

INNOVATION AND COMPETITIVENESS LEGISLATION

HEARING

BEFORE THE

COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION UNITED STATES SENATE

ONE HUNDRED NINTH CONGRESS

SECOND SESSION

MARCH 15, 2006

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SENATE COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION

ONE HUNDRED NINTH CONGRESS

SECOND SESSION

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INNOVATION AND COMPETITIVENESS LEGISLATION

WEDNESDAY MARCH 15, 2006

U.S. SENATE,
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION,
Washington, DC.

The Committee met, pursuant to notice, at 1:50 p.m. in room SD-562, Dirksen Senate Office Building, Hon. John Ensign, presiding.

OPENING STATEMENT OF HON. JOHN ENSIGN, U.S. SENATOR FROM NEVADA

Senator ENSIGN. [presiding] I want to welcome everybody to today's full Commerce Committee hearing on innovation and competitiveness legislation. Thank you all for attending. I want to thank Senator Stevens for allowing me to chair this hearing on this very important topic for America's future.

Today the world is becoming dramatically more interconnected and competitive, and in order to remain globally competitive the United States must continue to lead the world in innovation. Innovation fosters the new ideas, technologies and processes that lead to better jobs, higher wages, and a higher standard-of-living for Americans.

Unfortunately in the disciplines that foster innovation in the 21st century: science, technology, engineering, and mathematics, America is steadily losing its global edge. The trouble signs are numerous. Fewer than 6 percent of our high school seniors plan to pursue engineering degrees, down from 36 percent a decade ago. In 2004, China graduated approximately 500,000 engineers and India graduated over 200,000 engineers. At the same time the United States graduated less than 70,000 engineers. If this present trend continues 90 percent of all the world's scientists and engineers will be living in Asia, by the year 2010.

We must address these long-term competitive challenges to America's economic vitality and national security now, or risk losing our essential leadership position on innovation. The National Innovation Act, which I introduced with Senator Lieberman in December 2005, will help America meet these interconnected challenges. The legislation responds to the recommendations contained in the National Innovation Initiative report entitled, "*Innovate America*." This report was circulated last year by the Council on Competitiveness. The Council is a distinguished nonpartisan group of leaders from industry and academia.

In responding to the Council's report, the National Innovation Act focuses on three primary areas of importance to maintaining and improving United States innovation in the 21st century. The first is increasing research investment, the second is increasing science and technology talent, and the third is developing an innovation infrastructure. Many, who know me, know that I am a fiscal conservative. Current Federal budget constraints will require prioritization in spending. New programs must be funded through existing funds, or through identifiable funding offsets, whenever possible.

I look forward to working with Senator Lieberman, others on this committee, and other co-sponsors as we go forward. However, I do believe that increased support of basic research though should be a national priority. Accordingly my bill would increase the national commitment to basic research by nearly doubling research funding for the National Science Foundation by Fiscal Year 2011.

The National Science Foundation plays a critical role in underwriting basic research at colleges, universities, and other institutions throughout our Nation. NSF-supported basic research in chemistry, physics, nanotechnology, genomics, and semi-conductor manufacturing has brought about some of the most significant innovations of the last 20 years.

For example the World Wide Web, magnetic resonance imaging, and fiber optics technology all emerged through basic research projects that received NSF funding. Research supported by NSF accounts for approximately 40 percent of non-life science basic research at U.S. academic institutions, while representing less than 4 percent of funding for R&D.

I will submit the rest of my statement for the record.
[The prepared statement of Senator Ensign follows:]

PREPARED STATEMENT OF HON. JOHN ENSIGN, U.S. SENATOR FROM NEVADA

Welcome. Thank you for attending this full Committee hearing on innovation and competitiveness legislation. In addition, I would like to thank Senator Stevens for allowing me to chair this hearing on a very important topic for America's future.

Today, the world is becoming dramatically more interconnected and competitive. In order to remain globally competitive, the United States must continue to lead the world in innovation. Innovation fosters the new ideas, technologies, and processes that lead to better jobs, higher wages, and a higher standard-of-living.

Unfortunately, in the disciplines that foster innovation in the 21st century—science, technology, engineering, and mathematics—America is steadily losing its global edge. The trouble signs are numerous. Less than 6 percent of high school seniors plan to pursue engineering degrees, down from 36 percent from a decade ago. In 2000, only 17 percent of undergraduate degrees earned in the United States were in the hard sciences. In the same year 56 percent of China's undergraduate degrees were in the hard sciences. In 2004, China graduated 500,000 engineers and India graduated approximately 200,000 engineers. The United States, by contrast, graduated less than 70,000 engineers. If present trends continue, 90 percent of all the world's scientists and engineers will be living in Asia by 2010.

We must address these long-term competitive challenges to America's economic vitality and national security now or risk losing our essential leadership position on innovation.

The National Innovation Act that I introduced with Senator Lieberman in December 2005, will help America meet these interconnected challenges. The legislation responds to the recommendations contained in the National Innovation Initiative Report, entitled *Innovate America*. This report was circulated last year by the Council on Competitiveness. The Council is a distinguished, nonpartisan group of leaders from industry and academia.

In responding to the Council's report, this legislation focuses on three primary areas of importance to maintaining and improving United States' innovation in the 21st century: (1) research investment, (2) increasing science and technology talent, and (3) developing an innovation infrastructure.

I am a fiscal conservative, and current Federal budget constraints will require prioritization of spending. New programs must be funded through existing funds or through identifiable funding offsets whenever possible. I look forward to working with Senator Lieberman, members of this committee, and other co-sponsors in this effort.

I believe, however, that increased support of basic research through should be a national priority. Accordingly, my bill would increase the national commitment to basic research by nearly doubling research funding for the National Science Foundation (NSF) by Fiscal Year 2011.

NSF plays a critical role in underwriting basic research at colleges, universities, and other institutions throughout our Nation. NSF-supported basic research in chemistry, physics, nanotechnology, genomics, and semiconductor manufacturing has brought about some of the most significant innovations of the last 20 years. For example, the World Wide Web, magnetic resonance imaging and fiber optics technology all emerged through basic research projects that received NSF funding.

Research supported by NSF accounts for approximately 40 percent of non-life-science basic research at U.S. academic institutions while representing less than 4 percent of the Federal funding for research and development.

Because our Nation's long-term future economic strength depends in large part on the support we give to basic research projects now, the National Innovation bill also establishes the Innovation Acceleration Grants Program, which encourages Federal agencies funding research in science, technology, engineering, and mathematics to allocate at least 3 percent of their research and development (R&D) budgets to grants directed toward high-risk frontier research. All grants provided through this program will be assessed with metrics and no grants will be renewed unless the agency distributing the grant determines that all metrics have been satisfied.

In addition, the National Innovation bill addresses the need to encourage more American students from kindergarten through graduate school to pursue careers in science, technology, engineering, or mathematics. Although scientists and engineers make up less than 5 percent of our population, they create up to 50 percent of our Gross Domestic Product. Especially as our current scientific workforce ages, we need to encourage more American students to pursue careers in these fields. The National Innovation bill does this by creating more graduate fellowships and graduate traineeships.

Today, we are pleased to have one panel of witnesses here to testify on these important innovation and competitiveness issues.

Senator ENSIGN. I do want to make a couple of other quick comments. First of all, I applaud the bipartisan effort that is underway on innovation and competitiveness issues. Bipartisanship is desperately needed in the Senate. Especially when addressing innovation, bipartisanship, really nonpartisanship is required. Innovation is an American issue. We need to look at how we are competing with the rest of the world. I applaud the President for including a lot of the ideas from the National Innovation Act in his State of the Union address and in his American Competitiveness Initiative. The reason this hearing's start-time was moved up, is because we had a meeting originally scheduled for a little after 3 o'clock at the White House to discuss a lot of these issues. That meeting has been postponed because we have votes on the budget today.

So I'm very excited about what is happening here in the U.S. Senate, the House and the White House and I think that we can work together toward keeping America innovative and competitive in this world today. So that we can let our colleague go, if it is OK with you, Senator Allen, I would like to call on Senator Baucus. Senator Lieberman will be here around 2:30. When he comes we will allow him to testify as well. Senator Baucus?

**STATEMENT OF HON. MAX BAUCUS,
U.S. SENATOR FROM MONTANA**

Senator BAUCUS. Thank you Chairman. It works for me. I'm just a lowly witness; you're a member of the Committee.

Senator ALLEN. I'm gonna be hospitable toward friends of my family.

Thank you. I appreciate it very much, this good old Virginia hospitality. I appreciate it. Mr. Chairman and Senator Allen, thank you very much.

By addressing American competitiveness now, I think this committee, the Commerce Committee is providing vital leadership and I'm very pleased to join you.

Many are using the word "competitiveness" these days. But here's the real question: what action will we take to make competitiveness more than a word? What actions can we take to make competitiveness a way of thinking for this Nation's leaders, and a way of life for this Nation?

The need to strengthen America's "global competitiveness" is a new idea for many Americans. Americans are used to global dominance. This is something that's not quite firmly imprinted in the frontal lobe of most Americans. We have to work at it.

But take a look at the next 5-year-old you see. Our attention to competitiveness now will determine the kind of job that child can have in 20 years. Whether she can afford healthcare or pay her energy bills, and what standard-of-living her child will have even further down the road.

India, China, and other nations are on the rise. These countries have committed to educating their children in math, science, and engineering. I might say, India not long ago, it stunned me that the President of India, has made every single Indian a Hallmark of his presidency in India. It's not Prime Minister Singh, it's the President of India, has said very clearly, that's his major goal, he's a very, very prestigious guy in India and he's going to, I'm quite sure go a long way in making that happen. They're preparing new generations to win high-skill, high-wage jobs. And it's working. They have plans in those countries.

America's economic clock isn't being cleaned—just yet. Our infrastructure remains the strongest. Our workers remain the most productive. This committee, with its jurisdiction over science and technology, knows that our thinkers remain the most innovative. I heard it constantly when I was in India and China, talking to the public- and private-sector people, 2 months ago; we're still ahead in creativity and innovation. Maybe not in other areas, but in creativity and innovation and I'm not too convinced how long that's going to last, frankly. We have to get on the stick here, to make sure it does last. In fact we make important advances in other areas as well.

But to keep that the case—the best leadership; we need long-range leadership. We must make policy changes now to multiply America's strengths and reduce our liabilities in decades to come.

Education is the place to start. I am introducing a comprehensive legislative package this year to improve American competitiveness. Education is not just one of the pillars of that agenda. It is the

foundation. My bill will improve the system from pre-kindergarten all the way through college and worker retraining.

But we cannot stop at education. We must take a comprehensive view of what competitiveness means for our country. America needs a strong hand in the world marketplace. I have introduced legislation with Senator Hatch to improve trade enforcement. Dramatically improve trade enforcement. America needs energy independence. As long as we are beholden to politically-unstable nations for our energy, we are less able to determine our own economic destiny.

My new energy legislation promotes radical research and alternative energy strategies. America needs to save more. Tomorrow I will introduce legislation to help increase Americans' individual savings, and to restore fiscal responsibility for our government. Americans who save are Americans who can invest. A government out of debt is a government with resources to build a strong economic future.

Other elements demand attention. High healthcare costs are shackles on the feet of this country, dragging down our ability to compete. And American thinkers need funding and encouragement to continue the innovation that first brought us to world leadership. Even America's international tax structure must bolster every company's ability to run with the world's big dogs. We have to look and restructure our tax structure, essentially, our international tax structure in America.

These are tall orders. But ensuring American competitiveness is not a one-session or one-Congress accomplishment. It will take a long, slow, permanent shift of the rudder on our ship-of-state.

I firmly believe that we are called, it is our obligation, it is our mission in this Congress, to begin to turn the wheel. And we must act not only this year; we must lay the groundwork for ever-bolder action in the years to come.

And I'll make a confession. The bills I'm introducing this year won't finish the job. But nothing proposed in this Congress, nothing we've heard from the President, will finish the job either.

Ensuring American competitiveness will take far-reaching energy and healthcare transformations. It will take fundamental fiscal changes. Those discussions have yet to commence. But we must make a start today.

I am encouraged by this hearing. I know I am surrounded by partners in the quest for American competitiveness. One of the best things we can do for the people who elected us is to ensure the prosperity of their children and grandchildren. That's what the quest for competitiveness is really about. I will be proud to work with you, Mr. Chairman, Senator Allen, and others on this committee to achieve this important goal.

If you have a question, I'm passionate about this stuff.

[The prepared statement of Senator Baucus follows:]

PREPARED STATEMENT OF HON. MAX BAUCUS, U.S. SENATOR FROM MONTANA

Thank you, Chairman Stevens and Co-Chairman Inouye, for allowing me to speak with you today. By addressing American competitiveness now, the Commerce Committee is providing vital leadership. I'm pleased to join you.

Many are using the word "competitiveness" these days. But here's the real question: what action will we take to make competitiveness more than a word? What

actions can make competitiveness a way of thinking for this Nation's leaders, a way of life for this Nation?

The need to strengthen America's "global competitiveness" is a new idea for many. Americans are used to global dominance.

But take a look at the next five-year-old you see. Our attention to competitiveness now will determine the kind of job that child can have in 20 years. Our attention to competitiveness now will determine whether she can afford healthcare or pay her energy bills, and what standard-of-living her child will have even farther down the road.

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Ensuring American competitiveness will take far-reaching energy and healthcare transformations. It will take fundamental fiscal changes. Those discussions have yet to commence. But we must make a start today.

I am encouraged by this hearing. I know I am surrounded by partners in the quest for American competitiveness.

One of the best things we can do for the people who elected us is to ensure the prosperity of their children and grandchildren. That's what the quest for competitiveness is really about. I will be proud to work with you to achieve this important goal.

Senator ENSIGN. Thank you, we have limited time today, so I want to get to our panel. If I can call our panel forward as Senator Allen makes his opening statement.

**STATEMENT OF THE HON. GEORGE ALLEN,
U.S. SENATOR FROM VIRGINIA**

Senator ALLEN. Thank you. Thank you, Mr. Chairman, for holding this hearing, let me commend Senator Baucus and you, we have a convergence of similar views and missions, and also the urgency of making sure the United States is more competitive for investment and jobs, and that we are the world capital of innovation. I think it is our responsibility as legislators and leaders of this country, to make sure that we're implementing and fostering the policies that will make sure that we are effectively competitive. These policies mean everything from less taxation to less litigation, to less regulation. We need energy security. Clearly education will be the focus here that's important, the Internet being tax free and especially broadband is important. And our economic competitors around the world, particularly when you look at China and India, they're very focused. They know where they're going, they're determined to be leaders in innovation and technology. In fact China, nanotechnology working with Senator Wyden and myself, we've made that a leadership effort for us and for our country.

I look Mr. Chairman at China, in nanotechnology like George Steinbrenner, when I was over there around Thanksgiving and nanotechnology is multifaceted it's everything from microelectronics, to life sciences, health sciences, energy, and materials engineering. That's where their most interest is in the materials engineering and they are buying or paying the very best scientists and engineers in the carbon nanotubes research which is important for materials engineering. And they are like George Steinbrenner, they're focused, they're determined, they're directed.

You mentioned the difference in education, India graduating three to four times as many engineers every year as we are; China, it's seven times or more engineers. Then you look at our engineers at this country, and oh maybe a third or more are from another country. Which is fine, I want America to be the magnet for the best minds of the world, and if somebody gets a science or technology or engineering degree, I think we ought to staple a green card, or a Visa to that diploma.

But one also looks into it, and you see that out of the engineers only about 15 percent or so are women, only 6 percent are Latino, or African-American. And so these initiatives that I'm proud to co-sponsor with you and Senator Lieberman, and this is a non-partisan, or bipartisan effort, is one where we do need to get the infrastructure, the incentives for young people to recognize that if they do well in math and science, they can get these scholarships and these degrees. It struck me talking to the India Institutes of Technology leaders that the young people in India where there's a great deal of heartbreaking poverty, those kids in middle school they're focused on passing the end of high school exam so they can get into the India Institutes of Technology. That's their ticket out of poverty. In this country, it may be baseball, football, basketball, something like that, which is fine, but it's maybe one out of 10 million chance of hitting it there. Whereas obviously in engineering and science and technology is more important, so we need to incent people regardless of their gender, regardless of their race, or ethnicity to get interested in science and technology, engineering

which are all important for our future. It's been said before, but it needs to be said for the record. We've faced these sorts of challenges in the past, President Eisenhower saw it with *Sputnik*, and this country with the National Defense Education Act responded. And that's the same sort of urgency we need right now for our country.

And I appreciate your leadership Mr. Chairman, it's always a pleasure to be working with you and our colleagues on this, because this—we need to protect so to speak, our freedom and secure our freedom. But one of the key ways that we're going to do it is by being that world capital of innovation using this intellectual property, not just for national defense but improving people's lives. And I thank Mr. Augustine in particular for his leadership and it's good to see Mr. Barrett, has shown up here. I was just waiting for you to come.

Senator ENSIGN. That's Dr. Barrett.

Senator ALLEN. Dr. Barrett. Excuse me. And with that, since you're here, and he's even helping me give a St. Patrick's speech on giving an economic object lesson on how great Ireland is. Ireland's never been better. Lower taxes, better education, and so that's going to be the theme of my St. Patrick's Day, and St. Patrick's week speeches in various places. So I thank you Mr. Chairman, and I thank all our witnesses. And I've gone on just good timing, so that we can hear from them. And we're going to take action. The people of America expect us to take action. And it's essential for our future and I thank all our witnesses.

Senator ENSIGN. Thank you, Senator Allen. Ms. Deborah Wince-Smith, if you could begin. Ms. Wince-Smith is President of the Council on Competitiveness. We welcome you here. If you could keep your comments to about 5 minutes, any full written statements that you and all other witnesses submit will be made part of the official record. So if you could summarize your testimony, we can have as much time for questions and discussion as possible.

STATEMENT OF DEBORAH L. WINCE-SMITH, PRESIDENT, COUNCIL ON COMPETITIVENESS

Ms. WINCE-SMITH. Thank you Mr. Chairman, Senator Allen, and other members of the Committee. I'm delighted to be here and to have this opportunity to present testimony on the National Innovation Act and related proposals for ensuring America's leadership and competitiveness in the 21st century. This hearing is at the heart of the Council on Competitiveness' mission to drive productivity and increase the standard-of-living for all Americans. It's of great importance to our new Chairman, Chad Holliday, the CEO of DuPont.

Our members across all universities, industry and labor know that America cannot compete on low wage, commodity products, or standardized services. Our prosperity depends on high-value economic activity. Above-the-line, new value creation that is transformational in scope and that commands a premium in fiercely contested global markets.

Mr. Chairman, we do not stand on the cliff's edge, but we do stand at the crossroads. Complacency, and inaction, and incremental steps lead America down a path that will erode our eco-

conomic leadership, reduce our standard-of-living and jeopardize our national security. Dramatic action will lead America to an innovation-driven future. A path that will turbocharge America's growth and prosperity, galvanize creativity, and exploration, fuel our unique entrepreneurial prowess, and revitalize the strategic investments and risk-taking required to achieve success and reap reward for all our citizens.

Later this year the Council will release our flagship publication, the *2006 Competitiveness Index*, a comprehensive quantitative assessment of America's economic performance, and vitality. Benchmarked against global peers and an emerging competitors, the *2006 Index* will highlight the divergent paths we face and the potential impacts of each on America's economic future.

The National Innovation Act introduced by you, Mr. Chairman, and Senator Lieberman, and supported by so many members of this committee has indeed chosen commitment and bold action as the optimal path to our future. President Bush's Competitiveness Initiative has endorsed many of the same priorities. And with the recent introduction of the PACE legislation, based on the Academy's *Gathering Storm* report, there is now a tremendous convergence of the public and private sectors to implement a sustainable national competitive agenda fueled by the power of innovation, and the Council on Competitiveness wholeheartedly supports these efforts.

