Mr. Chairman. I yield the balance of my time, and request that my other questions be submitted.

Chairman BOEHLERT. They will be, as will others, be submitted to the witnesses, and we would ask for a response in a timely fashion.

Here is what we are going to do. Ms. Eddie Bernice Johnson, who has been so faithful, for a minute, and then Mr. Davis for a minute, and then we have got to run over to the floor, and get your running shoes on.

Ms. Johnson.

Ms. JOHNSON. Thank you, Mr. Chairman, and our Ranking Member. I won't, hopefully, take the whole minute. I just want to say that this is my 13th year on this committee, and this has been my great passion, of trying to get information out, so that young people can become more interested. And we are having a little headway in Dallas, Texas, because we are in the midst of TI and EDS, but I want to involve Cisco and IBM as well, so I will be in touch with you. I am chair of the science and tech brain trust for the Congressional Black Caucus, and we have a meeting coming up in September. Thank you.

Chairman BOEHLERT. Thank you. Mr. Davis.

Mr. DAVIS. I will be very brief as well, and I will also have a copy that I leave for the record. I want to make a pretty brief comment. Number one, some of the Members here are saying in K–12, we have a failed educational system, and then others are saying we can't get good math teachers or science teachers. Let us make a comparison as to what we spend on education and national defense.

National defense is extremely important, and we should spend what we are spending there. But yes, in reality, you are looking at about $500 billion for national defense, and about $50 billion for education, one out of ten dollars. So, if someone goes to work for a defense contractor for $150,000, either a scientist or a mathematician, why in the heck would they go to work teaching school for $45,000 a year? Until we get our head screwed on right, education is just as important of a defense mechanism for our nation as what we are spending in many other areas. That is part of our national defense, and for some reason, we can't get that through the heads of a lot of folks who serve in Congress. We are failing at that as well, but I do have a deep and abiding concern that when a company is bought by a Chinese company, like Murray, Inc., and they take bankruptcy after giving all the research and technology, all the patents that they own, that Murray, Inc. has, and then they shut the plants down, and take that technology to

China, and then start shipping them back over here under some other name.

We have got to also take a serious look at corporate America. A lot of it is driven by greed and profit, and the patriotism of the American corporate structure is not like it used to be. If they were as patriotic as our troops, who are offering their lives up for sacrifice in Iraq and in Afghanistan, if corporate America was that patriotic, we would be a whole lot better shape in our jobs in this country.

Chairman BOEHLERT. Thank you very much, and Mr. Donofrio, Mr. Morgridge, Dr. Brody, thank you. I think we have had a spirited and intriguing exchange of views and ideas. We have covered poetry and prose. Thank you for being facilitators, and we will continue this, and keep up the good work. I just wish we could have more act responsibly like your institutions are, Johns Hopkins, what a wonderful, great place that is, and Cisco, and IBM.

Thank you very much. This hearing is adjourned.

[Whereupon, at 12:00 p.m., the Committee was adjourned.]

Appendix 1:

Answers to Post-Hearing Questions

ANSWERS TO POST-HEARING QUESTIONS

Responses by Nicholas M. Donofrio, Executive Vice President for Innovation and Technology, IBM Corporation

Questions submitted by Representative Lincoln Davis

Q1. What is the most important point in the education system for children to be encouraged in math and science? If the Federal Government was to strengthen its education investments in math and science, at what age should the focus be?

A1. Although it's important to focus on the quality of math and science programs at the college and university level, this will impact the near-term preparedness for innovation within the current scope of opportunity. We also need substantial increases in the number and proportion of students in colleges and universities who are well-grounded in math and science and are prepared to enter science, technology, engineering and mathematics (STEM) careers.

In fact, we must expand the pipeline for STEM careers and ensure that young people are well-equipped to participate in a society that is increasingly characterized by math, science and technology. In this regard, grades 4–8 are critical, as students prepare to move from basic computation and simple scientific concepts to master higher level math and science concepts. Students who complete the middle school years with a solid grounding in math and science will be successful in high school. Mastery encourages interest and commitment.

A focus on grades 4–8 requires well prepared teachers. The Federal Government can offer new incentives to attract college students to teaching and encourage second-career teachers in math and science. Succeeding in grades 4–8 also requires an ongoing review of standards, assessments and curriculum to ensure that all students will be exposed to math and science and the curriculum will be of the highest quality. This means an emphasis on hands-on learning, problem-solving and best practices. The new requirement for a science assessment is a good first step. Federal investment in curriculum development and evaluation in these areas is also important. The recent loan forgiveness program for math and science teachers is another good beginning that needs to be evaluated for effectiveness and, if appropriate, expanded.

Q2. How can rural areas uniquely cope with the loss of U.S. competitiveness?

A2. First it should be noted that the U.S. remains competitive by many measures. But America cannot be complacent as many nations become more competitive by opening their economies, educating their citizens, and investing in modern infrastructures.

In today's global economy, a region's capacity to innovate will determine whether it competes in commoditized, low-margin markets or whether it will participate in the high-margin, rapid growth markets driven by innovative goods and services.

Rural areas in the U.S. should evaluate how well they are preparing their citizens to compete by examining the policies and resources offered to support innovation. Many U.S. locales are pursuing strategies that include components such as:

- Cyber infrastructure—including high-speed Internet availability and networks to enable collaboration, such as computer "grids" that also expand processing capacity for advanced tasks.
- Education reform—including business-academia partnerships to: establish new curriculums and research across traditional scientific disciplines; teach students entrepreneurship and how to commercialize new ideas; and train students in the rapidly growing field of business services.
- Risk Capital—including incentives for early stage investors in qualified start-ups and regional networks to increase awareness of investment opportunities.

Regional innovation strategies also rely on collaboration between business, government, and academic institutions. Each plays a role in the innovation ecosystem that determines how attractive and productive a region will be for innovators.

Q3. How can U.S. industry partner with schools and universities more to help encourage technology competitiveness? Can government help facilitate that partnership, and how?

A3. U.S. industry can partner with state education departments and school districts to improve technology competitiveness. Businesses input and consultation is essential to a regular review of academic standards to ensure that elementary and secondary schools are encouraging innovation and supporting students in their efforts

to master math and science. This should be built into the process for developing all state standards.

Industry can be a co-sponsor in programs to provide high quality math and science instructional content (like IBM's TryScience initiative), provide mentors to individual students—even e-mentors—and provide opportunities for young people to learn about math, science and engineering first-hand (as they do in IBM's EXITS camps each summer). Each year, more than 3000 IBMers visit schools in the United States and encourage young people to explore math, science and engineering with hands on activities and personal mentoring during National Engineers Week (recently renamed EWeek). Businesses throughout the Nation can join, support and help EWeek grow until we can reach every middle and high school student.

Businesses also can share their experience using data for decision-making and other business approaches that can help education leaders improve school operations and outcomes (e.g., IBM's Change Toolkit). The Federal Government can work with business and education leaders to launch a major national campaign to raise the status of math, science and engineering careers and provide young people with information to make good career choices.

ANSWERS TO POST-HEARING QUESTIONS

Responses by John P. Morgridge, Chairman of the Board, Cisco Systems, Inc.

Questions submitted by Representative Lincoln Davis

Q1. What is the most important point in the education system for children to be encouraged in math and science? If the Federal Government were to strengthen its education investments in math and science, at what age should the focus be?

A1. I'm not an education expert and have not studied this issue extensively, but anecdotal evidence seems to point to early education as when students are most susceptible to gaining an aptitude for math and science. Early encouragement in any discipline, as you know, can have an enormous impact on a child. If math and science were more squarely focused on in K–5, I think it would have an enormous impact in later educational years, especially if math and science were made to be as "matter-of-fact" as spelling and reading, i.e., nothing to fear and in the normal course of business. Math and science can have a stigma attached to them as too hard or not easily grasped and that "culture" also needs to be changed.