Now, we approach this tipping point in American competitiveness from a position as a global leader and the benchmark for competitiveness. We have a strong foundation on which to build a dynamic and resilient innovation ecosystem. Consider, the U.S. has 5 percent of the world's population, 40 percent of global wealth. The U.S. has been responsible for 98 percent of global growth between 1995 and 2002. Our GDP per capita is among the highest in the world and has doubled since 1970. Per worker, Americans are five times more productive than workers in China. We still lead the world in manufacturing output, as well as manufacturing value-added. Yet, the challenges are real, systemic and if ignored will undermine our foundation of strength and leadership.

America is facing triple deficits: in savings, the Federal deficit and current account deficit. The trade is projected to reach 7 percent of GDP in 2007, constituting 70 percent of the world's deficits. Manufacturing output is lagging that of early economic recoveries. Federal funding of basic research is now only half of the mid-1960s peak of 2 percent of GDP.

And as we know, 15-year-olds, rank 21st in international comparisons of mathematics and science. One-third of our scientists and engineers were born outside the U.S. and as Senator Baucus said, we are dealing with the unfunded, pension liability, healthcare costs, well into the future. But most importantly, other countries are adopting America's innovation-led growth strategies. They're investing in their people. They're building world-class research enterprises, and enabling infrastructure. In short, they're creating high-potential innovation ecosystems.

Low-wage nations have developed highly-skilled workforce and they are hungry for the world's work. Everyday, work that is routine, rule-based, and digitized, is being shipped around the world

to a low-cost performer. But other nations know that the competitiveness advantages, once obtained through cost and quality are now table stakes. And that's why the Council launched the National Innovation Initiative, under the leadership of Duane Ackerman CEO of Bell South, and co-chaired by Sam Palmisano, the CEO of IBM, and Wayne Clough, the President of Georgia Institute of Technology. Today, building on the momentum of our report, downloaded over 300,000 times, leaders from across the private-sector are working hard to implement its recommendations. Our current Co-Chairs, Dr. Craig Barrett of Intel, and , Bill Brody of John Hopkins University, are focused on the Federal policy recommendations contained in the NII, complimentary reports and new legislation.

Our new NII Leadership Council is already working on the next generation of policy, research and actions focused on high-leverage transformational challenges; 21st century advanced manufacturing; national deployment of a high-performance computational network accessible to entrepreneurs and small and medium-sized businesses; catalyzing regional innovation hotspots and the longer-term competitiveness imperative for affordable access to energy. Underpinning all of these efforts is the Council's Green Field Innovation Metrics research that is developing for the first time new performance-based measures to assess innovation outcomes. Currently, it is not possible to measure innovation given our reliance on today's static input-based metrics. And we're very proud that guiding this work is our NII Strategy Council, lead by Norm Augustine, Chuck Vest and David Baltimore.

Our agenda has the three foundational platforms of talent, investment and infrastructure, the building blocks for a resilient innovation ecosystem as set forth in the Council's report and in the legislation under consideration today. Increased national investment and a balanced basic research portfolio, Innovation Acceleration Grants, regional economic development, and transition to an extended global manufacturing enterprise constitute critical components of a robust competitiveness plan.

But let us not forget people innovate, not government, or companies and this is why our government must lead the way in investing in the vitality of our greatest asset, the American people. We must ensure that our children are equipped with the knowledge and problem-solving skills through better math-science education that will allow them to reach their full potential as high-performing citizens and workers, creative entrepreneurs and leaders of global enterprises. Government must ensure that our universities, colleges, community colleges, and K-12 system remain preeminent in the world and accelerate its historic R&D investment at the frontiers of knowledge.

And finally, the Federal Government in partnership with the private-sector and states must stimulate innovation-based growth in our regional economies where high-value investment and output activity is performed. So, as we stand on the threshold of a technological revolution in manufacturing, and its merger with high-value service solutions, the government has a pivotal role to play in accelerating the infrastructures of broadband, HPC networks, and 21st century patent systems collectively. This will enable America

to capture the benefits from our strategic investments in our people, research and regions.

Mr. Chairman, and members of the Committee, thank you and I would be pleased to answer any questions.

[The prepared statement of Ms. Wince-Smith follows:]

PREPARED STATEMENT OF DEBORAH L. WINCE-SMITH, PRESIDENT,
COUNCIL ON COMPETITIVENESS

Good morning, I'm Deborah Wince-Smith, the President of the Council on Competitiveness. Thank you, Chairman Stevens, Co-Chairman Inouye, Senator Ensign and the members of the Committee, for this opportunity to present testimony on the National Innovation Act and related proposals for assuring America's leadership and competitiveness in the 21st century. The Council on Competitiveness is a membership organization of CEOs, university presidents and labor leaders committed to developing an action-agenda to drive U.S. competitiveness and productivity, so this hearing is of great interest to our organization and, in particular, our Chairman, Chad Holliday, President and CEO of DuPont. The Council has over 120 members including many Fortune 100 companies and top research universities in the country.

One of our members at the Council likes to say that when it comes to competitiveness, Americans tend to veer between complacency and hysteria. On the one hand, many Americans find it hard to conceive of a world where the U.S. is not the global innovation leader. But others point to increasing signs that America's leadership is being challenged in certain areas and could even fall behind if current trends continue. We, as a Nation, do not stand on the cliff's edge as some would argue, but instead at a crossroads. Complacency, a defense of the *status quo*, leads down a path that could take us to the cliff, but at the very least risks subjecting the United States to a slow erosion of economic leadership and a reduced standard-of-living for its citizens—our ultimate metric for competitiveness, established 20 years ago at the founding of the Council on Competitiveness. Down the other path lies entrepreneurship, risk-taking and a national commitment to innovation that can ensure continued economic growth and prosperity. This divergence will be highlighted later this year when we release the Council's flagship publication, the *Competitiveness Index*, a comprehensive measure of the health of America's economic vitality.

The National Innovation Act introduced by Senator Ensign and Senator Lieberman, and supported by many members of this committee, is a critical part of an action-agenda to fuel America's innovation capacity. The Administration, through the President's American Competitiveness Initiative, has endorsed many of the same priorities and, in fact, a tremendous convergence of public- and private-sector support has coalesced around implementing a national competitiveness plan, underpinned by the power of innovation. The Council is pleased to wholeheartedly support these efforts.

A Strong Foundation

Given America's still dominant position in the world and our leadership through most of the twentieth century, a certain amount of complacency is inevitable. Statistics indicate that our glass is more than half full and we have a strong foundation on which to build our future. Let me share a few key metrics:

- U.S. GDP per capita is among the highest in the world (It has doubled since 1970).
- The U.S. consumer market is the largest in the world by far. It is more than twice the size of Japan's—the next largest consumer market.¹
- While developing nations like China are growing much faster than the U.S., the U.S. economy is still responsible for a larger share of global economic growth than any other country. Over the past 5 years China has grown more than three times as fast as the U.S. But since the U.S. economy is 8 times larger than the Chinese economy, that cumulative 3 percent growth over 5 years added \$1.7 trillion to our economy (an amount that exceeds the total size of China's economy).²

¹ Global Insight preliminary data for 2006 *Competitiveness Index*.

² Global Insight preliminary data for 2006 *Competitiveness Index*.

- Total U.S. R&D spending is greater than all of the other countries combined and accounts for nearly 43 percent of all R&D spending in the OECD.³
- The U.S. holds nearly 40 percent of the total global financial stock.⁴
- The United States still leads the world in manufacturing output—as well as in manufacturing value-add.⁵
- Despite a dramatic drop in 2003, the United States remains the top destination for Foreign Direct Investment. China nearly overtook the U.S. in 2003, but the U.S. has bounced back—garnering almost \$96 billion in inward investment in 2004 (compared to China's \$61 billion).⁶

So clearly, the United States is still a global leader and the benchmark for competitiveness. So it would seem as though the complacent among us would have the upper hand and say, continue to do what we have done and not rock the boat.

The Challenge

But all of us in this room know that the waters we must navigate in the future 21st century are not those that propelled us to our safe harbor in the 20th century. Consider these statistics:

- In 1970 the U.S. enrolled approximately 30 percent of tertiary level students in the world, and over half of science and engineering (S&E) doctorates were granted by U.S. institutions of higher education. In 2001–2002, UNESCO data shows that U.S. enrolled just 14 percent of tertiary students.⁷
- Asia now spends as much on nanotechnology as the United States.⁸
- Only six of the world's 25 most competitive information technology companies are based in the United States; 14 are based in Asia.⁹
- Federal funding of basic research is now only half of its mid-1960s peak of 2 percent of GDP.¹⁰
- Total scientific papers by American authors peaked in 1992 and have been flat ever since.¹¹
- Manufacturing output is lagging that of earlier economic recoveries.¹²

Finally, other countries are adopting America's innovation-led growth strategies and are rapidly moving up in the world rankings. And they are doing it with tremendous focus and intensity. This is a positive development generally, but can and is causing anxiety, particularly in the job market. Satchel Page once said, "Don't look back; someone might be gaining on you." His point that it is important to focus your attention forward always striving to stay ahead is an important one in the context of global competition. While I would argue that a little paranoia is justified given the direction of current trends, we must remain focused on future opportunities to generate economic growth and jobs; not try and recapture the industries and jobs of the past.

As Americans we know that we cannot, nor would we want to, compete on low wages, commodity products, or standardized services, but on high-value economic activity—above-the line activities—that commands a premium in fiercely contested global markets. There will always be a nation somewhere in the world willing to do the work for less. And those nations are hungry for the world's work. At the Council we say, if work is routine, rule-based, if it can be digitized, and reliably codified, there's going to be a low-cost source of labor somewhere in the world to compete for that work and for those jobs.

³NSF, *Science and Engineering Indicators 2006*, p. 4–40.

⁴McKinsey Global Institute, *\$118 Trillion and Counting: Taking Stock of the World's Capital Markets* (Feb. 2005), p. 16.

⁵NSF, *Science and Engineering Indicators 2006*, p. 6–12.

⁶UNCTAD, *World Investment Report 2005*, p. 303.

⁷Richard B. Freeman, *Does Globalization of the Scientific/Engineering Workforce Threaten U.S. Economic Leadership?* NBER Working Paper 11457, Cambridge, MA.: National Bureau of Economic Research, 2005.

⁸Lux Research, *The Nanotech Report 2004*, August 15, 2004. <https://www.global salespartners.com/lux/>.

⁹*BusinessWeek*, "The Information Technology 100 Scoreboard," June 21, 2004. http://www.businessweek.com/pdfs/2004/0425_it100.pdf.

¹⁰NSF, *Science and Engineering Indicators*, 2006.

¹¹NSF, *Science and Engineering Indicators*, 2006.

¹²Popkin, Joel and Kathryn Kobe, "U.S. Manufacturing Innovation at Risk," Council of Manufacturing Associations and the Manufacturing Institute, February 2006.

The Role of Innovation

Innovation is the key to meeting these challenges. Beginning with its founding in 1986 in the face of increased competition from the economic engines of Japan, Germany and others, the Council has a long history of private-sector-led innovation initiatives. Our first innovation summit was held in 1998 at MIT under the leadership of MIT President Emeritus, Chuck Vest. Three years later the Council hosted a major innovation summit in San Diego and in 2003, we launched the National Innovation Initiative which culminated in the release of *Innovate America* at the National Innovation Summit in Washington, D.C. in December 2004.

The National Innovation Initiative (NII), brought together over a 15 month process over 500 of the country's most talented thinkers and leaders to ponder the changing nature of innovation, the evolution of the global economy, and, most importantly, what the United States needs to do to remain the world leader in innovation. They developed an action-agenda that calls on all sectors of society to work together to solve the great challenges of our day.

Why focus on innovation? Well, our members—CEOs from across industrial sectors, university presidents and labor leaders—firmly believe that innovation will be the single most important factor in determining America's success through the 21st century.

The NII defines innovation as the intersection between ideas, imagination, insight, invention and implementation. We call it, "I" to the fifth power. Fundamentally, it is about the creation of new value. And the Council's long-standing policy research has demonstrated that innovation has been the principal driver of U.S. GDP and productivity growth and a rising standard-of-living for the past 50 years. More specifically, studies show that total factor productivity—generally attributed to innovation—was responsible for 47 percent of U.S. economic growth between 2000 and 2004.¹³

But, let me emphasize—for this is crucial to building the public institutions to support new policies and new behaviors—innovation is more than just a driver of economic growth. Innovation has always been the way people solved the great challenges facing society. Today, innovations not yet imagined may enable us to achieve dramatically higher levels of health across the planet; feed vast populations with the protein-based diets essential to health; meet the challenge of a rapidly aging population; find plentiful, affordable, environmentally-friendly sources of energy; and, continually push the frontier of exploration. And innovation will lead to the solution of problems that do not even exist yet and to the opening of new vistas of undreamt of opportunities for ourselves and for future generations.

Innovation has changed tremendously from the days of large industrial research laboratories and ivory tower universities. Where, how and why innovation occurs are in flux—across geography and industries, in speed and scope of impact, and even in terms of who is innovating. We see this transformation in a number of areas:

- The pace of innovation is increasing. For example: while it took 55 years for a quarter of the country to get an automobile, 35 years for the telephone, and 22 years for the radio, it has only taken 16 years for the PC, 13 years for the cell phone, and just 7 years for the Internet to penetrate a quarter of the U.S. population (and those trends are just as quick in other countries).
- Innovation has become multidisciplinary. It arises from the intersections of different fields or spheres of activity.
- At the same time, it is collaborative—requiring active cooperation and communication across organizations, companies, regions and countries. "Co-creation" is the new buzzword.
- Consumers are now in charge as we have moved from a production-driven world to one in which discerning customers are in charge with choice and power.
- And it is rapidly becoming global in scope—with advances coming from centers of excellence around the world.
- Manufacturing and services are merging:
 - The sharp dividing line between manufacturing and services is increasingly blurred.
 - Manufacturing companies are transforming themselves from product suppliers into solutions providers—melding services seamlessly into product lines.

¹³ Global Insight preliminary data for 2006 *Competitiveness Index*.

—When they blend like this we’re actually creating whole new markets and market opportunities.

At the same time that innovation has become a global enterprise, the world economy has globalized and integrated at a pace few predicted even 10 years ago. In less than 20 years, many nations have at last embraced market economies and moved toward political democratic norms. And this is a fantastic metric of success for world stability and quality-of-life. It also means that countries can now compete on traditional cost and quality terms, but they know that it is innovation—the ability to create new value—that will confer a competitive advantage in the 21st century. The playing field is leveling, and the barriers to innovation are falling.

My core message is that America’s long-standing lead in innovation and entrepreneurship is by no means assured. We must create an environment in which innovation can flourish and transformational value can be achieved.

The National Innovation Initiative

This challenge is why the Council launched the National Innovation Initiative—the NII—under the leadership of Duane Ackerman, CEO of BellSouth and Chairman of the Council from 2003–2005. To launch the NII in 2004, Duane asked Sam Palmisano, the Chairman and CEO of IBM, and Wayne Clough, the President of the Georgia Institute of Technology, to guide a Principals Committee of 17 other CEO’s and university presidents representing organizations as diverse as American Airlines, AMD, Pepsi, GM, Morgan Stanley, Texas A&M, MIT, Rensselaer Polytechnic Institute, and the University of Michigan. Engaging more than 500 leaders and experts across industry, academia, government and labor, the NII epitomizes the changing nature of 21st century innovation itself—exemplifying a dynamic process of collaboration and competition. This unprecedented group of thought-leaders came together to understand the changing nature of innovation in the 21st century, and—even more important—to generate a set of actions for companies, universities, community colleges, state and local government, and entrepreneurs to ensure that the United States stays at the leading edge of innovation. With the release of *Innovate America*, we laid out the challenges we face, the opportunities that lie ahead and the path to get us there.

And since the beginning of 2005, we have worked hard to engage others across the private-sector in the work of the NII—starting with our new Co-Chairs: Dr. Craig Barrett, Chairman of Intel Corporation, and Dr. Bill Brody, President of The Johns Hopkins University; and, including not only many of the CEOs and leaders from the launch, but also new champions—Jeff Immelt of GE, John Chambers of Cisco, Bob Reynolds of Fidelity Investments, Doug McCarron of the United Brotherhood of Carpenters & Joiners, Dr. Karen Holbrook of Ohio State University, and many others.

The Innovation Agenda advocated by our NII Leadership Council has three foundational platforms or building blocks—Talent, Investment and Infrastructure. Each platform has three primary objectives and specific recommendations, and collectively, these recommendations constitute an integrated sustainable path for 21st century prosperity. Let me just highlight one or two for each of the objectives.

Talent addresses our human capital needs. In this area we have three objectives:

1. Build the base of scientists and engineers;
 - For example, by pioneering an extensive portable graduate fellowship program to give control of educational choices back to students. Attract the best and the brightest students and workers from around the world by reforming our immigration system.
2. Catalyze the next generation of innovators;
 - By funding internships for innovation-oriented students to experience local startup and small business environments; and
3. Empower workers to succeed in the global economy;
 - Ensure Federal job training programs have the flexibility to target the skills needed for the jobs of the 21st century.

The Investment area addresses the balance between risk and reward and the incentives—or disincentives—for people and institutions to invest in innovation. Our priorities here are:

1. Revitalize frontier and multidisciplinary research;
 - Increase Federal funding of basic research, with an emphasis on the physical sciences.

- By reallocating 3 percent of all Federal agency R&D budgets toward “Innovation Acceleration” grants that invest in novel, high-risk and exploratory research.
- 2. Energize the entrepreneurial economy;
 - Catalyze10 Innovation Hotspots™ at regional locations across the United States over the next 5 years through public-private partnerships explicitly focused on supporting regional innovation; and
- 3. Reinforce risk-taking and long-term investment;
 - Make the R&D Tax credit permanent.

And that brings me to a core reality. Investing in innovation demands adherence to two fundamental principles: a willingness to accept risk and a willingness to wait for the return on investment. Although America’s entrepreneurial economy understands and embraces these principles, the much larger financial mainstream may be now moving in the opposite direction. Investment time horizons are getting shorter. Long-term innovation strategies remain undervalued. And business executives in publicly-held companies now face a regulatory climate that is blurring the line between business risk and legal risk. Intangible assets, which represent an increasingly large percentage of the value of corporations, still don’t show up on the balance sheet, reducing incentives to invest in creating more value. The challenge is transparency, disclosure and corporate governance.

The Infrastructure area covers not only the physical infrastructure that supports innovation but also to the political, regulatory and legal infrastructure that facilitates innovative behavior.

1. Create a 21st century intellectual property regime;
2. Strengthen America’s advanced manufacturing capacity; and
3. Put in place a national, coordinated innovation policy with representatives from the public and private sector.

The National Innovation Act and Related Proposals

The National Innovation Act (NIA) and S. 2390, which embodies the provisions of the NIA under the Commerce Committee’s jurisdiction, are based largely upon the recommendations included in *Innovate America*, but also are consistent with many of the key recommendations included in reports by the National Academies, Business Roundtable and President’s Council of Advisors on Science, and Technology to name a few. The bills recognize the importance of approaching innovation as an ecosystem requiring investments in talent, research and infrastructure. To be clear, these are still only the Federal component to what must be a public and private-sector initiative. We, in the private-sector, must lead as well and the gentlemen joining me on the panel today can ably describe the efforts their companies are undertaking to support the innovation enterprise.