Q2. How can rural areas uniquely cope with the loss of U.S. competitiveness?

A2. Broadband can have an enormous impact on rural areas to help with competitiveness. If you think of broadband as the always-on, high-speed connection to the world, then location becomes more and more irrelevant. With energy costs rising and telecommuting more acceptable in the private and public sectors, rural areas have the decided advantage of being more cost effective places for people to locate, live, work, learn and play. An affordable cost of living while being connected to the world through broadband, can be an actual advantage of being located in a rural area for a knowledge worker.

Q3. How can U.S. industry partner with schools and universities more to help encourage technology competitiveness? Can government help facilitate that partnership, and how?

A3. Industry can help colleges and universities identify the jobs of the future by placing bets on where technology is going. Clearly, basic training in math and the sciences is a good start, but, as we know, it is the engineering specialists and technology programmers who will help determine the next innovative new technologies. We need to work hand in glove with universities to determine where some of the new technologies will be coming from and help shape the curriculum and training in these areas. This includes offering internships, job offers to new college grads, endowing professorships in advanced technologies and helping fund the research and development at universities. I would like to note that Stanford University was the genesis of Sun Microsystems, Cisco Systems, and Google to name a few success stories out of university/industry cooperation. (As of this writing, these companies employ 72,434 people.)

ANSWERS TO POST-HEARING QUESTIONS

Responses by William R. Brody, President, The Johns Hopkins University

Questions submitted by Representative Lincoln Davis

Q1. What is the most important point in the education system for children to be encouraged in math and science? If the Federal Government were to strengthen its education investments in math and science, at what age should the focus be?

A1. While it is never too early to encourage children to excel in math and science, I would say we ought to be increasing our focus on the middle school years. Increasing the emphasis on middle school prepares students to succeed at higher-level math courses in high school arid encourages them by strengthening their skills in the fundamentals. The 2004 NAEPP "Nation's Report Card" for mathematics education indicates some improvement in scores since 1999, however, we still see evidence that indicators such as poverty level and parents' educational attainment have a significant negative impact on achievement.

International rankings of achievement in schools offer another indicator of declining U.S. scholastic standing and competitiveness. Among 15-year-olds, U.S., students declined to 28th place, behind China, Japan, Korea, Finland, Canada, France and the Czech Republic, among others, according to the Program for International Student Assessment (PISA, 2003).

The U.S. educational system is falling behind that of other advanced countries just as the Nation's scientific and technical workforce is about to experience a high rate of retirement. One quarter of current workers in science and engineering are older than 50 years. At the same time, the U.S. Department of Labor projects that new jobs requiring science, engineering, and technical training will increase at a rate four times higher than the average national job growth.

The relatively poor achievement of U.S. school children in math and science—particularly in secondary school—is well-documented. The problem begins early in the K–12 pipeline. Survey results indicate that the United States is losing its potential science and engineering majors around the middle school level, In the 2000 NAEP Science test (the most recent one available), there was virtually no change in performance between 4th and 8th grade. But the significant decline for 12th grade indicates that we are losing the battle by high school.

To me, this raises other questions: Are today's school teachers qualified to teach math and science? What are we doing to provide math and science teachers in mile schools and high schools with the proper training, support, and curricula to reach their students? How do we recruit to the teaching profession those college students with an interest in math and science, especially when the job market for people with technical skills is so competitive and pays so much better? These questions are a critical part of the solution.

Teaching jobs still are not well-compensated, especially in comparison to technical jobs in the private sector. Then factor in these impediments: Teaching adolescents is especially challenging today. Teachers are overburdened with classroom management. New teachers often do not receive support from their more experienced colleagues.