I will briefly comment on each of the major provisions included in S. 2390:

The Presidents Council on Innovation (PCI)—To provide for America’s future economic security, the President must develop a comprehensive agenda for strengthening U.S. innovation capabilities across government, academia, and the private sector. This cabinet-level council would direct innovation policy across the Executive Branch. The PCI would be chaired by the Secretary of Commerce and include other Cabinet Secretaries and Department Heads including Defense, Education, Energy, Health and Human Services, Homeland Security among others. The PCI will develop a National Innovation Policy to foster a dynamic national environment for innovation capacity to ensure the attraction of high-value investment to build 21st century infrastructures across legal, digital, and physical systems. Among its objectives, the PCI should seek to strengthen America’s talent pool of innovators and skilled workers, develop market-based incentives and rewards to fuel all stages of the innovation cycle, identify and remove barriers to America’s innovative capacity and global competitiveness, and stimulate renewed adoption and deployment of innovative infrastructures.

The PCI should:

1. monitor implementation of proposals made in this and similar legislation in the areas of research funding, taxation, immigration, trade, education, regulatory reform and infrastructure development.
2. work with OMB to lead a process to assess the impact of current and proposed policies and rules on U.S. innovation capacity and outcomes.
3. develop metrics for measuring the government’s progress toward improving conditions for innovation in the areas of talent, investment, and infrastructure.

To engage the many constituencies in the “innovation ecosystem” outside the Federal Government, the legislation appropriately calls for the PCI Chair to consult with advisors drawn from the private sector, academia and scientific organizations.

Innovation Acceleration Grants—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. No one dreamed in the 1940s that the esoteric field of quantum mechanics would spawn the semiconductor and IT revolutions. Likewise, engineers working on time-sharing techniques probably never envisioned the World Wide Web and e-commerce. And scientists researching atomic motion certainly could not foresee the development of global positioning devices. The United States has led the world in science and engineering thanks in great part to public support of research. In the decades following World War II, industrial labs conducted frontier investigations alongside government agencies. However, in the 1980s, market pressures forced corporations to shift their research focus to projects offering near-term commercial benefit. The lengthy time frames and high risks associated with frontier research—coupled with the inability of investors to capture returns on investment—demanded that the U.S. Government bear the lion’s share of responsibility for funding.

In recent years, Washington’s commitment to pursuing true discovery—so essential to innovation—has begun to erode. Funding decisions have become increasingly conservative, driven by consensus, precedent, and incremental approaches. Investigators early in their careers, who often have the freshest ideas, are frequently shut out of the peer review process. Further, most Federal grant programs have not kept pace with the changing nature of innovation: Major scientific advances of recent years have drawn from multiple disciplines, and the move from laboratory to marketplace has required creative partnering across the public and private sectors.

At this time of intense global challenge, the Nation’s leaders must reconnect with America’s tradition of exploration and invest public resources in the type of research that, while promising little in the short-run, can lead to new knowledge and breakthrough innovation down the line. Innovation Acceleration Grants can go a long way toward meeting this lofty objective. The Council’s report recommended 3 percent of research agencies’ budgets be set aside for these grants and this recommendation was echoed and expanded to 8 percent of research budgets by the National Academies.

One example of this type of program with a successful track record is the Department of Energy’s LDRD program in which Lab Directors have a small percentage of their budgets dedicated to a discretionary fund that can be used to support high-risk, projects outside-of-the-box and general mission of the labs with the potential for great return. Indeed, many of the breakthrough discoveries from our National Laboratories can be linked back to the LDRD investments.

A National Commitment to Basic Research—Increasingly, innovation is occurring at the intersection of disciplines, with progress made in one area of scientific endeavor depending on advances in other areas. Medical breakthroughs, for example, now commonly combine modern biology, nanotechnology, information sciences, physical sciences, and engineering. Given the growing importance of multidisciplinary research, government R&D funding cannot be a zero-sum game that shifts resources from one field to another. Investment must be balanced across disciplines. However, recent appropriations have generated a significant imbalance: Federal funding for life sciences has increased four-fold since the 1980s. Over the same period, appropriations for the physical sciences, engineering, and mathematics have remained essentially flat.

The legislative proposals before the Senate appropriately give special attention to the National Science Foundation, and the Departments of Energy and Defense. The President’s ACI further highlights the critical role that the National Institute of Standards and Technology plays in this area. The National Science Foundation supports basic research across all disciplines. In FY 2002, Congress committed to doubling NSF’s budget within 5 years, but so far, only 16 percent of that commitment has been met. In addition to bringing much needed balance to the Federal research portfolio, this recommendation aims to strengthen the government’s overall commitment to R&D so critical to the innovation enterprise. Whereas in the late 1960s, the Federal commitment approached a full 2 percent of GDP, the current commitment is only 0.8 percent, less than the percentages spent by Sweden, Finland, Japan, and South Korea. By boosting agency research budgets as proposed, the U.S. Government will move toward a more robust R&D funding level of 1 percent of GDP.

Development of Advanced Manufacturing Systems—America must design and implement a new foundation for high-performance production. Although America remains the leading producer of manufactured goods, the Nation now trails other

major regions of the world in manufacturing growth. In 2005, the U.S. trade deficit in manufactured goods was a record \$781.6 billion.¹⁴ This imbalance not only speaks to the continuing erosion of manufacturing employment across the country, but also signals a growing risk to our ability to innovate.

For U.S. manufacturers to regain their competitive edge, they must embrace and accelerate innovations now occurring in the sector. A new paradigm is emerging—the “extended production enterprise”—in which services, design, and production are integrated in modular fashion. Manufacturers who grew up producing goods under one roof are now functioning as system integrators, managing supply chains or virtual networks of independent business process suppliers. They depend upon cutting-edge software, communications technology, and computing devices and sensors. Beyond technology, companies must adopt new organizational, marketing, and financial models to succeed—focusing on “above the line” priorities to drive innovation and growth. A reinvigorated manufacturing sector is essential to U.S. global competitiveness and security. Viewed more broadly, America’s fundamental ability to innovate depends upon the existence of a cutting-edge manufacturing infrastructure. The extended production enterprise is becoming an integral component of the innovation process, and the Nation must invest in research related to manufacturing technology in parallel with the pursuit of scientific breakthroughs.

The Federal Government should work with industry and the research community to strengthen America’s manufacturing capacity. The growing perception that the United States has “lost its manufacturing edge for good” need not—and cannot—become a reality. Federal resources should be targeted in the following areas: identifying and leveraging technological advantages, enhancing collaboration across the extended production enterprise, establishing shared, cutting-edge production facilities, improving the adaptive ability of small and mid-sized manufacturers, and charting the likely course of innovation in the sector.

Regional Innovation—The United States is not an innovative country—it is an agglomeration of innovative, and less innovative, regions. To optimize our national innovation output regions must implement innovation-based growth strategies. The NIA embraces a key recommendation included in *Innovate America* that argues, for America to prosper, we must help all our regions reach their full potential to support innovative firms and organizations and better integrate economic development and workforce training strategies. Let me make clear that this must be a bottom-up process driven by those on the ground in the regions and I believe the language proposed in the NIA is consistent with this goal.

A Consensus for Action

The issue of innovation and competitiveness has recently risen to the level of a first-tier economic priority. The President’s announcement of his new American Competitiveness Initiative at the State of the Union represented the confluence of a number of trends. We’ve seen bipartisan legislation introduced in both the Senate and the House based on the Council’s *Innovate America* report and the National Academies’ *Rising Above the Gathering Storm* report. Last December the Department of Commerce hosted a meeting of CEO’s and university presidents to address the issue with members of the President’s Cabinet, and a few weeks ago, under the leadership of current NII Chairs, Dr. Craig Barrett, Chairman of Intel, and Dr. Bill Brody, President of Johns Hopkins, over 140 CEOs, university presidents, Governors and other leaders joined together to sign an ad that was placed in *The Wall Street Journal* and the *Washington Post*, jointly calling on Congress to act on the innovation issue, and providing an “innovation resource” at www.innovateamerica.org—bringing together under one umbrella key information detailing the latest thinking and activities in the innovation and competitiveness space.

This growing consensus for action is not going unnoticed around the world. Not a month goes by at the Council that we are not visited by representatives from other countries looking for guidance and insight on how to mimic the U.S. model for innovative growth. And we believe it is in America’s best interest to tell them, for the global pie is growing and if we are smart and invest in our people, in the creation of new knowledge and in the infrastructure to glean value from these investments; our share of the pie will grow as well. Global competition is not a zero-sum game and this is why it is critically important to conclude the Doha Round of trade liberalizations to open global markets and expand the opportunities for global investment and high value economic activity. It has been reported that within a decade, nearly 80 percent of the world’s middle-income consumers could live in nations outside the currently industrialized world. To maintain our leadership and derive

¹⁴U.S. Department of Commerce, Bureau of Economic Analysis, www.bea.gov.

value, jobs and wealth for our citizens will require the commitment of the public and private sectors.

Further, we must collaborate globally on issues such as the measurement of innovation. How we measure innovation, both in terms of inputs—like our investment in R&D, education, etc.—as well as in terms of performance will be critical to determining the value of our investments and, at a very basic level, what works and what does not. Many countries around the world are tackling these same concerns and we will be well served to cooperate even as we compete. Companies such as Cisco Systems—as well as our partners in the EU, Japan, Korea, Mexico and Brazil—are working closely with the Council to initiate research in this field.

The Path Forward

Not resting on our laurels, the National Innovation Initiative continues to evolve and with the tremendous support of many of our members we are moving forward with the next generation of programs to build upon the findings and recommendations of *Innovate America*. During the development of the NII Report, Norm Augustine and Chuck Vest led a preeminent panel of advisors who contributed much of the intellectual capital to the final document. We have turned once again to these gentlemen along with Dr. David Baltimore, the President of the California Institute of Technology, to head a Strategy Council intended to guide our work in the innovation space going forward. Initiatives around the future of manufacturing, a national high-performance computational infrastructure, regional innovation, energy and sustainability in the 21st century, and innovation metrics are being developed as we map out tipping points facing our Nation and the actions needed to bolster long-term prosperity in America.

We will follow-up on what we call the NII “over the horizon” initiatives. It is important that we work to extend this agenda at home, in new regions and across the globe in order to maximize the potential for collaborative efforts and the benefits of innovation to our economy. For example:

21st Century Manufacturing—New value creation is the goal of the innovation continuum. This theme was echoed at a meeting held at the Council last week with 25 experts representing diverse fields of manufacturing. The meeting was a brainstorming session to begin the process of better understanding the role of manufacturing in the American economy and what the future might hold.

We are on the cusp of a technological renaissance in advanced manufacturing with the emergence of desktop fabrication, touch-sense-feel process controls, production slicing, nanoscale manipulation of matter, and the acceleration and transformation of product development through high-performance computing tools that will radically change the move from mass production to mass customization. The NII report warned that the Nation has been too quick to write-off manufacturing with the 4Ds: dirty, dumb, dangerous—and disappearing.

Indeed, in emerging areas like nano- and biotechnologies, we should balance our leadership in cutting-edge science with leadership in cutting-edge manufacturing (like the Japanese, Germans, and increasingly, the Chinese). In fact, Japan has been repatriating and “black boxing” much of its most advanced manufacturing research, processes and technologies.

We are also in the midst of a process revolution that will require a completely new set of skills and strategies. The Council is poised to undertake an effort to understand better this phenomenon and make recommendations to ensure America’s future manufacturing capacity—a future that will focus increasingly on “above the line” issues (like design, efficient supplies chains, best-of-world customer service, etc.) that add value to the manufacturing extended enterprise.

A critical part of this initiative is the power of high performance computing (HPC) to drive the manufacturing renaissance. The Council’s groundbreaking 3-year initiative supported by DARPA, DOE, NSF and NSA to explore the untapped potential of HPC as a driver of economic growth has brought together industry leaders from across all sectors. The goal is to better understand the power of HPC to answer the “what if” questions that could not be addressed even a few years ago and to give the U.S. a competitive advantage.

In today’s competitive global market, HPC has become essential to accelerating innovation, which is one reason President Bush highlighted its importance in his State of the Union address earlier this year. We like to say that “To Out Compete Is to Out Compute.” HPC assists companies in creating new inventions and products; in designing better, more reliable products, processes and services; in minimizing the time to build engineering prototypes; and in streamlining production processes and reducing production costs.

One of America’s greatest comparative advantages is our global leadership in HPC . . . not only manufacturing these powerful systems but applying them to ad-

dress our most challenging, and therefore, most competitively important problems. The Council has a major HPC initiative led by Dr. Karen Holbrook, the President of The Ohio State University, and David Shaw, of D.E. Shaw & Co., Inc., to identify the business and technical barriers preventing HPC from being used as aggressively as it could and should be by our companies, the important role of the private sector and what role public-private partnerships can play to address these challenges. HPC must be a key part of regional economic development strategies, as well.

Regional Innovation—Hotspots™

Building on the Council's long history in launching the national debate in the mid-1990s around "clusters of innovation" as well our more recent and groundbreaking work on "regional innovation" with the Department of Commerce, we are looking to catalyze the development of "Hotspots" of regional innovation and economic growth across the country. We define a Hotspot as a region that successfully integrates four critical strategies to drive innovation and economic growth: economic development, workforce development, education, and entrepreneurship. HPC can also play a critical role in that process. While data shows that this technology is an important driver of innovation at the corporate and industry level, we also know that increasingly, innovation occurs at the intersection between businesses, research centers, universities, and skilled workers in innovation centers across the U.S. Linking regional HPC assets to address regional challenges can turbocharge the innovation process on the ground and optimize regional economic growth.

Successful "hotspots" also require abundant talent. The good news is that both the Department of Commerce's Economic Development Administration and the Department of Labor (DOL), through their Workforce Innovation in Regional Economic Development (WIRED) program are adopting innovation as a guiding principle in regional economic development. The Council is proud to be a key partner with DOL in the design and implementation of the WIRED program. The NIA would go a long way toward codifying and strengthening this important progress, but most of the work is and should be down on the ground, in the regions.

Since issuing *Innovate America*, the Council has been approached by numerous governors and others seeking to partner to spur regional innovation-based growth. The Council is planning regional summits in Massachusetts and Ohio in the near-term, and several other events are in the planning stage. The good news is that many states are moving beyond the view of economic development as a zero-sum game where one tax break might outdo another. Instead, they are turning to innovation as the driver of growth and looking to the assets they have in place to catalyze economic activity. Indeed, the reigning mantra in regional innovation is "earn it, keep it, grow it."

Energy—A 21st century energy infrastructure is one of the linchpins of America's ability to compete in the global economy. The tight linkage between energy and the economy is not a new concept; every President since Nixon has made energy security, efficiency and diversification a national priority. What is new is that geo-strategic, geo-economic and bottom-line interests are converging with technological opportunity—creating a tipping point for action.

At the same time, the technological options for energy efficiency and fuel and feedstock diversification create significant opportunities to effect real change in the marketplace. At the Federal level, the National Energy Plan lays out the urgency to develop reliable and affordable energy supplies. For the first time, perhaps, America's major energy providers are investing hundreds of billions of dollars in alternative energy sources while leading corporations are proving the business case for sustainability. DuPont's CEO, Chad Holliday, recently announced that he expects 25 percent (up from 10 percent) of Dupont's products to be made with non-petrochemical substances by 2010.

The Nation can rise to the global energy challenge by applying both its capacity for innovation and its ability to forge public-private partnerships that share ideas, talent and investments. Never has it been so critical to create innovative energy solutions that will sustain both our global economic leadership and domestic prosperity. This year the Council will launch an initiative to create a private sector energy roadmap—grounding the Nation's investment and policy priorities in the business case for sustainability, diversification and energy efficiency.

Conclusion

Government plays critical roles in enhancing and supporting the competitiveness of American businesses starting with ensuring there is an innovation-friendly climate for U.S. enterprises to develop and compete at home and abroad. Today, more than ever before, the government must invest in the long-term vitality of our greatest asset, the American people. We must ensure that our children are equipped with

the knowledge and problem-solving skills through better math science education that will allow them to reach their full potential as high-performing entrepreneurs. Another Council member once commented that “We need artists who can think like engineers, and engineers who can think like artists.” These are the small and medium-sized business leaders that will drive America’s economic growth in the future if government makes the investments in their future now.

Government must accelerate its long-standing commitment to invest in research and development at the frontiers of knowledge and ensure that America’s universities and colleges remain preeminent in the world. Finally, the government must look for avenues to support the development of an advanced manufacturing capability in the United States that will position us to take full advantage of the investments in research and human capital. At one of our recent meetings, Roger Enrico, former CEO of PepsiCo and now CEO of Dreamworks Animation, talked about the importance of making big changes to big things. Change and progress, he explained, will never come if you don’t free yourself from the tyranny of incrementalism. Dramatic results do not come from undramatic action.

Senator ENSIGN. Thank you. Our next witness will be Mr. Norman Augustine. Mr. Augustine is retired Chairman of the Board, and CEO of Lockheed-Martin Corporation. In addition, Mr. Augustine is making a lot of waves, with the *Rising Above the Gathering Storm* report with the rest of you. So we look forward to hearing your testimony today. Welcome.

STATEMENT OF NORMAN R. AUGUSTINE, CHAIRMAN/CHIEF EXECUTIVE OFFICER (RETIRED), LOCKHEED MARTIN CORPORATION; CHAIR, COMMITTEE ON PROSPERING IN THE GLOBAL ECONOMY OF THE 21ST CENTURY, NATIONAL ACADEMIES

Mr. AUGUSTINE. Thank you Mr. Chairman, Senator Allen, members of the Committee. I will submit for the record, if I may, a written copy of a statement. It was my privilege to chair the National Academy study on competitiveness, and also to co-chair the strategy board for the Council of Competitiveness study of the topic. The legislation that has been introduced already including certainly the PACE bill and the National Innovation Act are very compatible with the findings of our report as is the President’s American Competitiveness Initiative. I’m here today on behalf of the National Academies and would briefly describe our work—it was performed by a panel of 20 members, whom my colleague Dr. Barrett on my left was one of the members. We were given 90 days to undertake our work because of the urgency that the Academy and the Senate had assigned to us.

Many of us have already been working on this topic for as long as 20 years. It’s a particularly difficult topic, because of its importance and because of the fact that there’s no Pearl Harbor here, there’s no 9/11, there’s no *Sputnik*. Our analogy is much more than of the frog being slowly boiled. It’s our committee’s unanimous view that America is facing a very, very serious problem.

It’s a problem that’s been decades in the making and will take decades to resolve. This has been brought about partly because of our own inaction in many instances, but partly because the rest of the world is getting better and its often getting better by copying the things that we used to do well.

The question of course comes up, is it not good that the rest of world is prospering and the answer has to be a resounding yes. Not only does that probably produce a more stable world for all of us,

it creates customers for our products and it provides our consumers with less costly goods. Nonetheless, we want to be sure that America prospers too in this new world that is going to happen, whether we bring it about or someone else does.

The question arises what has brought this situation that we find? I would cite four examples, or four primary forces. The first has been referred to as, "The Death of Distance," which has been brought about by the advent of the airplane in the last century; telecommunications in this century, and the end of the last century, where the cost of storage and processing and transmission is almost negligible.

What this means is that the parties to most transactions don't have to live near each other; they don't have to be in physical proximity. Many people think that may be true of assembly work in a factory. But it's increasingly becoming true throughout the job food chain. And whether you're a dentist or a researcher or an accountant this will affect you as well as an individual.

The second factor is that 3 billion new capitalists have entered the labor force of the world in the last 15 years, these people are well educated. In many cases they're hungry, they're dedicated, they're very able. And they're seeking jobs just like our neighbors are.

Third, there has been a change in the character of the funding of research in America. It used to be that government supported about two-thirds of the R&D, which fell to one-third. Industry picked up the missing third, but it did it with a very different nature and because of the pressures of the marketplace for short-term returns. What will do next quarter? Industry is abandoning slowing the R part of R&D, and investing heavily in the D. But somebody has to produce that seed-corn that benefits society as a whole. And that frankly is going to have to be our Federal Government, by and large.