One solution already exists, but awaits full funding by Congress. To ensure that every student is able to learn from a teacher who is fully qualified in math and science, Congress created the Robert Noyce Scholarship Program. It offers incentives for talented college students in science, math, engineering, and technology to enter the teaching profession. Each Noyce Scholar is eligible to receive a $10,000 scholarship in exchange for a two-year commitment to teach math or science in elementary or secondary school. While this program has the potential to provide our schools with desperately needed teachers who are highly qualified in these fields, finding has hovered only around the $8 million mark. This program should be expanded to $20 trillion, the level authorized by Congress.

U.S. universities and colleges need to do more to partner with their local K–12 institutions to train teachers, revamp science and math curriculum, and mentor students. These are just a few programs underway at Johns Hopkins and many of its sister institutions. We do much to advance that state of K–12 education, but we can clearly must and should do more.

We also need to do a better job of tailoring science and math education to attract minorities and women into middle and upper-level classes. For example, many women avoid computer and science classes because of social views of the field as limiting and unwelcoming. But that impression may be more based on how we

present the goals and requirements of science education. These stereotypes then are reinforced by the limited pool of students who self-select to go into these fields.

If we are to make science, math, and technology education more inclusive, we need to recognize that girls and boys may go into a field for different reasons, If educators are not able to communicate how scientists and innovators contribute to the greater good, to the social good, we will not be able to break that stereotype.

Q2. How can rural areas uniquely cope with the loss of U.S. competitiveness?

A2. The most obvious solution is to attract more business by upgrading our country's electronic infrastructure. By giving rural locations better access to broadband and satellite communications, workers in remote areas can easily access jobs that might otherwise be outsourced overseas. American companies should look first to America's rural labor force, where everyone speaks English, educational went for at least the high school level can be certified, and states want and need jobs to revitalize their communities. In fact, this is how the U.S. call center business first expanded during the dot-com boom, when these facilities sprouting in small Midwestern towns to support businesses around the country.

A federal investment to expand broadband and satellite communications to underserved communities—both in rural areas and in inner cities—would provide a boost comparable to the *Rural Electrification Act of 1936.* This expansion would also give companies additional opportunities to invest.

To build the capacity to handle technology jobs, the Nation's investment in rural communities would require job training and support, retraining, and continuous learning opportunities, especially in computer skills. With the expansion of distance learning and satellite hookups, college classes can be delivered anywhere, anytime. At the same time, expanding the investment in community colleges would enable these locally based schools to reach more people in rural areas. In both cases, scholarships and financial aid, as well as company-funded training, could expand the opportunities.

Q3. How can U.S. industry partner with schools and universities more to help encourage technology competitiveness? Can government facilitate that partnership, and how?

A3. Corporate partners could make it easier for their scientific and technical employees to lend their skills and time to further technology training and teaching. A number of companies offer technology programs and support to schools nationwide; among them are Intel, Hewlett-Packard, Microsoft, IBM, and Apple. Some companies, including 3M, IBM, DuPont, and General Electric, already encourage their employees to volunteer in science and math classrooms, as well as in other K–12 classes in their communities. The MCI Foundation, through its innovative Marco Polo Web portal, sponsors teacher support and curriculum enhancement in science, math, and economics education; this is a partnership with government and non-profit organizations.

The social investment in education being made by these companies is both altruistic and mission critical. These companies, while serving their communities and employees, recognize that their future success depends upon a large talent pool to recruit for the next generations of employees. Without the trained technical and scientific workforce of tomorrow, their businesses would not be able to continue to innovate and compete successfully in an increasingly competitive global arena.

Company leaders also act as role models. They could reach out to schools and youth groups through community forums, through the media (including new media such as Web, podcasting, instant messaging, and blogs), through sponsoring sports teams and after-school clubs, and through internships and exchange programs to excite youth about the opportunities for careers in math and science. This corporate commitment might include special outreach efforts to minority communities and women.