Finally there is the deterioration of the public K-12 system about which much has been said, and so I won't repeat it, other than to point out that the problems are particularly true in the area of science and mathematics. What can we do about this? Our committee has proposed four recommendations, as a part of the package and it is a package. We proposed 20 implementing actions; we propose energy dependence be one of the central themes of our overall effort. How do we reduce our dependence on foreign energy? In order of priority we propose solutions to some of the K-12 problems that we confront. We propose strengthening the basic research program, for example: by doubling the investment in aspects of that program over the next 10 years. We propose encouraging more people to go into science and technology and into the higher education system. Not because we want more scientists and technologists *per se*, only 4 percent of our workforce is made up of scientists and technologists. But science and technologists disproportionately produce jobs for the other 96 percent and that is why we have our interest in this area.

And finally, we propose addressing issues in our competitiveness environment leading to patent policy, litigation, tax policy and so forth.

So that is the proposal of the Academies report, and again I would say, it's very compatible with the bills that are being discussed in the Senate. Thank you very much.

[The prepared statement of Mr. Augustine follows:]

PREPARED STATEMENT OF NORMAN R. AUGUSTINE, CHAIRMAN/CHIEF EXECUTIVE OFFICER (RETIRED), LOCKHEED MARTIN CORPORATION; CHAIR, COMMITTEE ON PROSPERING IN THE GLOBAL ECONOMY OF THE 21ST CENTURY, NATIONAL ACADEMIES

Mr. Chairman and members of the Committee.

Thank you for this opportunity to appear before you on behalf of the National Academies' Committee on Prospering in the Global Economy of the 21st Century. As you know, our effort was sponsored by the National Academy of Sciences, National Academy of Engineering and Institute of Medicine, which are collectively known as the National Academies. The National Academies were created by President Lincoln and chartered by Congress in 1863 to advise the government on matters of science and technology.

Our study had as its origin a conversation which took place at the National Academies with Senator Lamar Alexander a number of months ago. As a result of that discussion, the Academies were requested by Senator Alexander and Senator Jeff Bingaman, members of the Senate Committee on Energy and Natural Resources, to conduct an assessment of America's ability to compete and prosper in the 21st century—and to propose appropriate actions to enhance the likelihood of success in that endeavor. This request was endorsed by the House Committee on Science.

To respond to that request the Academies assembled twenty individuals with diverse backgrounds, including university presidents, public school educators, CEOs, Nobel Laureates and former Presidential appointees. The result of our committee's work was examined by 37 highly qualified anonymous reviewers who were also designated by the Academies. In undertaking our assignment we considered the results of a number of prior studies which were conducted on various aspects of America's future prosperity. We also gathered over sixty subject-matter experts with whom we consulted for a weekend here in Washington and who provided over 100 recommendations related to their various fields of specialization.

It is the unanimous view of our committee that America today faces a serious and intensifying challenge with regard to its future competitiveness and standard-of-living. Further, we appear to be on a losing path. We are here today hoping to elevate the Nation's awareness of this situation, which has been developing for several decades, and to propose constructive solutions.

The thrust of our findings is straightforward. The standard-of-living of Americans in the years ahead will depend to a very large degree on the quality of the jobs that they are able to hold. Without quality jobs our citizens will not have the purchasing power to support the standard-of-living which they seek and to which many have become accustomed; tax revenues will not be generated to provide for strong national security and healthcare; and the lack of a vibrant domestic consumer market will provide a *disincentive* for either U.S. or foreign companies to invest in jobs in America. Further, the weakening scientific and technological base in America will be diminished in its ability to meet such important challenges as the provision of clean, secure, sustainable, affordable energy.

What has brought about the current situation? The answer is that the prosperity equation has a new ingredient, an ingredient that some have referred to as "The Death of Distance." In the last century, breakthroughs in aviation created the opportunity to move people and goods rapidly and efficiently over very great distances. Bill Gates has referred to aviation as the "World Wide Web of the twentieth century." In the early part of the present century, we are approaching the point where the communication, storage and processing of information are nearly free. That is, we can now move not only physical items efficiently over great distances, we can also transport *information* in large volumes and at little cost.

The consequences of these developments are profound. Soon, only those jobs that require near-physical contact among the parties to a transaction will not be opened to competition from job seekers around the world. Further, with the end of the Cold War and the evaporation of many of the political barriers that previously existed throughout the world, nearly three *billion* new, highly-motivated, often well-educated, new capitalists entered the job market.

Suddenly, Americans find themselves in competition for their jobs not just with their neighbors as was the case in the past but with highly-motivated and well-qualified individuals from around the world. The impact of this was initially felt in

manufacturing, but soon extended to the development of software and the conduct of design activities. Next to be affected were administrative and support services. Today, “high end” jobs, such as professional services, research and management, are impacted. In short, few jobs seem “safe.” Consider that—

- U.S. companies each morning receive software that was written in India overnight in time to be tested in the U.S. and returned to India for further production that same evening—making the 24-hour workday a practicality.
- Back-offices of U.S. firms operate in such places as Costa Rica, Ireland and Switzerland.
- Drawings used by American architectural firms are produced in Brazil.
- U.S. firm’s call centers are based in India—where employees are now being taught to speak with a mid-Western accent.
- U.S. hospitals have x-rays and CAT scans read by radiologists in Australia and India.
- At some McDonald’s drive-in windows, orders are transmitted to a processing center a thousand miles away (currently in the U.S.), where they are processed and returned to the worker who actually prepares the order.
- Accounting firms in the U.S. have clients’ tax returns prepared by experts in India.
- Visitors to an office not far from the White House are greeted by a receptionist appearing on a flat screen display who controls access to the building and arranges contacts—she is in Pakistan.
- U.S. patients have dental work performed in the Dominican Republic, since an air fare is a minor part of the cost of such treatment.
- Surgeons sit on the opposite side of the operating room and control robots which perform the procedures. It is not a huge leap of imagination to have highly-specialized, world-class surgeons located not just across the operating room but across the oceans.

As Tom Friedman concluded in *The World is Flat*, globalization has “accidentally made Beijing, Bangalore and Bethesda next door neighbors”. And the neighborhood is one wherein able candidates for many jobs which currently reside in the U.S. are now just a “mouse-click” away.

How will America compete in this rough and tumble global environment that is approaching much faster than many had expected? The answer appears to be, “not very well”—at least not unless we do a number of things differently from the way we have been doing them in the past. The Red Queen in Lewis Carroll’s, *Through the Looking Glass*, offers us some sound advice, “Now, *here*, you see, it takes all the running you can do to keep in the same place. If you want to get somewhere else, you must run at least twice as fast as that!”

Why do we reach this conclusion? One need only examine the principal ingredients of competitiveness to discern that not only is the world flat, but in fact it may be tipping *against* us.

One element of competitiveness is, of course, the cost of labor. I recently traveled to Vietnam, where the wage rate for low-skilled workers is about twenty-five cents per hour, about one-twentieth of the U.S. minimum wage. And the problem is not confined to the so-called “lower-end” of the employment spectrum. For example, five qualified chemists can be hired in India for the cost of just one in America. Eight engineers can be hired in India for the cost of one in America. Given such enormous disadvantages in labor cost, we cannot be satisfied merely to match other economies in those other areas where we do enjoy strength; rather we must excel markedly.

The existence of a vibrant domestic market for products and services is another important factor in determining our Nation’s competitiveness, since such a market helps attract business to our shores. But here, too, there are warning signs: Goldman Sachs analysts project that within about a decade, fully 80 percent of the world’s *middle-income* consumers will live in nations outside the currently industrialized world. It is projected that in China alone there will be twice as many middle-class consumers as the entire population of the U.S. The availability of financial capital has in the past represented a significant competitive advantage for America. But the evolving mobility of financial capital is legion, as evidenced by the willingness of U.S. firms to build factories in Mexico, Vietnam and China if a competitive advantage can be derived by doing so. Capital, as we have repeatedly observed, crosses geopolitical borders at the speed of light. Consider that—

- In 2005, American investors put more new money in foreign stock funds than in domestic stock portfolios.¹
- In 1995 (the most recent year for which data is available), U.S. 12th graders performed below the international average for 21 countries on a test of general knowledge in mathematics and science.
- U.S. 15-year-olds ranked 24th out of 40 countries that participated in a 2003 examination administered by the Program for International Student Assessment (PISA) of students' ability to apply mathematical concepts to real-world problems.

Human capital—the *quality* of our workforce—is a particularly important factor in our competitiveness. Our public school system comprises the foundation of this asset. But as it exists today, that system compares, in the aggregate, abysmally with those of many other developed—and even developing—nations. This is particularly true in the fields which underpin most innovation, namely science, mathematics and technology.

Of the utmost importance to competitiveness is the availability of knowledge capital—“ideas.” And once again, scientific research and engineering applications are crucial. But knowledge capital, like financial capital, is highly mobile. There *is* one major difference: being first-to-market, by virtue of access to new knowledge, can be immensely valuable—even if by only a few months. Dr. Craig Barrett, a member of our committee and Chairman of Intel, points out that ninety percent of the products his company delivers on December 31st did not even exist on January 1st of that same year. Such is the dependence of hi-tech firms on being at the leading edge of scientific and technological progress. And it is not simply so-called hi-tech firms that share this dependence. For example, the CEO of America's largest consumer products firm has characterized his firm as largely an R&D organization.

There are of course many other factors influencing our Nation's competitiveness than those discussed above. These include patent processes, tax policy and overhead costs—such as healthcare, regulation and litigation—all of which tend to work against us today. On the other hand, America's version of the Free Enterprise System has proven to be a powerful asset, with its inherent aggressiveness in introducing new ideas and discipline and flushing out the obsolescent. But others have now recognized these virtues and are seeking to emulate many of the aspects of our system.

But is it not a *good* thing that others are prospering? Our committee's answer to that question is a resounding “yes.” Broadly based prosperity can make the world more stable and safer for all; it can make less costly products available for American consumers; it can provide new customers for the products we produce. Yet it is inevitable that there will be relative winners and relative losers—and as the world prospers, we seek to assure that America does not fall behind in the race.

The enigma is that in spite of all these factors, America seems to be doing quite well just now. Our Nation has the highest R&D investment intensity in the world. We have indisputably the finest research universities in the world. California alone has more venture capital than any nation in the world other than the United States. Total household net worth is now approaching \$50 *trillion*. Two million jobs were created in America in the past year alone, and citizens of other nations continue to invest their savings in America at a remarkable rate.

The reason for this prosperity is that we are reaping the benefits of past investments—many of them in the fields of science and technology. But the early indicators of future prosperity are generally heading in the wrong direction. Consider the following—

- The United States is today a net importer of *high-technology* products. Its trade balance in high-technology manufactured goods shifted from *plus* \$54 billion in 1990 to *negative* \$50 billion in just 11 years.²
- In one recent period, low-wage employers, such as Wal-Mart (now the Nation's largest employer) and McDonald's, created 44 percent of the new jobs, while high-wage employers created only 29 percent of the new jobs.³

¹Paul J. Lim. *Looking Ahead Means Looking Abroad*. *New York Times*. January 8, 2006.

²For 2001, the dollar value of high-technology imports was \$561 billion; the value of high-technology exports was \$511 billion. See National Science Board. 2004. *Science and Engineering Indicators 2004* (NSB 04-01). Arlington, Virginia. National Science Foundation. Appendix Table 6-01. Page A6-5 provides the export numbers for 1990 and 2001 and page A6-6 has the import numbers.

³Steve Roach. *More Jobs, Worse Work*. *New York Times*. July 22, 2004.

- The United States is one of the few countries in which industry plays a major role in providing healthcare for its employees and their families. Starbucks spends more on healthcare than on coffee. General Motors spends more on healthcare than on steel.⁴
- Chemical companies closed 70 facilities in the United States in 2004, and tagged 40 more for shutdown. Of 120 chemical plants being built around the world with price tags of \$1 billion or more, one is in the United States and 50 are in China. No new refineries have been built in the United States since 1976.⁵
- The share of leading-edge semiconductor manufacturing capacity owned or partly owned by U.S. companies today is half what it was as recently as 2001.⁶
- During 2004, China overtook the United States to become the leading exporter of information technology products, according to the OECD.⁷
- The United States ranks only 12th among OECD countries in the number of broadband connections per 100 inhabitants.⁸
- In 2001 (the most recent year for which data are available), U.S. industry spent more on tort litigation than on research and development.⁹
- In 2005, only four American companies ranked among the top 10 corporate recipients of patents granted by the *United States* Patent and Trademark Office.¹⁰
- Beginning in 2007, the most capable high-energy particle accelerator on Earth will, for the first time, reside outside the United States.¹¹
- Federal funding of research in the physical sciences, as a percentage of GDP, was 45 percent less in FY 2004 than in FY 1976.¹² The amount invested annually by the U.S. Federal Government in research in the physical sciences, mathematics, and engineering combined equals the annual increase in U.S. health care costs incurred every 20 days.¹³
- Eight different studies by various economists of the societal benefits from expenditures on research and development reveal returns on investments ranging from 11 percent to 147 percent.

⁴Chris Noon. 2005. "Starbucks' Schultz Bemoans Health Care Costs." *Forbes.com*, September 19. Available at: http://www.forbes.com/facesinthenews/2005/09/15/starbuckshealthcarebenefitscn_0915autofacescan01.html?partner=yahooti; Ron Scherer. 2005. "Rising Benefits Burden." *Christian Science Monitor*, June 9. Available at: <http://www.csmonitor.com/2005/0609/p01s01-usec.html>.

⁵Michael Arndt. 2005. "No Longer the Lab of the World: U.S. Chemical Plants are Closing in Drove as Production Heads Abroad." *BusinessWeek*, May 2. Available at: http://www.businessweek.com/magazine/content/05_18/b3931106.htm and <http://www.usnews.com/usnews/biztech/articles/051010/10energy.htm>.

⁶Semiconductor Industry Association. 2005. "Choosing to Compete." December 12. Available at: <http://www.sia-online.org/downloads/FAD%20'05%20-%20scalise%20Presentation.pdf>.

⁷OECD. 2005. "China Overtakes U.S. As World's Leading Exporter of Information Technology Goods." December 12. Available at: http://www.oecd.org/document/60/0,2340,en_2649_201185_35834236_1_1_1_1,00.html. The main categories included in OECD's definition of ICT (information and communications technology) goods are electronic components, computers and related equipment, audio and video equipment and telecommunication equipment.

⁸OECD. 2005. "OECD Broadband Statistics, June 2005." October 20. Available at: http://www.oecd.org/document/16/0,2340,en_2649_201185_35526608_1_1_1_1,00.html#data2004.

⁹U.S. research and development spending in 2001 was \$273.6 billion, of which industry performed \$194 billion and funded about \$184 billion. National Science Board. 2004. *Science and Engineering Indicators 2004* (NSB 04-01). Arlington, VA: National Science Foundation. One estimate of tort litigation costs in the United States was \$205 billion in 2001.

Jeremy A. Leonard. 2003. "How Structural Costs Imposed on U.S. Manufacturers Harm Workers and Threaten Competitiveness." Prepared for the Manufacturing Institute of the National Association of Manufacturers. Available at: http://www.nam.org/s_nam/bin.asp?CID=216&DID=227525&DOC=FILE.PDF.

¹⁰U.S. Patent and Trademark Office 2006. *USPTO Annual List of Top 10 Organizations Receiving Most U.S. Patents*. January 10, 2006. <http://www.uspto.gov/web/offices/com/speeches/06-03.htm>.

¹¹CERN. Internet Homepage. <http://public.web.cern.ch/Public/Welcome.html>.

¹²AAAS. 2004. "Trends in Federal Research by Discipline, FY 1976-2004." October. Available at: <http://www.aaas.org/spp/rd/disc04tb.pdf> and <http://www.aaas.org/spp/rd/discip04c.pdf>.

¹³Centers for Medicare and Medicaid Services. 2005. *National Health Expenditures*. Available at: <http://www.cms.hhs.gov/NationalHealthExpendData/downloads/tables.pdf>.

- When asked in spring 2005 what is the most attractive place in the world in which to “lead a good life”, respondents in only one (India) of the 16 countries polled indicated the United States.¹⁴

As important as jobs are, the impact of these circumstances on our Nation’s security could be even more profound. In the view of the bipartisan Hart-Rudman Commission on National Security, “. . . the inadequacies of our system of research and education pose a greater threat to U.S. national security over the next quarter century than any potential conventional war that we might imagine.” Indeed, the consequences of current trends are particularly acute for the defense sector, which must rely upon U.S. citizens for much of its engineering force and cannot shift sensitive work to overseas firms. Further, a service economy (which accounts for 75 percent of today’s jobs) is, in general, not the foundation of military equipment and power.

The good news is that there are things we can do to assure that America does in fact share in the prosperity that science and technology are bringing the world. In this regard, our committee has made four broad recommendations as the basis of a prosperity initiative—and offers 20 specific actions to make these recommendations a reality. They should be viewed as an integrated package and include:

- “*Ten Thousand Teachers, Ten Million Minds*”—which addresses America’s K–12 education system. We recommend that America’s talent pool in science, math and technology be increased by vastly improving K–12 education. Among the specific steps we propose are:
 - Recruitment of 10,000 new science and math teachers each year through the award of competitive scholarships in math, science and engineering that lead to a bachelor’s degree *accompanied by a teaching certificate*—and a 5-year commitment to teach in a public school.
 - Strengthening the skills of 250,000 current teachers through funded training and education in part-time master’s programs, summer institutes and Advanced Placement training programs.
 - Increasing the number of students who take Advanced Placement science and mathematics courses and pass exams.
- “*Sowing the Seeds*”—which addresses America’s research base. We recommend strengthening the Nation’s traditional commitment to long-term *basic* research through:
 - Increasing Federal investment in research by 10 percent per year over the next 7 years, with primary attention devoted to the physical sciences, engineering, mathematics, and information sciences—without *disinvesting* in the health and biological sciences.
 - Providing research grants to early career researchers.
 - Instituting a National Coordination Office for Research Infrastructure to oversee the investment of an additional \$500M per year for 5 years for advanced research facilities and equipment.
 - Allocating at least 8 percent of the existing budgets of Federal research agencies to discretionary funding under the control of local laboratory directors.
 - Creation of an Advanced Research Projects Agency—Energy (ARPA-E), modeled after DARPA in the Department of Defense, reporting to the Department of Energy Undersecretary for Science. The purpose is to support the conduct of out-of-the-box, transformational, generic, energy research by universities, industry and government laboratories.
 - Establish a Presidential Innovation Award to recognize and stimulate scientific and engineering advances in the national interest.
- “*Best and Brightest*”—which addresses higher education. In this area we recommend:
 - Establishing 25,000 competitive science, mathematics, engineering, and technology undergraduate scholarships and 5,000 graduate fellowships in areas of national need for U.S. citizens pursuing study at U.S. universities.

¹⁴ Pew Research Center, 2005 “U.S. Image Up Slightly, But Still Negative, American Character Gets Mixed Reviews” Pew Global Attitudes Project. Washington, D.C. Available at: <http://pewglobal.org/reports/display.php?ReportID=247>.

The interview asked nearly 17,000 people the question: “Supposed a young person who wanted to leave this country asked you to recommend where to go to lead a good life—what country would you recommend?” Except for respondents in India, Poland, and Canada, no more than one-tenth of the people in the other nations said they would recommend the United States. Canada and Australia won the popularity contest.

- Providing a Federal tax credit to employers to encourage their support of continuing education.
- Providing a one-year automatic visa extension to international students who receive a science or engineering doctorate at a U.S. university, and providing automatic work permits and expedited residence status if these students are offered employment in the U.S.
- Instituting a skill-based, preferential immigration option.
- Reforming the current system of “deemed exports” so that international students and researchers have access to necessary non-classified information or research equipment while studying and working in the U.S.
- “*Incentives for Innovation*”—in which we address the innovation environment itself. We recommend:
 - Enhancements to intellectual property protection, such as the adoption of a first-to-file system.
 - Increasing the R&D tax credit from the current 20 percent to 40 percent, and making the credit permanent.
 - Providing permanent tax incentives for U.S.-based innovation so that the United States is one of the most attractive places in the world for long-term innovation-related investments.
 - Ensuring ubiquitous broadband Internet access to enable U.S. firms and researchers to operate at the state-of-the-art in this important technology.

The committee notes that, just as when America was faced with the science and technology challenge posed by *Sputnik* and President Kennedy announced the program to land Americans on the Moon, the proposals made herein will best be served by having a “centerpiece goal”—particularly with regard to the proposals affecting research. It is not intended that all the suggested efforts be directed at one particular national goal, but rather that a goal be established to provide a focus under which a central core of research can be pursued. The goal selected by the Committee is that of providing the Nation with sustainable, safe, clean, secure and affordable energy. This particular choice was made, first, because it represents a highly critical national problem and, second, because the challenge it offers relates closely to those particular aspects of science and technology of greatest concern herein; namely, physics, chemistry, mathematics, computer science and engineering.

Since the Academies’ draft report was released in October 2005, the response has been quite remarkable. We are particularly pleased that the President has embraced the challenge we are facing and proposed important actions in his American Competitiveness Initiative (ACI). As you also know, the House and Senate have been very active on this issue both before and after the National Academies report was released. Among the bills proposed is that of Senators Ensign and Lieberman—the National Innovation Act (NIA). This bill, along with the Protecting America’s Competitive Edge Act (PACE) proposed by Senators Domenici, Bingaman, Alexander, and Mikulski, are generally harmonious with our recommendations. All three activities recognize the importance of increasing the Nation’s investment in research—particularly at the National Science Foundation.

The National Academies does not endorse legislation, but we would like to note that PACE and much of the NIA closely match the actions proposed in the *Gathering Storm* report. For example, the NIA would:

- Establish an *Innovation Acceleration Grants Program* which would encourage Federal agencies funding research in science and technology to allocate a fraction of their research and development (R&D) budgets to grants directed toward high-risk frontier research.
- Increase the national commitment to basic research by nearly doubling research funding for the *National Science Foundation* (NSF) by FY 2011.
- Make permanent the *Research and Experimentation (R&E) tax credit* with modifications expanding eligibility for incentives to a greater number of firms.
- Expand existing educational programs in the physical sciences and engineering by increasing funding for *NSF graduate research fellowship* programs as well as Department of Defense science and engineering scholarship programs.

Today we are not confronting a so-called “typical” crisis, in the sense that there is no 9/11, *Sputnik* or Pearl Harbor to alert us as a Nation. Our situation is more akin to that of the proverbial frog being slowly boiled. Nonetheless, while our committee believes the problem we confront is both real and serious, the good news is that we may well have time to do something about it—if we start now.

Americans, with only 5 percent of the world's population but with nearly 30 percent of the world's wealth, tend to believe that scientific and technological leadership and the high standard-of-living it makes possible is somehow the natural state-of-affairs for our people. But such good fortune is *not* a birthright. If we wish our children and grandchildren to enjoy the standard-of-living most Americans have come to expect, there is only one answer: We must get out and *compete*.

I would like to close my remarks with a perceptive and very relevant poem. It was written by Richard Hodgetts, and eloquently summarizes the essence of innovation in the highly competitive, global environment. The poem goes as follows:

Every morning in Africa a gazelle wakes up. It knows it must outrun the fastest lion or it will be killed.

Every morning in Africa a lion wakes up. It knows it must outrun the slowest gazelle or it will starve.

It doesn't matter whether you're a lion or a gazelle—when the sun comes up, you'd better be running.

And indeed we should.

Thank you for providing me with this opportunity to testify on behalf of my colleagues before the Committee. I would be pleased to answer any questions you may have about our report.

Senator ENSIGN. Thank you. Our next witness will be Dr. Craig Barrett. Craig, welcome. Dr. Barrett is Chairman of the Board of Intel Corporation. We have worked together many times. Welcome to our committee. It is good to have you here. We look forward to hearing from you.

**STATEMENT OF DR. CRAIG R. BARRETT,
CHAIRMAN OF THE BOARD, INTEL CORPORATION**

Dr. BARRETT. Thank you Mr. Chairman, and Senator Allen, and other members of the Committee. It's a pleasure to be here to testify in front of you today. As you may have ascertained from the previous two speakers, I'm deeply involved with the Council on Competitiveness, I was deeply involved with the National Academies and their report. And when we get to Dr. Kelly on my left I'm deeply involved with John, and the Semi-Conductor Industry Association and other associations, and frankly, all of these associations say exactly the same thing. They say the same sort of thing that was included in the National Innovation Act that you and Senator Lieberman have put forward; they're exactly what is said in the PACE legislation put forward by Senators Domenici, Alexander, Bingaman, and Mikulski. Both—those pieces of legislation talk exactly about what Norm and Deborah have spoken about earlier, which is the U.S. is in a position of having to choose to compete in the future and choose to compete for a standard-of-living and competitiveness around the world.

And if I could just capsule what was said earlier. I think we need to choose to compete, in three specific areas which I'll just enumerate briefly. One is with smart people, second is with smart ideas, and the third is in an environment that lets smart people work with smart ideas to be successful. And the legislation and the reports all say the same thing about K-12 education, and young Americans majoring in mathematics and science, and their poor performance relative to their international peers. That needs to be corrected. The legislation in many instances suggest that the issue of smart ideas is really basic research and development. Research and development done in our universities and national labs, supported by National Science Foundation, NIST, DOE, and DOD. The

reports call for an increase in that Federal expenditure, after about 20 years of flatness, in an environment when the rest of the world is catching us. As Norm Augustine mentioned, the last area is the environment to allow smart people to go forward with smart ideas and that is really the policy put forward by regulating agencies and the Federal Government and state governments, in some instances.

If I could only make one suggestion in that space it's that the regulators and the legislators about the Hippocratic Oath of Competitiveness, which is "Do No Harm." And if I just might point out a few quick examples where Do No Harm could be implemented it's in the issue of telecom policy, which in the last 10 years has really promoted the U.S. to fall from number 1, in many instances to number 15 in broadband per capita implementation. And I think number 45 in mobile telephony implementation, so we've fallen dramatically behind as we focus more on fostering competition than we have focused on bringing capability to the consumer. And I would think that we could make great improvements there. Issues of fostering an environment for innovation and an investment in innovation, permanent R&D tax credits are I think important, I think, in that space. And if we look at the area of immigration and immigration reform, and Senator Allen and I spoke about this yesterday. The real issue of immigration ought to be protecting our borders on the one hand, but also looking at the best and brightest minds around the world and making the United States the most attractive place for them to come pursue their graduate education and stay and work. So something that I started to speak on about 5 years ago which is stapling a green card or an H1B Visa to every advanced degree granted to a foreign national from an U.S. university, which by the way, U.S. taxpayers pay for in great part, I think would be wise policy going forward.

Let me just conclude by saying I'm very heartened by the Senate action, both the National Innovation Act and the PACE legislation. I'm very heartened by President's State of Union message on the American Competitiveness Initiative. And I look forward to working with the Senate and the House and the Administration to make sure that these pieces of legislation get enacted and help us improve our overall competitiveness. As Mr. Gretzky said many times, "it's not where the puck is, it's where the puck is going." The puck is in a pretty good place right now from a competitiveness position, but we really need to see where the puck is going in five or 10 years and make sure we're there at that time.

Thank you for this opportunity.

[The prepared statement of Dr. Barrett follows:]

PREPARED STATEMENT OF DR. CRAIG R. BARRETT,
CHAIRMAN OF THE BOARD, INTEL CORPORATION

Mr. Chairman, members of the Committee:

A once-in-a-lifetime event has taken place over the last 15 years. Half of the world's population has joined the free economic system. Approximately 3 billion people from China, India, Russia and the Eastern European countries have entered the world marketplace. They represent a tremendous opportunity for U.S. companies. They are the consumers of today and tomorrow—who are ready, willing and often increasingly able to purchase products "Made in the U.S.A." Three-quarters of Intel's sales, for example, are now outside the United States, and the Asia-Pacific region accounted for 40 percent of our revenue in 2003. But these nations also present an enormous challenge to U.S. economic and technological leadership.

Aside from the growing competency and success of the foreign companies U.S. corporations must compete against, governments around the world are fighting to make their nations the best place to do business. They are developing their infrastructures, offering incentives to attract investment, and in many cases, providing a highly educated and motivated workforce. They are investing in research and creating their own domestic industries. As a result, we no longer have a lock on the ideas and innovations of the future.

This was the challenge posed to the panel, upon which I served, convened by the National Academy of Sciences/National Academy of Engineering: What do we, as a country, need to do to prepare for this changing global dynamic? The report we issued, *Rising Above The Gathering Storm*,² tackles these questions.

The Policy Prescription

To retain or create jobs here in the U.S., we (as a society) first have to *choose to compete*. We won't win the race by asking others to slow down or by throwing barriers in their paths. Rather, we will win by being better than the competition. That means we must have higher productivity, greater innovation, superior education, and cooperative government policy. Here are four key points to remember:

First, the competitiveness of the U.S. workforce depends on a strong educational foundation, particularly in the math and science skills required to succeed in the information technology industry. Yet, U.S. secondary school students continue to score significantly below the international average in both general and advanced math and science. In fact, out of developed countries, the U.S. ranked 19th in math achievement and 18th in science achievement. And this trend continues into the U.S. university environment where we see declining interest and number of graduates in engineering and the physical sciences. The fact that approximately one-half of advanced engineering degrees granted in the U.S. go to foreign nationals further exacerbates this issue.

Fixing this problem requires a long-term commitment to some basic principles. We need to assure that teachers are well-prepared, academically, to instruct in math and science. We need to give them ongoing training opportunities to improve their skills. We need to pay market-competitive salaries to attract and retain good math and science teachers. We need our school administrators to open the doors to people who want to serve in teaching as a "second career" and who are qualified to do so—with a minimum of bureaucratic hassle. Most importantly, we need to raise our sights and not tolerate the mediocrity we currently have.

Second, we must invest in the technologies and industries of the 21st century. This means our government should prioritize where it puts its limited resources—will we subsidize the industries of the past, or invest in those of the future? Innovation is the backbone of new technologies, new industries and new jobs. It drives business process improvements, increases productivity, boosts economic development, and improves our standard-of-living. Yet, the Federal commitment to basic R&D is at its lowest level in percentage terms since the National Science Foundation began compiling data in 1953.

In 2000, the Federal Government sponsored 26 percent of all R&D, compared to 47 percent in 1981 and 50 percent of basic research, down from 71 percent in 1981. Some would say, "what's the problem? The private sector should pick up the difference." But the numbers don't tell the whole story: most of the Federal share of this research today is in the life sciences, while funding for the physical sciences has been flat for over two decades in real dollar terms. And most research done by the private sector is not basic, but developmental and applied research. Private sector companies with obligations to shareholders cannot afford to devote a great percentage of resources to basic research, which "stretches the frontiers of knowledge." Only the Federal Government can support such research on the scale needed to support the graduate programs in areas such as engineering, physics, chemistry, materials science, computing technology and mathematics. A goal for the U.S. over the next few years should be to grow the budgets of key public research agencies like NSF by 10–12 percent a year. This funding goes primarily to America's universities, which are the best in the world, and we need to maintain their preeminence.

Third, the U.S. must develop the infrastructure to support the industries and advancements upon which much of our economic growth will rely. In a recent survey by the International Telecommunications Union, the U.S. ranked 16th of 20 countries in broadband Internet penetration. Similarly, cellular mobile subscribers made up 54 percent of the U.S. population in 2003, compared with 106 percent in Hong Kong, 84 percent in the United Kingdom and 69 percent in South Korea.

Our government should adopt telecom policies that encourage broadband deployment and facilities-based competition and, at the same time, assure consumers full access to Internet content and use of related applications and devices. Also, the

radio spectrum needs substantial reform. Recently, the Technology CEO Council—the information technology industry’s public-policy advocacy organization comprising CEOs from Applied Materials, Dell, EMC, Hewlett-Packard, IBM, Intel, Motorola, NCR and Unisys—made 10 specific recommendations that would maximize our Nation’s spectrum efficiency and wireless potential. Simply put, we need to give licensees more flexibility and allow more unlicensed use where appropriate.

Fourth, apply the Hippocratic Oath: “Do No Harm”. We are hurting ourselves in three key areas: tax policy, immigration policy, and the intellectual property system. JLW

Tax: Our tax policies today discourage investment in research, and investment in new manufacturing, in the U.S. Two examples:

- The erratic nature of how Congress has handled the Research and Development Tax Credit (one-year extensions, allowing it to expire)—which does not give any secure basis upon which companies can know what the tax treatment of such expenditures will be over time.
- The relatively high degree of taxation of U.S. corporate revenues in the U.S., compared to the tax concessions that foreign governments—eager to secure foreign investment dollars—are willing to give to bring those investments to their shores. Businesses have to make rational economic judgments. We can pursue our existing tax policies, but we must face up to the fact that the rest of the world is out to win investment in new facilities. Our global competitors have no compunctions about taking investment away from the U.S.

Intel continues to invest substantially in new and upgraded manufacturing facilities in the U.S. But building a fabricating plant in the U.S. vs. overseas means starting out with a billion dollar deficit in return on that investment in the U.S.—and most of that delta is due to our domestic tax policies.

Immigration: Our policies are a shambles. While illegal immigration rightly concerns all Americans, and the threat of terrorists crossing our borders must be dealt with, we also have to remember that our graduate schools of engineering are heavily dependent upon foreign talent. We must continue to attract the most talented students from other countries—and keep them here after they graduate, to work and build new companies and industries in the U.S. Yet our visa policies today work against these goals: H1B Visas are limited in number compared to our needs, and the backlog for those seeking permanent resident alien status is becoming a huge obstacle to keeping foreign graduates in the U.S.—particularly when there are superb opportunities for those graduates in their home countries as well. These problems must be fixed or our graduate engineering programs in the U.S. will be in jeopardy, as well as industry’s ability to find enough talent in the U.S. to support expansion of research, engineering, and manufacturing capabilities.

Intellectual Property: The patent system is in disrepair. We need a 21st century system: more and better paid examiners; better search tools including expanded databases in computing technologies, semiconductors, and software; and we need to “get back to basics” with regard to how the courts handle patent infringement lawsuits.

The point of the patent system is to encourage innovation and the use, for the benefit of society, of those innovations. Today, the system is beset by “patent speculators,” parties who buy up patent claims in the secondary market for the purpose of pursuing often specious claims of infringement. The hope is to use existing judicial rules on remedies and damages to extract large settlements. We need to rebalance the laws to return to the fundamental premise: the patent system exists for the benefit of society at large, and should not simply become a tool for the game of “legal jeopardy.”

“*Gathering Storm*” addresses these concerns with specific recommendations.

New Directions: American Competitiveness Initiative, PACE, and the National Innovation Act

In our industry we have a belief that you cannot save your way out of a recession . . . you can only invest your way to prosperity. I believe this holds true for the U.S. as a whole. We have to decide whether we are willing to make that investment.

In his State of the Union speech this past January, and in the FY07 budget transmitted to Congress in February, President Bush set forth a program—the *American Competitiveness Initiative*—which is designed to begin attacking these problems. The President’s program embraces a wide-ranging plan to strengthen our workforce, our math and science education programs, research funding, and investment incentives.

Congress has also embraced this challenge with legislation such as the *National Innovation Act* and the three *PACE bills* introduced last month. Those of us in industry who have been working on these issues for several years now are encouraged by this new national focus on competitiveness. The President's Initiative, and the bills that have been introduced, represent the directions that we must move in as a society if we expect to retain our place as the global leader in innovation, the creation of new technologies, and new industries which provide high-value jobs. The business community is united in supporting rapid action on these initiatives.

Our challenge over time will be to ensure that the focus is not lost as the process goes forward, and this year's budget and appropriations are history. Reversing the path of stagnation and decline will require a dedicated commitment in Congress to continuous improvement in programs and funding levels over the next several years. We in industry stand ready to work with you to make long-term success a reality; to educate and help lead a rebuilding of the foundations of innovation that have served us so well over the past 50 years.

Thank you for your attention.

Senator ENSIGN. Thank you. Our next witness will be Dr. John Kelly III, Senior Vice President of Technology and Intellectual Property for IBM Corporation. Welcome, Dr. Kelly. We look forward to hearing from you.

**STATEMENT OF DR. JOHN E. KELLY III, SENIOR VICE
PRESIDENT, TECHNOLOGY AND INTELLECTUAL PROPERTY,
IBM CORPORATION**

Dr. KELLY. Good afternoon, Mr. Chairman and Senator Allen. I want to thank you both for the bipartisan support of the National Innovation Act. Together you have produced both practical steps and an intellectual framework for the United States to drive our competitiveness.

As a company, IBM is committed to innovation as being a central driver for a sustained competitive advantage; we're encouraged by the momentum that is ongoing here in the Senate. Now, IBM believes the drivers of growth are very different today than they were just a few years ago and that the rewards of this growth will not be equally shared. They will flow to those enterprises and nations that can innovate and turn these global shifts to their advantage.

As an example, IBM and several companies from around the world are collaborating in semiconductors or in nanoelectronics in the State of New York, in the Hudson Valley. Companies from the U.S. such as AMD, Sony and Toshiba from Japan, Samsung from Korea, Chartered Semiconductor from Singapore and Infineon from Germany all are in the U.S. in New York, collaborating in a partnership with state government with the university systems and with this industry collaboration. I assure you that the U.S. and New York would not have been chosen had we not had this open collaborative innovative model in the U.S.

So how do we as a Nation enable innovation in its many forms? How do we capitalize on the changes in technology, business, and innovation itself and translate this into differentiators for American prosperity?

Achieving innovation success requires more than just the traditional pillars that we have spoken about here today, such as education, research and development, and technology transfer policy. There are other factors that govern whether and where new ideas will make it to the market, including the availability of risk capital, the ability to leverage intellectual capital, infrastructure and as was previously mentioned health, legal and regulatory costs.

The point is that America needs a strategic, integrated and sustainable focus on strengthening our national innovation ecosystem. And this ecosystem includes both policies and physical infrastructure.

The National Innovation Act recognizes this and raises important issues through this committee. The National Innovation Act would almost double, as you know, the funding authorized for NSF over 5 years; it would set goals for committing 3 percent of its annual R&D for Innovation Acceleration Grants and support novel approaches to address fundamental technology challenges. I urge the Committee to approve these measures.

IBM, working with hundreds of people through the National Innovation Initiative, learned that many of the richest opportunities for growth reside at the intersections of technology, insight and traditional disciplines. Research funding and academic curricula, however, often remains stove-piped and make this type of collaboration very difficult.

The National Innovation Act directs that a percentage of the research funding be devoted to these multidisciplinary research projects. The bill also supports multidisciplinary education, in fact the bill takes the next strategic step and helps integrate scientific and business knowledge that underpin our rapidly growing services economy. Some of the fastest growing well-paid professions in fact require both technology and business expertise that are integrated.

Our Nation's transition to a globally-integrated high-value service economy requires these skills not only for services, but for areas like manufacturing and I sense that we perhaps are ignoring innovation in services and that could be a tremendous competitive mistake for us. I understand the service economy employs 75 percent of the civilian U.S. workforce, and generates two-thirds of our gross national product and produces \$56 billion of trade surplus. We simply can't afford to leave this portion behind in the innovation agenda.