In addition, there are other very active national and regional initiatives that involve business leaders in addressing education issues. These include the Council on Competitiveness, the Business Roundtable, the Business-Higher Education Forum, Chambers of Commerce. the Maryland Business Roundtable on Education, and local business groups. These groups do not work in a vacuum; they include educators and education organizations as partners and advocates for their experience and expertise in the classroom.

Leaders in higher education also play an important role in improving the level of math, science and technical teaching, as well as offering pre-college programs for children, often as young as those at the elementary school level.

We, at Johns Hopkins University, take our own commitment to providing opportunities for K–12 learning in math, science and technology very seriously. Just re-

cently, I addressed the members of the Johns Hopkins K–12 Council, a collaborative coalition drawn from the University, Baltimore City and the Maryland K–12 community. The Council's goal is to catalyze research-driven collaborations between Johns Hopkins and schools throughout Maryland. Though it has no five-standing school of education, Hopkins is considered a path breaker in education research and reform among national and local education policy-makers.

Johns Hopkins effort through the Council are geared towards sharing what we know as educators and scientists or mathematicians and engineers, what school teachers and administrators have learned, and what we think children need to know to succeed beyond high school. While the Council's efforts are geared to improving our schools, generally, and to students overall, it pays particular attention to providing opportunities for under-represented students to advance their knowledge in math and science.

To mention just a few examples, in the sciences, the Johns Hopkins University Applied Physics Laboratory (JHU/APL) has a wide range of programs for young explorers. Our Education and Public Outreach (E/PO) office strives to excite and inspire the next generation of explorers by creating hands-on, interactive learning experiences for students. educators and the general public. Our civilian space education and public outreach office provides unique opportunities for students, educators, museums, science centers and the general public to share in the excitement of APL's current endeavors—from landing on an asteroid to looking for water on Mars.

The Maryland Mathematics, Engineering, Science Achievement Program (MESA) is a statewide pre-college program sponsored by JHU/APL. Morgan State University, The University of Maryland, Towson University, local school systems, and businesses throughout Maryland. Maryland MESA works directly with schools and educators to support and develop the interests, skills, and abilities of K–12 students in science, technology, engineering, and mathematics. The program also serves as a driving force in encouraging and assisting minorities and females in achieving academic and professional success in these fields.

In an effort to boost middle school math achievement, Johns Hopkins University researchers are spending a great deal of time in a magical, pixilated place called Descartes' CoVE. This innovative CD–ROM learning environment helps youngsters develop higher-level math skills including geometry, logic, and number theory. It is a collaborative virtual space, accessible via the Web and CD–ROM, where students can explore the farthest reaches of their mathematical reasoning by solving real-world puzzles and problems. Development of Descartes' CoVE is funded by corporate grants from AT&T and the Toyota USA Foundation.

In cooperation with the Johns Hopkins Center for Talented Youth, the Materials Research Science and Engineering Center (MRSEC) at The Johns Hopkins University offers paid summer internships in JHU materials research laboratories to six qualified and under-represented high school students from the greater metropolitan Baltimore area and surrounding counties. In addition, seven teachers, nominated by their schools and selected by MRSEC and CTY, participate in a four-day program designed to introduce them to the research and the scientists of MRSEC.

Appendix 2:

Additional Material for the Record

STATEMENT OF THE INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS—UNITED STATES OF AMERICA (IEEE–USA)

IEEE–USA appreciates the opportunity to submit comments for inclusion in the record of House Science Committee hearings on the innovation challenges facing the United States. These comments address the question posed by the Committee on what the Federal Government should be doing to strengthen the Nation's innovation system, with special emphasis on federal programs of support for research and technical workforce development.

IEEE–USA was established in 1973 to advance the public good and promote the professional careers and public policy interests of the more than 220,000 electrical, electronics and computer engineers who are U.S. members of the Institute of Electrical and Electronics Engineers (IEEE), one of the world's largest technical-professional societies. Our members have been present at the creation of electro-technological innovations that have fueled more than a century of remarkable growth in American industry sectors, ranging from aerospace and defense, computers and telecommunications, electrical power generation and robotics to new and emerging fields including biomedical devices and nanotechnology.

At the dawn of the 21st Century, America desperately needs a new national competitiveness strategy. After a decade of economic prosperity in the 1990's, the Nation was buffeted by recession in 2001 and by a prolonged jobless recovery marked by unprecedented levels of unemployment in high technology fields. Today we face a new, more rough and tumble form of global economic competition, especially in science, engineering and technology-based sectors that have fueled U.S. prosperity since World War II.

China's emergence as a manufacturing superpower, India's strength as a leading provider of business process out-sourcing services and the collapse of the former Soviet Union have added at least 2.5 billion people to world labor markets already awash in talented, highly motivated people. Continuing advances in digital technologies and the inexorable spread of the Internet have added a whole new dimension to America's competitiveness challenge. Any task that can be digitized—from chip design to financial analysis to sophisticated pharmaceutical research—can now be performed in many less developed countries at prices developed countries just can't match.

Key Elements of a National Competitiveness Strategy

Twenty years ago, U.S. policy-makers faced a different competitiveness challenge driven by the aggressive expansion of the Japanese and European economies. In response to pressure from business, educational, labor and professional leaders, Congress enacted and federal agencies implemented fiscal and monetary initiatives that helped to stimulate public and private investments. To an existing commitment to basic research, they added a new emphasis on applied research and technology transfer to accelerate commercialization of new ideas and inventions. Public sector investments in education and training were expanded to include a new focus on lifelong learning to help incumbent workers acquire knowledge and skills needed to master newly emerging and rapidly changing technologies. And trade policy initiatives were expanded to include a greater emphasis on export promotion and open access to overseas markets. As a result, the United States was able to maintain its global economic, military and technological preeminence and continue to provide its residents with individual opportunities and living standards unmatched anywhere else in the world.

To help maintain America's economic, military and homeland security in increasingly interdependent, technology-driven global markets, public and private policy-makers must work together to forge a new National Competitiveness Strategy for the 21st Century. Key policy objectives ought to be:

- To improve the Nation's education system from pre-school to graduate school and beyond, with special emphasis on improving math, science and communications skills in grades K–12;
- To increase systemic incentives for individuals to pursue education and careers in Science, Math, Engineering and Technical fields and promote more effective utilization of SMET personnel by public and private sector employers; and
- To strengthen the Federal Government's commitment to basic research and enhance its ability to encourage public and private sector investments leading to the development and application of innovative processes, products and services.

Implications for the SMET Workforce—Labor Market Supply and Demand Considerations

Innovation is ultimately about people, their knowledge and their creativity. The S&T workforce challenge, therefore, is to create and sustain an environment that will attract the best and brightest minds and enable them to innovate. A workplace in which creative people at all levels share in the rewards—as well as the risks—associated with innovative behavior is essential to meet changing labor market needs.

Much of the advice directed at Congress on S&T workforce issues is predicated upon looming shortages of scientists and engineers. Such speculative claims were used in the 1980's and '90's to justify immigration policy interventions that worsened rather than eased prevailing labor market imbalances. This year, proponents of "Increase the Supply" policies are using the coming retirement of the baby-boom generation, the Nation's growing dependence on foreign-born graduate students and researchers and statistics comparing science and engineering degree production in China, India and the United States to justify similar policy interventions. Business groups are calling on Congress to fill America's S&T educational pipeline with a younger, more diverse—and less expensive—crop of future S&T workers.

The Business Roundtable's recent call for a doubling of U.S. science and engineering degree awards by 2015 is an example of just such an appeal.

IEEE–USA believes that policy-makers should distinguish between the important societal need to increase the technological literacy of all Americans from narrowly focused calls to increase the supply (and reduce the cost) of science and engineering graduates. Effective solutions to the broader societal problem will help to ensure the ready availability of people with the knowledge and skills needed to meet constantly changing labor market demands.