Now IBM is working with some of our top institutions, academic institutions in the U.S., such as Georgia Tech, North Carolina State, Rensselaer Polytechnic Institute to develop services science curricula that will help produce the needed skills in these high innovation fields. The National Innovation Act would require the NSF in consultation with industry and academia to examine how the Federal Government should best support services science through research education and training. We also need a mechanism to sustain our focus and our policy on innovation.

These issues include boosting services innovation, reforming the patent system and making risk capital more available in America. The National Innovation Act establishes such a mechanism, the President's Council on Innovation chaired by the Secretary of Commerce. IBM believes that we can draw on the expertise of the Economic Development Administration to help more communities join the type of collaborative work I talked about in New York State.

So in summary, Mr. Chairman, Senator Allen, your legislation sets the Committee on the right path; it sends the right message, and we understand that the changes taking place around the world can work to our advantage. And I assure you that the IBM Cor-

poration stands ready to help in any way. Thank you again for the opportunity to be with you today.

[The prepared statement of Dr. Kelly follows:]

PREPARED STATEMENT OF DR. JOHN E. KELLY III, SENIOR VICE PRESIDENT,
TECHNOLOGY AND INTELLECTUAL PROPERTY, IBM CORPORATION

Good afternoon, Senator Ensign, Mr. Chairman, and members of the Committee. Thank you for inviting me to join you today. My name is John Kelly and I am Senior Vice President of Technology and Intellectual Property for the IBM Corporation. I appreciate the opportunity to offer IBM's views on innovation and U.S. competitiveness and the actions that this committee can take to strengthen our standing in the world. Innovation rightly has taken center stage in discussions across the country about our economic future and I thank you for your leadership.

I also wish to thank Senator Ensign's co-author, Senator Lieberman, for working in a bipartisan fashion to craft S. 2109, the National Innovation Act. Together you have produced both practical steps and an intellectual framework for a competitiveness strategy for the United States based on innovation. IBM co-chaired the National Innovation Initiative that helped inspire this important legislation and we commend it highly.

As a company committed to innovation as the central driver of sustainable competitive advantage, we're encouraged by the momentum building in the Senate. IBM supports the President's American Competitiveness Initiative and the Protecting America's Competitive Edge (PACE) legislation introduced by Senators Alexander, Bingaman, Domenici and Mikulski. We support efforts in the Judiciary, Energy, and HELP Committees to reform the patent system, invest in basic research and strengthen math and science education as well as the Finance Committee's proposal to reform and make permanent the R&D credit. We also look to the Appropriations Committee to prioritize key innovation investments.

Our task today is to understand more clearly the changing nature of innovation and its importance to U.S. competitiveness—and to identify how the Committee on Commerce, Science, and Transportation should lead this effort. The National Innovation Act points the way. I understand that Senator Ensign has reintroduced Title I of the National Innovation Act as a stand-alone bill, S. 2390, under this committee's jurisdiction.

At IBM, we no longer focus exclusively on developing, manufacturing and delivering information technology. Our clients around the world need more. They want an innovation partner who can help them apply and integrate technology in ways that deliver new and lasting value for their customers. We are proud that IBM is more than an innovative company; we are an innovation company.

IBM is at the forefront of innovation and it is far more than creating new products and services. IBM's view of innovation includes business processes, new business models, management and corporate culture and, of course, innovation as a source of societal change. Our Chairman, Sam Palmisano, says that innovation is both an IBM value and our value proposition.

Innovation has been a driving force behind the remarkable productivity growth that has buoyed the U.S. economy through the turbulent waters of the tech bubble, the war on terror, energy price increases and natural disasters. It is both generating growth and creating new U.S. jobs in the face of all these obstacles and the increasing strength of our global competitors.

Americans know, however, that we cannot be complacent and hope to remain competitive. We have to recognize the genuine challenges on the horizon—including all the pressures of a flattening world—address our shortcomings, and embark on a thoughtful, sustained commitment to put in place the policies, incentives and investments that support U.S. innovation, spanning from knowledge creation to commercial application.

IBM knows innovation literally inside and out. We are not only innovation partners with our clients; we are transforming our own business, driven by major new global marketplace realities and opportunities. As a company with \$91 billion in revenue that does business in more than 170 countries, IBM has unique insight into global trends and a very broad platform from which to make national recommendations.

Trends

We believe that the drivers of growth are very different today than they were just a few years ago and that 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.

Let me give you three examples of what I mean by disruptive shifts:

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 not only has connected people and opened access to the world's information; it is rapidly becoming the planet's operational infrastructure. It is linking people, cultures, 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 healthcare, 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 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 is—and should remain—the ultimate open standard.) No one can deny that the Internet has generated tremendous innovation.

Open standards promote innovation in several ways. They form a common base upon which others can build. The best open standards are almost invisible. Home builders, for examples, design most homes to use standard size windows. Window manufacturers then compete on the quality of the glass and on innovations such as locking mechanisms. Standard sizes lower the price of windows for consumers and they lower the barriers of entry for competitors with new technologies to enter the marketplace.

Collaborative Innovation: The final shift I'll mention—collaborative innovation—is an outgrowth of the previous two. In the Industrial Age, innovation primarily was the result of work by individuals or small groups within an enterprise.

Today, the ubiquity of networks and the adoption of open standards have created an environment that allows groups of people to innovate together across enterprises and national boundaries.

Collaborative innovation is real. It is the basis for open source software, such as Linux. If America is going to remain the innovation leaders, we must embrace and incent collaborative innovation.

For example, in New York's Hudson Valley there is an unique collaboration in advanced semiconductors that started with international companies including IBM and AMD from the United States, Sony and Toshiba from Japan, Samsung from Korea, Chartered Semiconductor from Singapore, and Infineon from Germany. It has begun to spread and now includes ASML from the Netherlands; Sematech, a consortium of semiconductor companies; and Albany Nanotech at The University of Albany.

There is only one reason why all these companies have chosen to base this collaboration in New York. There was a partnership between New York State government, which had the vision to provide incentives for this collaboration; the university system, which is pumping out the skilled graduates to fill jobs that have been created and companies that have chosen to invest billions of dollars in the region. I can assure you that if New York had not adopted this collaborative model, all the investment, all the students and all the jobs that have been created would now be located in Asia.

Earlier this month, IBM released the findings of a global survey on the subject of innovation. It was a unique piece of work—765 personal interviews with CEOs and other business leaders. One of the more striking findings is the correlation between collaborative innovation and financial performance. Those that do it best, outperform their competitors.

The fundamental shifts I have described are creating significant competitive advantages for institutions around the world. 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 reorganizing around missions rather than departments. Academic institutions are redefining their curriculums and delivering courseware through the Internet in addition to classrooms.

In healthcare, we see personalized medicine on the horizon as the integration of patient histories and genomic data is changing the nature of diagnosis and patient care.

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 as enterprises around the world transform themselves recognizing that new and integrated processes result in genuine competitive advantage.

So, how do we, as a Nation, enable innovation in its many forms? How do we capitalize on the most important developments in technology, infrastructure and business organization and translate them into differentiators for American prosperity? In short, how do we optimize for innovation?

Innovation Ecosystem: a Key Concept

Achieving national innovation success requires, to be sure, the traditional pillars of education, research and development, and technology transfer policy. But today it requires more. The challenge is not only to generate fresh ideas and intellectual property, but to transform them into new value. The private sector is the primary agent for innovation, marshalling insight, technology, management and capital on a global scale to meet market and societal demands.

The Federal Government, however, has enormous influence over the physical and policy environment in which the private sector innovates. Federal basic research sets the pace of fundamental knowledge advances, tax policies encourage private enterprises to invest in innovation, and education policy at all levels of government impacts our most crucial asset—skilled citizens.

And this is only a small sampling. There are many other factors that govern whether (or where) a new idea makes it to market—including the availability and cost of risk capital, the ability to leverage intellectual capital, adequate infrastructure, and health, legal and regulatory costs. Bankruptcy law plays a role in whether an entrepreneur can fail before succeeding. Trade policy can determine who provides new services to a networked global marketplace.

The point is that America needs a strategic, integrated and sustained focus on strengthening the *national innovation ecosystem*. This ecosystem includes the policies (e.g., research, education, tax, immigration, intellectual property) and physical infrastructure (e.g., national and university labs, high-speed networks, transportation) that accelerate or hinder innovation. As important as it is this year to boost basic research and improve math and science education, we will have failed if we only accomplish those pieces of the puzzle.

Priorities for the Commerce, Science, and Transportation Committee

The National Innovation Act places many thoughtful measures before this committee that would accelerate innovation-based prosperity for the United States. The Act would:

1. Reinvigorate basic research and math & science education at the National Science Foundation (NSF) and National Institute of Standards and Technology (NIST).
2. Encourage multidisciplinary learning and research.
3. Launch a strategic effort to grow America's high-value service economy.
4. Establish a mechanism to frame, assess and coordinate strategically the future direction of the Nation's innovation policies.
5. Coordinate Federal economic development programs on regional innovation hotspots and create more dynamic innovative industry clusters.

NSF and NIST: Senator Ensign stated, when introducing the National Innovation Act, that current Federal budget restraints require a prioritization of spending—and that increased support for basic research should be a national priority. Senator Ensign is absolutely correct.

The Federal Government is the primary source of funds for university-based fundamental research. This research is the base from which new technologies are derived. This is not research, however, that will get done in the private sector. Industry has a major R&D responsibility to build on fundamental research and it is investing heavily. For example, the semiconductor industry invests on average 13 percent of sales in research and development. However, industrial R&D cannot replace government investment in long-term fundamental research.

The National Innovation Act would almost double the funding authorized for NSF over 5 years and set a goal of committing at least 3 percent of its annual R&D budget for "Innovation Acceleration Grants" that support novel approaches to address fundamental technological challenges. It also requires NSF to focus on the physical

sciences and engineering. This is a critical emphasis area. Much of our country's success is built on this type of smart, purposeful investment. I urge the Committee to approve these measures.

The bill also would authorize \$300 million for NIST to support advanced manufacturing. This investment would support research on state-of-the-art production processes and facilitate a NIST competition for three "Test Beds of Excellence." The test beds would be places where entrepreneurs could develop and test prototypes for new technologies, helping them bridge one of the most difficult stages between a good idea and a job-generating enterprise. NIST would fund one-third of the test-bed facilities, requiring the remaining two-thirds to come from industry and state or local government.

Speaking as both an engineer and a scientist, I am encouraged that S. 2109 would create additional NSF graduate level fellowships and traineeships for study in science, technology, engineering and mathematics (STEM). Coupled with similar investment in Department of Defense education programs, this legislation would train 5,000 more scientists over 5 years. The bill also makes smart investments in: (1) the NSF Tech Talent program to increase the pool of undergraduate STEM students; and (2) in innovation-based experiential learning in 1,000 schools at the K-12 level.

IBM strongly supports these provisions and I'd like to highlight the importance IBM places particularly on experiential learning. We believe this type of hands-on, problem-solving and analytical skill set is crucial to educating the next generation of innovators—especially in the engineering and technical professions. Experiential learning focuses on ill-structured problem-solving and provides deeper meaning, applicability and relevancy to classroom materials. A curriculum focused exclusively on acquiring discreet skills and memorizing information will not produce the leaders and innovators America needs.

Senator Ensign, we look forward to working with you to ensure that these provisions are considered by the Health, Education, Labor, and Pensions Committee.

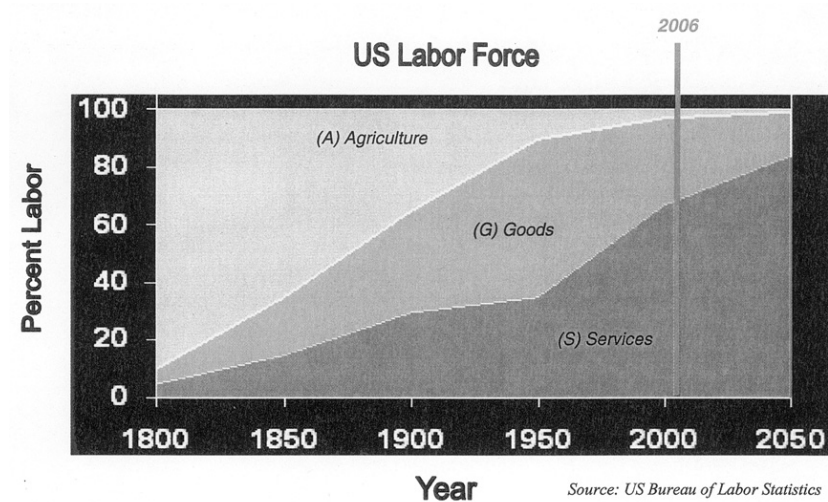
Multidisciplinary learning and research: Competitive advantage today comes from expertise—and expertise is not static. The United States needs the world's deepest, most diverse collection of business and technology innovators, supported by advanced collaboration systems and a culture that enables continuous 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 multidisciplinary expertise.

Many of the richest opportunities for growth reside at the intersection of technology, insight and traditional disciplines. Advances in medical technologies, for example, integrate biology with physics, math, materials sciences, computing power and software engineering. Research funding and academic curriculums, however, often remain stove-piped and make this type of collaboration difficult.

S. 2109 responds to this reality, directing that Innovation Acceleration Grants and a percentage of Defense research be devoted to multidisciplinary research projects. The bill also supports multidisciplinary education, enabling students to better integrate insights from multiple scientific fields. In fact, the National Innovation Act takes the next strategic step—it helps integrate scientific and business knowledge that underpins contemporary innovation and our rapidly growing service economy.

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

Our Nation's structural transition to a services economy (see chart) 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, including America's. The service economy employs 75 percent of the civilian U.S. workforce; generates two-thirds of our gross domestic product; and produces a \$56 billion trade surplus. We simply cannot ignore innovation in services.



A wide community is beginning to discuss new developments in global connectivity, automation, technology integration and web services, opening a new scientific discipline. Leading universities are working with IBM to better understand the social and technical issues involved in collaborating across global enterprises. Much in the way the first computer science department was established at Columbia University in collaboration with IBM, we are working with institutions like Cal Berkeley, Georgia Tech, North Carolina State, and Rensselaer Polytechnic Institute to develop Service Science, Management and Engineering (SSME) curriculums. Federal research investment and collaboration could significantly accelerate learning in this area.

In my industry, the need for individuals with these skills is particularly acute. The information technology sector needs people able to fuse industry-specific knowledge, information technology and business process expertise. New information technology jobs are mushrooming in areas like business analysis, security analysis, vendor management, service management, system integration, and others.

Two sections of S. 2109 tackle this issue. The bill would require NSF, in consultation with industry and academia, to examine how the Federal Government should best support service science through research, education and training. The bill also would fund university Professional Science Masters Degree programs that include education in these multidisciplinary skill sets.

Mechanism to sustain national innovation focus: As I stated earlier, innovation relies on many factors. I am hopeful that we will address some of our most pressing problems this year, but we need a leadership mechanism to sustain our focus and policymaking for contemporary innovation challenges. These issues beyond research and education, like boosting services innovation, reforming the patent system, and making risk capital more available will differentiate America from our competitors—keeping this country the most fertile and attractive place in the world to innovate.

The National Innovation Act would establish such a mechanism, a President's Council on Innovation, chaired by the Secretary of Commerce. The Council would recommend policies annually across agencies to boost innovation. Our hope is that such a Council will sustain and lend political support to ideas that few others now have on their radar screens—things like S. 2109's proposal to examine how markets could better value intangible assets. In a knowledge economy, intangible assets like intellectual capital can be a company's most valuable asset; yet financial markets lack measurement tools to account for these assets.

Coordinate Federal economic development: I've already spoken about IBM's collaborative "innovation hot spot" in New York and we're familiar with other regional hotspots—places like Silicon Valley and Research Triangle. These communities have developed a culture of innovation and entrepreneurship that arises from collaboration between industry, academia, financial firms and government. IBM believes this committee can draw on the experience of the Economic Development Administration (EDA) to help more communities join in this prosperity.

The National Innovation Act prescribes simple but important steps, asking EDA to produce a *Guide to Developing Successful Regional Innovation Hotspots™* and to develop metrics that measure successful development strategies. This will enable states and the Federal Government to prioritize funding on those projects most likely to generate jobs and growth in return for taxpayer investment.

Summary

America has a long history of recognizing when change is required and rising to the challenge. We are at such an inflection point today. Although we retain many advantages, we must renew our commitment to basic research, improve dramatically our math and science abilities, and embark on a sustained effort to hone the supporting network of policies that enable contemporary innovation.

S. 2390 sets this committee on the right path. It sends a message to constituents back home that the Senate understands the changes taking place around the world and we're ready to turn them to our advantage. I also ask Members to revisit S. 2109, the broader National Innovation Act that includes provisions outside the scope of this committee and to help bring those important ideas into practice as well. The IBM Corporation stands ready to help.

Thank you for the opportunity to be with you today.

Senator ENSIGN. Thank you all for excellent testimony. I would like to go much further than even some of this legislation goes to address a lot of your recommendations. You know some of the costs in implementing health IT—and we've held hearings on that, and working on that within the Health, Education, Labor, and Pensions Committee we are exploring the implications of healthcare costs. I believe that the whole issue of medical liability reform is critically important. This topic gets into the whole area of legal reform and some of the comments that you all have made about more money being spent on legal costs by corporations today, than on R&D and that's—your report actually—the numbers that I saw in *Rising Above the Gathering Storm* on, graduations of engineers in 2004: 500,000 engineers in China, and 200,000 in India. Those were much higher numbers than I've seen before. The numbers I saw before were disturbing, and these are even higher numbers.

Last time I checked though, I think we might have one or two more lawyers than either one of those countries. So that might be something we need to take a look at as well. Taxes. You know, we passed the Invest in the USA Act last year, which has brought over \$350 billion back into the United States. And it is just an example that indicates that, we need to consider further tax reform to support competitiveness. Tax reform is an area beyond the jurisdiction of this committee, but tax policy is certainly an area we need to examine when considering comprehensive innovation and competitiveness legislation. Dr. Barrett, you mentioned Telecom, and you know I have a bill on Telecom Reform, and I totally agree it's an area where we need to act because of what positive action can do to drive broadband deployment in the United States. Competitiveness in the telecommunication sector not only benefits the consumers, it can also benefit our country when examined from the standpoint of global competitiveness. Now having said that, I want to get to a couple of questions. I want to start with Ms. Wince-Smith, and the idea of metrics. You know how we study things. How we measure whether some programs are working, we have been talking a lot with the Administration; we have a lot of different programs out there. Can you elaborate on the *Competitiveness Index* that you have talked about. As you know, the dollars that we have up here are limited? How do we measure what is

working and what is not, so that we can put money toward programs that are working and take money away from things that are not working?

Ms. WINCE-SMITH. Well first the *Competitiveness Index* that we've been doing at the Council since 1986—and we do this in collaboration with Michael Porter—is really a set of quantitative measures on U.S. economic performance across a whole range of dimensions; and then benchmarking our performance against global competitors. Now we do look at obvious inputs like savings levels, numbers of patents, scientists, engineers, education levels, and also we put a qualitative story around that, and much of that we've heard today. But what really has not been done—and there have been attempts by the Federal Government and OMB—is to really look at the outcome and the performance of these inputs.

We talk about the numbers of scientists and engineers and we compare ourselves to China and India, but let's not forget the Soviet Union had the largest number of scientists, and engineers in the world and they certainly didn't have a competitive, dynamic innovative economy. So what are the things that are going on that we can begin to elucidate and try to measure to produce outcomes of productivity growth, and standards of living? It's really green field research. It hasn't been done before and I think it's going to take some of the really best economists, not just in the United States, but with some of our international partners to begin to try to understand this. Federal agencies, once a program is going, they do not like to stop it. And they don't want to take something off the plate. And so there's priority setting, as the President has mentioned, two areas—it was interesting in his State of the Union, he mentioned supercomputing and nanotechnology out of all the potential areas, and of course they're interdisciplinary. But are we going to take some things off the plate in order to invest in that. Agencies are very reluctant to do that, and I think that's where those—the leadership in Congress is needed to help make that happen.

Senator ENSIGN. Mr. Augustine, I know that your group did not get into a lot of the details; it would be my recommendation for the further work, that you help us. Because you have seen what an impact some of these reports have had on the Congress. They have helped us move forward. When we do our own studies, even GAO, talked about the 207 different STEM programs that are out there, we—if we have outside groups like your's telling us that these programs over here are not working, and we should shift the money to these programs over there. It gives great credibility to us, who are trying to do those things if we have outside groups to support these actions. So I would encourage you to do that in some of your future work. This can be a great partnership, because the people that you have lined yourselves up with have so much credibility that it can really help to move all of this forward.

In the *Rising Above the Gathering Storm* report, the focus is on the need to improve K-12 mathematics. Did you look at the idea of how we motivate our kids? Senator Allen talked about it, in India, science, technology, engineering and mathematics are tickets out for young students. A lot of our children, especially minorities, look at becoming someone in the music industry or someone in the

sports industry as their ticket out. How do we motivate more kids to go into science and math? How should we encourage more students to become engineers? Teaching science and math is one thing, but we also have to motivate our children outside of the classroom.

Mr. AUGUSTINE. It's a terrific question and something we thought about a lot and frankly we didn't deal with it in great depth; because it's not something you could legislate obviously. But there are things you could do, and first of all, the notion that science and engineering is boring, which frankly is held by many young people. I'm an engineer; I've had a minor part in helping put 12 of my friends on the moon during my career. I mean what more could you ask in a life than to just to have done that. So it's exciting. The problem is we don't convey that: we particularly don't convey that to young women.

It's our committee's belief that the most powerful single thing we could do, would be to have qualified in the field teachers in K-12 who really have a degree in science, or a degree in engineering, or a degree in mathematics that can inspire our young people. Today if you're in eighth grade in a public school in America, there's a 58 percent chance, excuse me, a 68 percent chance that your math teacher won't have a degree or certificate in math. If you're in eighth grade there's a 93 percent chance that your science teacher, physical science teacher won't have a degree in the field. It's very likely to be the physical science teacher who is told, go teach math, and they don't like it, they don't understand it, they don't enjoy it and they convey that.

Then you have the father of the girl in eighth grade, who says Algebra isn't for girls, don't study Algebra. Well if you make the decision in 8th grade not to study Algebra you're never going to be an engineer or a scientist. You could be a lawyer, and decide to do that in your senior year of college, but if you want to preserve the option to be a scientist or engineer, that's an 8th grade decision.

So I think there are many things that we could do but foremost would be to have teachers who are qualified in the field, who are excited about it. And who can go beyond just what was in the text book, and tell the additional stories and what's related to what they just have to teach.

Senator ENSIGN. Dr. Barrett, you would like to make a comment.

Dr. BARRETT. If I could sir, we sponsor something called a science talent search. It's the Old Westinghouse Science Search for the last 8 years. We had the final gala awards ceremony last night here in Washington, D.C. The 40 top high school kids who have done research projects, kind of the junior Nobel Prize. Talking to most of those young people, I asked them specifically, what turned you onto math or science. Invariably it's a teacher they had some place that got them turned onto chemistry, mathematics, physics, and biology, something of that sort.

I just want to second Mr. Augustine's comment. The way you get young children interested in this, is you have teachers who are excited and love the topic and love conveying the topic to young people. If you have people who are teaching as a job, rather than something that they love doing in the K-12 education system you'll turn them off.

So teachers, and qualified teachers, and teachers who are excited are the first, second, and third priority in the system.

Senator ENSIGN. It is interesting that you say that, and my time has expired. But just to conclude, I want to compliment Senator Alexander for holding Subcommittee hearings on these issues in the HELP Committee. One really exciting program discussed in those hearings is the University of Texas at Austin's UTeach program. Instead of just having people who are education majors take a few science classes in the UTeach program, they are teaching science and math majors how to teach science and math. Citing early results, they have had 80 percent retention rates after 3 years. And if anybody knows anything about teachers today, retention rates are one of the biggest problems we have in American schools today. Good teachers often just get frustrated and they leave. But we are seeing some good, positive early results with the UTeach program and we want to build on those.

I promised Senator Lieberman that when he arrived he could make an opening statement, because I had to move the hearing start-time up because of a meeting that was supposed to be at the White House but then got postponed.

So, if you don't mind, we will turn it over to Senator Lieberman and allow him to make an opening statement. Senator Lieberman, I want to thank you by the way, it has been awesome working with you this year in a partnership to develop our legislation. We took a long time before we introduced the National Innovation Act. In creating the bill, we worked with members of the private sector in business and academia. Through it all, working with Senator Lieberman has been great. I am really looking forward to continuing our work on the National Innovation Act, as it moves through.

**STATEMENT OF HON. JOSEPH I. LIEBERMAN,
U.S. SENATOR FROM CONNECTICUT**

Senator LIEBERMAN. Thanks very much Mr. Chairman, thanks for your courtesy, thanks members of the panel for all the leadership that you have given us. I'm going to enter my statement in the record and just say very briefly a couple of things, which I would guess have been stated already. We're—just to step back a little bit, about 5 years—let's talk about pre-9/11. Most of us were looking forward to this next period in our history as a time of relative tranquility in the world. Relative. When the major national concern we would have is how to compete economically with particularly the rising super powers—economic super powers of China and India.

9/11 intervened; we're facing the challenge posed by militant Islam, by Islamic terrorism, terrorists, but the other challenge remains. And it goes to the heart of not only what we fight to secure, which is the American way of life, and the freedom and opportunity, and upward mobility that's been there for the previous generations; and we want it to be there in the future, and coincidentally this same fight is exactly the best alternative within the Islamic world to the hatred and suicidal death that al Qaeda offers as a path to the future.

So you know there are all sorts of indicators of that other challenge that we have to do these two simultaneously: protect our se-

curity and sustain America as an opportunity society. A little bit earlier this year the OECD had some numbers that were put out, yet another wake-up call I hope, which is that China has overtaken U.S. as the world's largest exporter of high-tech products. Shipping \$180 billion worth of high-tech goods worldwide last year, versus \$149 billion for the U.S.

Well you know it's not just a race this goes to the quality-of-life for people who live in this country and the promise of upward mobility that brought my grandparents here, and continue to bring people here. I always say to people, if you're looking for a market test on nations in the world, we come out very well. This is a country in which more people are trying to get in and fewer people are trying to get out, than any country in the world. I understand some are coming illegally, but they are coming for the same reason my grandparents came, which is for a better life for their families. And we're just not going to be able to sustain this remarkable American experience, focused on innovation from you know, the Franklin stove, to the personal computer and beyond unless we do something about it together. That's why I appreciate the leadership that all four of you—and particularly the work done by the National Council on Competitiveness. And Mr. Augustine and your group that has led to the legislation that Senator Ensign and I and more than 20 others co-sponsors, bipartisan, and Senator Alexander and Senator Bingaman have put in. And we've cross-endorsed each other's bills.

So we've got to find common ground here. We've separated parts out that come to this committee, as you know the focus of our bill Senator Ensign and I, and other co-sponsors developing talent, targeting investment, and creating infrastructure. And this is urgent stuff. Now there are a lot of important hearings that happen around the Capitol everyday, I don't know of one that's more important than this one happening right here. And the question is, whether we can generate enough of a response to put our money where our hopes are; and to invest in the improvement and the quality of education, sustain the spirit of entrepreneurship and innovation that has created millions and millions of jobs and better lives for people in this country. And again, it's only going to happen with the kind of partnerships that are reflected in the work that you all have done and that we have tried to do between the public and the private sectors. I think all of us up here, I know these two guys, we're optimists about this. That's the nature—that's the spirit of America. But this is a very different kind of challenge we're facing, I remain optimistic, but it's really time to get going on it, and Mr. Chairman I thank you for your leadership. It has been a great pleasure to work with you, and you and I are persistent and stubborn, right? And Senator George Allen is just, you know, outrageously persistent. He's more tenacious and stubborn—at least that's what his wife tells me. So we're not going to stop until we get this done, but we can't do it without the help from the folks on the other side of the table, so I thank them and you very much.

[The prepared statement of Senator Lieberman follows:]

PREPARED STATEMENT OF HON. JOSEPH I. LIEBERMAN,
U.S. SENATOR FROM CONNECTICUT

Thank you, Senator Ensign, and Committee Chairman Stevens, for holding this hearing to discuss building a new century of American prosperity by spurring a new wave of American innovation.

From the Franklin stove to the personal computer, Americans have a strong history of innovation. But we face new challenges. We live in a global age where competition can come as easily from across an ocean as across the street.

We got a wake up call earlier this year about how tough today's challenges are when the Organization for Economic Cooperation and Development (OECD) announced that China had overtaken the United States as the world's largest exporter of high-tech products—shipping \$180 billion worth of high-tech goods worldwide last year, versus \$149 billion for the U.S.

If this continues, the global high-tech centers could shift from America to China, and with them the high-skill, high-paying jobs that are key to the innovation economy will be lost as well.

America must prepare itself to compete in this new world.

Earlier this year, the Council on Competitiveness circulated a report in response to these challenges with detailed recommendations on how to reinvigorate our innovation economy.

In December, Senator Ensign and I—along with 22 bipartisan co-sponsors—introduced the National Innovation Act, which is based on the Council's recommendations in three key areas: developing talent; targeting investment, and creating infrastructure.

Last week, Senator Ensign and I reintroduced Title I of the bill, now called the National Innovation Act—Commerce Provisions, which contains key provisions of the original bill and has been referred to this Committee.

One of the key provisions of this bill is the creation of a President's Council on Innovation whose goal will be to develop a comprehensive national innovation agenda and coordinate all Federal efforts. The Secretary of Commerce will chair the Council which will have oversight over legislative proposals as well as Executive Branch initiatives.

But new ideas need research money if they are to move from imagination to market.

This bill strengthens the National Science Foundation by more than doubling its research budget from \$4.8 billion in 2004 to nearly \$10 billion by 2011.

Our bill also creates an "Innovation Acceleration Grants" program to stimulate high-risk research by urging Federal research agencies to allocate at least 3 percent of their current R&D budget to breakthrough research—the kind of research that gave us the Internet.

Now, having moved a product idea from imagination to the point where it's ready to market, we must be able to manufacture it as well. It's the manufacturing component of the innovation economy that creates and sustains high-paying, high-skilled jobs.

This bill directs Commerce Department's National Institute of Standards and Technology to hold a competition to develop three new pilot test beds where innovators could evaluate and refine new manufacturing ideas. The competition to create these test sites would be open to state and local governments and the business community.

As I said, the ideas contained in this bill were pulled from our larger bill, which, among other things, would also:

- Encourage students to train for technical professions by increasing Federal support for graduate fellowships and trainee programs in science, math, and engineering.
- Create a Professional Science Master's degree program that couples business or legal training with a traditional science or engineering discipline to create a cadre of new professionals with broad skills in both business and science.
- Direct the Defense Department to work with the private sector to identify and develop innovative manufacturing techniques and that could help create a 21st century manufacturing base.
- Make permanent the current Research and Experimentation tax credit and extend it to a greater number of enterprises—a provision that also appears in the Invest in America Act of 2005, sponsored by Senators Hatch and Baucus with 44 bipartisan co-sponsors.

I realize our bill is not the only one before the Senate. Several important pieces of legislation that have been introduced, including the PACE package introduced by Senators Alexander and Bingaman, of which I am also a cosponsor.

All of these different bills strive toward the same end—the renewal and reinvigoration of America’s historic role as a global leader in innovation that has made our economy the envy of the world. It is my hope that the Commerce committee, the HELP committee, and other committees of jurisdiction will take action soon in this session to report legislation incorporating important ideas from all of these proposals. And it’s my hope that the bipartisan leadership will work together to advance these bills.

Finally, I also want to commend the private sector, the academic sector, and the many outside organizations for their contributions to and support for this effort as was evidenced so eloquently by the testimony today.

Thank you, Mr. Chairman.

Senator ENSIGN. Thank you for your testimony. Senator Allen?

Senator ALLEN. Thank you Mr. Chairman, thank you Senator Lieberman as well, it’s a pleasure to work with you all and I’ve taken notes through the witnesses’ testimony. All four of you all were outstanding and, I like the analogies as well, frog slowly boiling and so forth. Generally speaking, I use the term, “you either make dust, or you eat dust.” I want America to be in the lead. And once you get behind it’s hard to catch back up especially with countries that have a focus, and also have the populations to stay in the lead. And that’s why I think nanotechnology which is a multifaceted field; it’s not any one field. It has at least six to seven different aspects and the President has made that a priority which is good, within that priority if you look at this present proposal, energy is one of the—the Department of Energy is actually getting more of that funding, which fits into one of those key missions that energy security aspect for our country. Senator Ensign mentioned metrics, I was speaking with Steve Appleton of Micron, who you partner with Dr. Barrett from time to time and I suspect Dr. Kelly as well with hers; and there is some focused research that the government funds but it’s also matched by the private sector.

And any government program will have a built-in constituency instantly and if you ever try to change it, three or four, or five, or 10 years down the road, it’s just very difficult. But in any event, in this sponsored or focused research the private sector matched—the private sector, you care about your shareholders, and you’re not going to be putting funds into research that doesn’t make economic sense insofar as whatever that research will develop into ultimately. The one aspect of this, and let me ask you Dr. Barrett about it. On this *Rising Above the Gathering Storm*, action item D4, ensure ubiquitous broadband Internet access.

The United States is lagging behind the rest of the world, not all of the world, but from other countries in Europe and Asia in particular. In this committee I have sponsored with Senator Kerry in a bipartisan way, and we have Senators Sununu, and Dorgan and Boxer, as we transition from analog to digital to make sure these white spaces in the analog spectrum, which would otherwise be unused. We call it the WIN ACT, the Wireless Innovation Act, I believe this is—can be a very efficient use of this otherwise unused space. To get broadband out there, especially to rural areas where it just doesn’t make a great deal of economic sense to get wires and digging, and digging, and digging. It’s the same reason they don’t have cable out there. It’s just there’s not the return on the invest-

ment. Could you share with our committee what you would think of this Wireless Innovation Act, insofar as making sure that broadband is more available to all people.

Dr. BARRETT. I'm going to have to say I love it. No, broadband comes in a variety of flavors, it can be either over glass fiber, twisted copper, or wireless. And if you look at the opportunities in the current TV spectrum, and as analog TV moves to digital and there's the movement to in fact free-up that spectrum, and make it available for high-quality broadband wireless, that's great. There's a time table now set for that transformation. But in the meantime there's also unused spectrum in that TV, kind of the channels 3 to 52 or whatever it is, target which could be used without interference with current TV broadcast. And we are great fans of using that, and using the technology that's available and that's come available recently for low interference, or noninterference light space use for broadband wireless technology, to provide a greater approach, or greater availability of broadband capability, especially in rural areas, where the wireless technology is wonderful. So we heartily endorse that approach, and think it's a great use of a scarce national resource, which is our wireless spectrum.

Senator ALLEN. Ms. Wince-Smith, I'm really glad you're here because you heard my opening statement and concern and in fact, Mr. Augustine mentioned also how few women and Latinos, and African-Americans are interested for whatever reason in science and engineering and technology. We've actually had hearings in another aspect of this committee and this is again partnering with Senator Wyden on this issue. And we actually—when you look at the Minority Serving Institutions in this country, historically black colleges and universities, a little over 100 of them. And there are about 200 Hispanic-serving institutions, a couple dozen tribal colleges, you find their infrastructure is way behind. And so therefore they don't attract the faculty. Therefore the students who go through these minority serving institutions do not get the training and education that they need to then be able to even apply for the 60 percent of the jobs out there in the real world which require technological proficiency.

This committee over the years and the Senate has passed a motion that I've had introduced to establish a grant program with the National Science Foundation to upgrade the technology infrastructure, to bridge this economic digital divide that we find in this country. The Administration hasn't necessarily been onboard with this. I'll be diplomatic with it. Do you have any suggestions for increasing and seeing as how you are a woman—and I'm glad you're the Chairperson, because that is a role model—any suggestions that you have for increasing the number of women and minorities, particularly African-Americans and Latinos, to get more interested, incented or involved in these key areas for the future, and there are great paying jobs also on top of it all.

Ms. WINCE-SMITH. Well, I certainly think teachers are critical role models. But one of the things we've learned, and a lot of this is anecdotal, is that young women, who are doing very well in math-science have a time once they get into undergraduate where they lose interest. And a lot of work has been done on that actually, at some of our research universities to kind of understand

those dynamics. They don't have mentors; there are a lot of social-cultural things going on.

Senator ALLEN. Such as?

Ms. WINCE-SMITH. Pardon?

Senator ALLEN. Such as? Because in China and India you don't see this.

Ms. WINCE-SMITH. I know and that's the great irony, that in a country such as ours, where women have risen up in so many fields, in this there are still some challenges on the mentoring and role modeling. One idea that we were floating with Dr. Rita Caldwell, who was Director of NSF, was in graduate NSF fellowships, where we would have doctoral students teaching undergraduates to ensure that there was a very strong mentoring program for women that are freshman and sophomores. Of course, if they don't have the K-12 background, that is a challenge before they even get there.

The other thing that is really fantastic, and this is an outcome to look at, are professional science masters degrees. These are the degrees that schools such as Georgia Tech, and others are giving that are multidisciplinary degrees, and they involve accounting, business, and other skills. Not setting someone up to be a research scientist, but women and minorities who are taking these professional science masters are having tremendous success being gobbled up in regional economies in entrepreneurial activities. There's something very good going on in these professional science masters programs that are attracting women and minorities, and of course that's where the growth of the economy is going to come from, small and medium-sized businesses.

Senator ALLEN. Thank you, do any of the other witnesses have any—I think Mr. Augustine brought it up, do you all have any specific suggestions on how we can encourage more Americans, particularly in the minorities and women to be more interested in these areas. Mr. Augustine?

Mr. AUGUSTINE. I would just add a footnote, and Deborah's comments I think are right on target. Because of the hierarchical nature of engineering or science education you've got to start very young to influence people. And that means it's basically parents and teachers. And teachers we've talked about and how you can do more to have the teachers really excite young people. I think this is an issue, not only particularly a problem with women and minorities. Engineering has always been the opening education for both young people who come from families without a lot of higher education: the first generation doesn't usually go into law, or into medicine. They become engineers very often, and so we doubly suffer when we discourage those people from going into those fields. I was the first of my family to go to college. It never occurred to me to be a lawyer, or a banker, an engineer is what you did. And I think that's still largely true today.

The challenge George Hollmeyer, who used to run the Advanced Research Projects Agency, told me the other day that when he was in Russia, he likes to go to the movies there, because the engineer always gets the girl.

[Laughter.]

I suspect the reciprocal may be true; the engineer gets the guy hopefully. And we need some help from all of you folks, from the media, from Hollywood. I once proposed we needed a TV program called LA Engineer, and I got laughed out of the House. But those things count, but I think it comes back that our greatest hope has got to be the teachers in K-12 particularly K-8.

Senator ALLEN. Thank you, both Dr. Barrett, and Dr. Kelly.