A policy of pushing or pulling more Americans into science and engineering educational pipelines—in the absence of reasonable assurances of rewarding job and career prospects—is unlikely to succeed. Students don't major in difficult fields just to get scholarships or help employers meet hiring targets. They major in difficult fields to get jobs—preferably professionally challenging and financially rewarding jobs.

As history has shown, Congressional decisions to address anticipated labor market imbalances by raising temporary H–1B work visa ceilings created serious oversupplies of scientists and engineers in the 1990's, led to prolonged periods of unemployment for substantial numbers of U.S. and foreign workers and probably helped to dissuade many of the best and brightest U.S. students from pursuing technical careers.

Improving SMET Labor Market Incentives and Rewards

As Harvard labor economist Richard Freeman has observed, the marketplace reality is that U.S. scientists and engineers rank low in terms of wages compared with income earned by other highly skilled professionals and lag significantly behind doctors, lawyers and business executives in terms of income earned over the course of their careers. When coupled with the length of time it takes to earn post-graduate degrees—two to four years in engineering and up to eight additional years in some scientific fields—and the challenge of maintaining technical proficiency over a 30- to 40-year career, it should come as no surprise that many Americans perceive science and engineering as an unattractive career choice. The growing reliance of U.S. employers on temporary foreign workers and their ability to transfer high tech jobs to lower cost overseas locations are making such choices even more difficult for many of America's best and brightest young students.

The challenge for policy-makers, then, is to find policies that improve opportunities for America's best and brightest students to pursue educations and careers in science and engineering fields. Trying to attract more students into the education pipeline without improving attendant incentives and rewards won't solve America's high tech workforce challenge. Such an approach will only increase hardships and disappointment when newly minted scientists and engineers find limited job opportunities, lagging financial rewards, job insecurity and uncertain career prospects when they receive their degrees.

Workforce Policy Objectives

As part of a comprehensive national innovation strategy, IEEE–USA believes that workforce-related policies and investments should be directed at the following objectives:

- Strengthen the Nation's education system from pre-school to graduate school and beyond, with special emphasis on improving math, science and commu-

nications capabilities in grades K–12 and promoting greater flexibility in undergraduate and graduate degree programs in science and engineering.

- Improve incentives for individuals to pursue education and careers in science, math, engineering and technical fields and promote more effective utilization of graduates by public and private sector employers. This objective can best be accomplished by establishing federal scholarships for service incentive programs in technology intensive agencies; enacting additional tax incentives for continuing education and training (lifelong learning); and expanding eligibility for Trade Adjustment Assistance to dislocated service sector workers.
- Promote balanced reforms in America's permanent, employment-based immigration system and reduce the Nation's growing dependence on temporary visa programs.

Critical Importance of Federal Investments in Research and Development

Substantial and sustained public and private investments in research over the past 50 years have spawned an abundance of technological breakthroughs, transformed American society and helped the United States to become the world's preeminent economy. Some economists estimate that as much as half of all recorded growth in Gross Domestic Product (GDP) over this period is attributable to technological advances.

While the U.S. continues to lead the world in its capacity to innovate—to convert ideas and inventions to useful and affordable products, services and processes—overall federal spending on research and development as a percentage of GDP has declined significantly since 1965. The focus of federally-funded R&D has also changed. It has shifted away from long-term investments in basic research—the kind of research that has done the most to spur innovation and economic growth—into much shorter-term investments in applied research and development.

Increases in spending on weapons-related research and development at the Department of Defense have accounted for 70 percent of all federally funded R&D increases in recent years. Of the remainder, 75 percent has gone to the National Institutes of Health (NIH) and the Department of Homeland Security (DHS). At $71 billion and $29 billion respectively, the R&D budgets at DOD and NIH now account for over 75 percent of all federal spending on research and development. Federal funding for R&D in the physical sciences and engineering, on the other hand, has been flat or declining for over 30 years. To be optimally successful, the Nation's investments in research must be balanced across science and engineering disciplines and between short-term needs for practical applications of state-of-the-art technologies and the longer-term search for promising technologies of the future.

The Federal Government has long played a critical role in helping to strengthen the Nation's innovation system by sponsoring basic and applied research at universities, government laboratories, and not-for-profit research laboratories. The Federal Government invests $132.3 billion in R&D, about one-third of the Nation's total investment. It funds long-term basic research, whereas industry-sponsored R&D investments are much more narrowly focused on near-term product and process improvements. Thus, federal support continues to be crucial to the discovery and early stage development of basic knowledge that the U.S. needs to maintain its position of preeminence in technological innovation.

Sustained national investment in research and development will be necessary, but is not going to be sufficient to ensure continuing economic and technological preeminence. *We must also be able to capture and commercialize the outcomes of such research in ways that will allow us to continue to produce goods and services that meet the test of international markets while simultaneously improving the living standards of our citizens.* While the Federal Government's funding priority should be basic research—where industry under-invests—there needs to be a renewed focus on bridging the "valley of death" between basic research and the commercialization of technology, as well as funding the applied research that leads to generic and enabling technologies that can be commercialized by private industry.

Policy-makers must also understand that research and development is only one component of the "commercialization" challenge. An even bigger obstacle to technology innovation than limited federal R&D dollars may be the Wall Street business imperative to return short-term profits each quarter, which discourages long-term, high-risk investments in innovation and technology commercialization. Other key components of a new National Competitiveness Strategy—impacting tax, trade, intellectual property and immigration policy—are beyond the scope of this particular statement.

R&D Policy Objectives

IEEE–USA believes that federal research and development policies and investments should be redirected as recommended by the Council on Competitiveness in its *Innovate America* report in order to:

- Stimulate high-risk research through "Innovation Acceleration" grants that re-allocate three percent of agency R&D budgets,
- Restore DOD's historic commitment to basic research by redirecting 20 percent of the S&T budget to long-term research,
- Intensify support for research in the physical sciences and engineering to achieve a more robust national R&D portfolio, and
- Enact a permanent, restructured research and experimentation tax credit and extend the credit to research conducted in university-industry research consortia.

In addition, we endorse related Council on Competitiveness recommendations, including:

- Stimulate greater workforce skills enhancement through the creation of tax-favored, life-long learning accounts,
- Enhance workforce flexibility and facilitate mobility by increasing the portability of health care and pension benefits,
- Expand programs of assistance to service sector and other workers who are dislocated by technology and trade,
- Build 10 Innovation Hot Spots over the next five years to capitalize on regional assets and leverage public and private sector investments.

In closing, we would also recommend the timely enactment of legislation to:

- Increase National Science Foundation funding in line with the previous Congressional authorization in Public Law 107–368 that its budget be doubled,
- Fully fund the FY 2002 commitment to expand incentives for NSF's science and engineering education initiatives,
- Maintain the long-term basic research focus in other science and technology programs, including those administered by the Defense Advanced Research Projects Administration (DARPA) and the Department of Homeland Security (DHS), and
- Increase high performance supercomputing research and development funding, revitalize manufacturing technology in the United States by enacting the *Manufacturing Technology Competitiveness Act* (H.R. 250) and support funding for the National Nanotechnology Initiative at levels recommended in the *21st Century Nanotechnology Act* (Public Law 108–153).

Conclusion

This statement focuses on two important components of a national innovation strategy, and therefore presents only a partial picture of what needs to be done to ensure the ability of the United States to maintain its technological competitiveness in the global economy.

IEEE–USA appreciate the enormity of the many interrelated tasks facing Congress and the Administration and remains committed to working with all interested parties to help identify and implement policy options that will help sustain the prosperity, security and quality of life that we associate with a strong and competitive America.