Dr. KELLY. I would just agree with our other members, it is about role models and it is about teaching. I think that one of the challenges is that the pipeline takes so long to fix. So one of the ideas and one of the things we've implemented very recently in IBM is something we call, Transition to Teaching. We have many engineers and scientists and mathematicians who see this problem, are very excited about trying to help and want to Transition to Teaching, and so we've created a program that helps them do that. From a time standpoint, we economically help them get the education they need to do the teaching part. They know the math and the science. But we think we can kick-start this, and very quickly create some role models, and work the diversity issue, Senator, that you raised.

Senator ALLEN. Now you're to be congratulated and commended on this Transition to Teaching. More and more companies need to try to do it. There are others I've heard, called Math is Cool. Philip Morris or Altria is doing that. It has got to be made relevant and exciting to kids. Mr. Augustine just went into it. He just could see—you could see he was a serious young man, but others of you do have to make it interesting and that is great that IBM is doing it. Dr. Barrett, I saw you raise your hand.

Dr. BARRETT. Just two vignettes to support the previous comments that talents—Science Talent Search Finals we had last night. The ultimate winner of the competition was a young lady from Utah, and the third place finisher was also a young lady, so two out of three isn't bad. But interestingly with both of those it was a teacher that turned them onto math and science. The other vignette is you may have read it in *Wired Magazine* in the last year, the story of Carl Hayden High School in South Phoenix, where four illegal alien, undocumented Hispanics, because of a robotics teacher in an after-school robotics club entered an open underwater robotics competition, competing at the university level. So this is four undocumented Hispanic boys competing against the likes of MIT, won the competition. Driven by the teacher who had a genuine interest in the kids and in the technology on basically a teacher, on their own nickel, doing it after school.

By the way the interesting thing, is as they were undocumented aliens they were not even eligible for in-state tuition grants at Arizona State University. A year later they were both, or all four of them were in manual labor-type positions until *Wired* wrote the story on them. Since then they all four got scholarships. And I think Warner Brothers bought the movie rights.

So the situation may turn around for them in the future. But they're all four studying to be engineers.

Senator ALLEN. Are they now legally in this country?

Dr. BARRETT. That I don't know.

Senator ALLEN. Thank you all. Let's not get into another issue, thank you.

Senator ENSIGN. Actually I do want to quickly address a related issue. Maybe Dr. Kelly you could start with this, the issue of the H1B Visas. The only reason I am asking about this today, is because when we come back from break, we will have 2 weeks of immigration on the floor and I met with someone from your association today and we talked about some of the H1B Visas, and there is always politics involved with immigration, and you have to be sensitive to that. So for those who are concerned about taking American jobs, what I hear from industry is that the jobs filled by H1B Visa holders are jobs that they cannot fill. They do not have enough people to fill these jobs.

Any comments about how we should structure the H1B Visas to make sure such Visas help admit immigrants for jobs that we cannot fill with Americans. Dr. Barrett, you talked about the green card for any kind of post doctoral work or advanced degrees, attach green cards. Well do you want them all or do you want the brightest. In other words the top 10 percent of the class, the top half of the class, or do you want them all? Anybody who's got an advanced degree, do you have any comments on that?

Dr. KELLY. There are certain fields where I would say that it's basically a no-brainer. Electrical engineers, a huge shortage of electrical engineers particularly in the IT industry. Certain areas of programming. Huge shortages of programmers. So, there ought to be some sort of grade standard obviously. But some of these fields are dramatic shortages and declining numbers; and that is causing us to have to reach deeper and deeper into the lower grades, and causing us to become less competitive and so I agree with Dr. Barrett, we ought to be stapling these Visas to people in these fields, with high-performance grades.

Dr. BARRETT. I totally concur, and in fact if you look at the number of advanced technical graduates in the field the number is not that large compared to the total budget of H1B Visas. And in fact the last legislation set aside 20,000 Visas, particularly for that category, I think that's absolutely the right thing to do. But I think you could even simplify it so we wouldn't argue numbers here. And that's where the "staple the green card to the diploma" idea came from.

The companies that are represented here, IBM and Intel, are internationally competitive, we do about 75–80 percent of our business outside the U.S., IBM does two-thirds of their business outside the U.S. We have to be competitive in the international marketplace, we have to hire the best and brightest wherever they are. So this is really a market-driven system. And we're just suggesting that you make it a market-driven system in the United States, and give these people the availability to work in the United States. You really want the United States to be the work place of choice for the best and brightest in the world. You don't do that by putting immigration barriers in front of them.

Senator ENSIGN. Well I have a tendency to agree with all of you on that. And especially because of these statistics that Mr. Augustine, I think you were the one that said it earlier, that 4 percent of the workforce produces the other 96 percent of the jobs. And the

really, really bright ones are the ones who really produce those jobs. So whether we look at ourselves, post-World War II and all the scientists that came over here after World War II, and the unbelievable impact that such immigrants had on our country. I think that we have to continue to look at that, and continue to draw the best and brightest. Especially in the short-term, because as you all mentioned, some of these initiatives that we put forward are really long-term measures and that is important. We have to get the long-term structures put in place with some of the recommendations you all have made. But some of the short-term measures involve making sure that we also have the people that we need here today so that we don't end up with an innovation or competitiveness gap. Because once you start trailing behind when it comes to innovation, technology, and competitiveness it is very, very hard to catch up and I think that meaningful H1B Visa reform is one of those stop-gap measures that can help keep us on that competitive edge as we move forward in a global economy.

We just started voting and we have a series of nine votes on the floor, relating to budgets. So once again, thank you all for being here today. In addition, thank you for all of the work that has been done by you on innovation and competitiveness. It will be very exciting to go forward. And I just encourage you to continue to work hard in support of innovation because I know none of you are getting paid, they're very few anyway who are getting paid for a lot of the work you are doing. This is work you are doing that is good for the country. So I applaud you, and I look forward to continuing to work with you and to seeing some of the products you are going to put out in the future. So thank you all very much.

[Whereupon, at 3:10 p.m., the hearing was adjourned].

A P P E N D I X

PREPARED STATEMENT OF HON. DANIEL K. INOUE, U.S. SENATOR FROM HAWAII

By the broadest definition, our committee is responsible for the economic and commercial health of the country. We have expertise that touches on fields of industry from telecommunications to transportation; from the safety of the home to the security of the homeland; and from marine containers to marine mammals.

But at the end of the day, "science" is our middle name. This hearing rightfully places our committee at the center of the debate on how this Nation will use technology and innovation to improve our national, economic competitiveness.

Our committee has particular expertise in science, technology, and economic development. We have a unique opportunity and responsibility to ensure that the United States remains strong and competitive in the face of emerging challenges from the rest of the world.

At today's hearing, we will discuss many of the ideas embodied in several bills that have been introduced. This committee should view those bills as a starting point.

Further, I believe this committee should begin a bipartisan, committee-wide effort to develop a Commerce Committee title that will be an integral part of any Senate competitiveness legislation. Each subcommittee can and should make significant contributions to this bill. Our members' ideas and involvement will be essential as we develop and advance what I believe will be a forward-looking, comprehensive proposal.

Interestingly, ocean sciences have been absent from the competitiveness discussion thus far. Oceans are 70 percent of the Earth's surface, yet they remain largely unexplored and under-researched. Our oceans present an astounding frontier for science and, I believe, an incredible source of inspiration for math and science students, or better yet, America's future scientists.

Economic competitiveness is the essence of our committee's work, so I look forward to working with Chairman Stevens and the rest of my colleagues in what could be a remarkable endeavor for this committee. Today's discussion on innovation and competitiveness with this distinguished panel of witnesses is an appropriate starting point.

PREPARED STATEMENT OF HON. GORDON H. SMITH, U.S. SENATOR FROM OREGON

Thank you Mr. Chairman.

The United States is a world leader in innovation and competitiveness; however, in recent years, as other countries have placed a higher priority on the importance of math and the sciences, our leadership position in this area has come into question.

In order to maintain and strengthen our leadership role in the years ahead, we all realize that more must be done to increase our competitiveness on the global stage.

We must make investment in math and science a priority to ensure that we as nation are the preeminent leader in the sciences and emerging technologies such as nanotechnology.

I am proud to cosponsor both the National Innovation Act and the PACE-Energy Act that emphasize the importance of these issues, and others that will lead to increased innovation and competitiveness.

Mr. Chairman, in addition to supporting these legislative initiatives, I have introduced two bills and announced another to advance technology and improve our Nation's competitiveness.

My bill, the Manufacturing Technology Competitiveness Act, will increase innovation and the competitiveness of small and medium-sized manufacturers in the global marketplace. Through a number of measures, this Act is aimed at improving productivity, advancing technology and promoting growth in the industry.

A version of this bill has already passed the House with broad bipartisan support. I urge all my colleagues to support quick passage of this bill.

As we discussed at a recent committee hearing, nanotechnology is being incorporated in more and more products everyday. While promising advancements in nanotechnology can be seen throughout research laboratories in the United States, other countries in Europe and Asia are making significant investments and advances in this area as well.

My bill, the Nanoscience to Commercialization Institutes Act, will promote the commercialization of this emerging technology throughout many industries and increase U.S. innovation and global competitiveness.

I announced recently my intention to introduce legislation that will increase the availability of broadband Internet services throughout the country. These networks are absolutely critical to the long-term competitiveness of the United States. Unfortunately, an oft-cited 2005 International Telecommunications Union study revealed that the United States has fallen to 16th in global broadband deployment. Congress must act swiftly to correct this disturbing trend.

My legislation will address four areas of reform essential to boosting broadband deployment: (1) broadband universal service, (2) video competition, (3) wireless broadband, and (4) community broadband. Faster broadband networks will benefit America's consumers and America's workers, and lead to enhanced economic growth and job-creation.

I urge my colleagues to support my bills that will bolster U.S. innovation and global competitiveness.

Mr. Chairman, thank you for holding today's hearing on this important topic.

The Washington Times, May 10, 2006

SCIENTIFIC R&D—CONGRESS SHOULD RETHINK ITS “FIX”

By Hon. John E. Sununu

Less than a year ago, I wrote an op-ed observing that “hydrogen-car” mania, having reached a fever pitch on Capitol Hill, had Members of Congress firmly under its spell. That was then; and despite the \$1.1 billion already spent on hydrogen-related programs, lawmakers have finally come to the realization that an affordable hydrogen car remains at least 20 years away.

Today, the tune is eerily similar, but the chant has become “competitiveness, competitiveness, competitiveness.” President Bush identified competitiveness as a priority in his State of the Union address, declaring this initiative essential to future economic growth. Its key goals are to increase Federal spending on critical research and to refocus the attention of today's public education system on mathematics and science—worthy goals indeed. But before Congress rushes forward with an expensive legislative package, this agenda deserves thorough review.

For the benefit of current and future generations, the primary focus of government-sponsored research should be to answer questions in the most fundamental of areas: science and mathematics. Perhaps the best model for this approach can be found within the National Science Foundation (NSF), which dedicates its funding to high-quality, peer-reviewed, merit-based projects. As mathematician and philosopher Rene Descartes declared, “Each problem that I solved became a rule which served afterwards to solve other problems.” Investing in basic science—that which is driven by curiosity to expand knowledge and has no immediate marketable value—will lead to solutions to fundamental puzzles that today stifle general scientific progress.

The role of the Federal Government on the education side of the competitiveness agenda is somewhat limited. With few exceptions, engaging young students' minds in the study of mathematics and science occurs very early in the education process. To know whether students in a particular school district will be interested in science and mathematics, we need only look at the commitment of the local school board or school district and its willingness to challenge students in a range of disciplines. Challenging students through a strong curriculum and with dedicated teachers, rather than new programs, is a better path to educational success.

As this debate moves forward, any legislation designed to promote American competitiveness and innovation should adhere to the following rules to ensure that American taxpayer dollars are not wasted or misused:

- *Focus on the basics.* Federal funding for research and development should be applied toward basic science and technology, (such as chemistry, physics, material science and computational mathematics) rather than applied research, tech-

nology transfer or commercialization efforts. The private sector—not the Federal Government—has the obligation to advance the findings of basic research into marketable products and technologies. Equally troubling, legislators await the movement of a competitiveness bill in hopes they may attach pet research projects or fund a favored industry. Politicizing the process only undermines the integrity of peer review and dilutes the effectiveness of these resources.

- *Don't over-promise.* To date, Senate competitiveness bills are littered with increased authorization levels for various purposes. Billions of dollars would be needed to actually fund programs at such inflated levels. Given this scenario, reasonable authorization levels must be utilized to ensure that funding can actually be secured through the appropriations process. It would not be beneficial to repeat an example from 2002, when Congress reauthorized the NSF with the goal of doubling its annual funding. Ultimately, NSF appropriations never approached such levels.
- *Limit new programs.* Like so many other sound-bite driven “debates” in Congress, competitiveness proposals often boil down to the usual simplistic solution: Create more government programs. How many times do we have to go down this same costly road? And when was the last time we dealt effectively with a complex problem by creating new Federal programs? One Senate bill would create more than 20 new programs without eliminating a single one. Dozens already exist, including the Advanced Technology Program, the Manufacturing Extension Partnership, and other questionable expenditures of funds. Congress should not create new programs without a thorough review of the value and efficacy of existing programs. Otherwise, we are merely diverting funding to new programs and layers of bureaucracy when such money could be used on basic research.
- *Make hard decisions.* Once realistic authorization levels are established, Congress needs to make the necessary adjustments to ensure funding increases actually occur. Spending billions on a competitiveness agenda through deficit spending restricts future economic growth, and stunts future innovation and competitiveness. If we are to increase funding for a competitiveness agenda, legislation needs to include necessary rescissions and program repeals to remain budget neutral.
- *Don't play favorites.* Given the popularity of a competitiveness initiative, it is disappointing that agencies integrally involved in basic research are being ignored. For instance, NASA's basic science mission, referred to by many as its crown jewel, results in significant scientific findings. Ironically, the Administration recently proposed that planned spending for these accounts be cut by more than \$3 billion over the next few years, a decision NASA Administrator Michael Griffin admitted was made solely for budgetary reasons. How is this internally consistent for the Administration?

If done for the right reasons, a successful plan to invest new resources in scientific research can have a positive impact. Without discipline and focus, however, Congress is doomed to repeat the same mistakes, fund more failed programs and expand Federal bureaucracy.

America's technology-driven economy grows despite, not because of, government intervention. That is a lesson we all need to learn before trying to “fix” what ails us.

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

IEEE-USA appreciates this opportunity to share our views on innovation and competitiveness challenges facing the United States and on legislative action that can be taken by Congress to address these challenges.

If the United States is to continue flourishing in the increasingly competitive global marketplace, the Federal Government needs to focus on ways to improve the science and technology research and development infrastructure and to broaden the technical expertise of its citizens. IEEE-USA believes that effective competitiveness and innovation policies will sustain U.S. technological leadership and encourage the development of a skilled, creative and competitive workforce critical for U.S. prosperity. To accomplish this goal, the United States needs sustained commitment for supporting fundamental research in the physical sciences and for improving education, training and lifelong learning.

We appreciate the emphasis being put on this issue by Congress and by President Bush with his American Competitiveness Initiative, and have indicated our support

for legislation currently under review in the Senate, in particular the National Innovation Act of 2005 (S. 2109) and the Protecting America's Competitive Advantage (PACE) Energy and Education Acts (S. 2197 and S. 2198). We strongly encourage Congress to work together and with the Administration for the good of country to pass consensus legislation during this legislative session to preserve America's competitive edge in the global arena.

To that end, IEEE-USA has identified workforce policies and federally-funded research policies as two broad areas where Federal Government policy can enhance the Nation's intellectual capital and technical skills. Each area will be a decisive contributor to U.S. innovation in the coming years.

Education Policy Objectives

IEEE-USA believes that legislators and Administration leaders should work to strengthen our current and future engineering workforce by improving the United States' education system and enhancing life-long employment opportunities for scientists and engineers. We support the recommendations of the National Academy of Engineering in its report *"Rising Above the Gathering Storm: Energizing and Employing America for a Brighter, Economic Future,"* with specific emphasis on those recommendations targeted at:

- Improving the Nation's education system from preschool through graduate school and beyond, with special emphasis on improving math, science and communications skills in grades K–12.
- Early recognition and support for students with aptitude and passion in Science, Technology, Engineering, and Math (STEM) fields.
- Strengthening the skills and recruitment of science and mathematics teachers.
- Increasing incentives for individuals to pursue an education and career in STEM fields, and promote more effective utilization of STEM personnel by public and private sector employers.
- Making continuing education available to practicing scientists and engineers.

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 and in the National Academy's *Rising Above the Gathering Storm* report, to:

- Intensify support for research in the physical sciences and engineering to achieve a more robust national R&D portfolio.
- Enact a permanent, restructured research and experimentation tax credit, and extend the credit to research conducted in university-industry research consortia.
- Address the looming energy concerns of the Nation by supporting appropriate innovative energy technologies.
- Promote innovative research through new approaches such as the establishment of innovation "hot spots" to capitalize on regional assets and leverage public and private sector investments and/or by reallocating at least 3 percent of agency R&D budgets to "Innovation Acceleration" grants.

IEEE-USA also recommends the timely enactment of legislation to:

- Increase National Science Foundation (NSF) funding to nearly double by 2011.
- Increase the funding for the Department of Energy basic research, development, demonstration, and commercial application to nearly double by 2011.
- Increase R&D funding for the National Institute of Standards and Technology (NIST) to double over 10 years.
- Maintain the long-term basic research focus in other science and technology programs, including those administered by the Department of Defense and its Defense Advanced Research Projects Agency, as well as the Department of Homeland Security and its Homeland Security Advanced Research Projects Agency.
- Increase high-performance computing research and expanded access to supercomputing resources, including enactment of the High Performance Computing Research and Development Act (H.R. 28).
- Support funding for the National Nanotechnology Initiative at levels recommended in the 21st Century Nanotechnology Act (Pub. L. 108–153).

- Strengthen R&D designed to revitalize the manufacturing and the technical services sectors, including enactment of the Manufacturing Technology Competitiveness Act (H.R. 250).
- Revitalize U.S. leadership in aerospace and aviation research and development.
- Support technologies that promote public health and safety, including deployment of advanced information technologies and bioinformatics infrastructure into the healthcare sector.
- Accelerate broadband deployment in the United States as a national priority.
- Protect intellectual property.

Collectively, these reforms channel Federal resources toward long-term research goals that will foster innovation. This investment helps foster innovation in two ways. First, it will generate scientific discoveries and technological breakthroughs that drive innovation, indirectly creating entire new industries. Second, the research itself provides valuable educational opportunities for the next generation of engineers and scientists, opportunities that cannot be reproduced any other way.

About the IEEE-USA

This statement was developed by the Technology Policy Council of the IEEE—United States of America (IEEE-USA) and represents the considered judgment of a group of U.S. IEEE members with expertise in the subject field. IEEE-USA is an organizational unit of the Institute of Electrical and Electronics Engineers, Inc., created in 1973 to advance the public good and promote the careers and public policy interests of the more than 220,000 electrical, electronics, computer and software engineers who are U.S. members of the IEEE. The positions taken by IEEE-USA do not necessarily reflect the views of IEEE or its other organizational units.

PREPARED STATEMENT OF THE R&D CREDIT COALITION

Introduction

Chairman Stevens, Co-Chairman Inouye, Senator Ensign, and members of the Committee. The R&D Credit Coalition (the “Coalition”), which represents more than 1,000 small, medium and large U.S. companies and 85 professional and trade associations, respectfully submits this statement for the record of the Commerce Committee’s March 15, 2006 hearing on innovation and competitiveness legislation.

First, we want to express our appreciation to Senator Ensign and to Senator Lieberman for their leadership in introducing the National Innovation Act (S. 2109). This comprehensive legislative agenda focused on the need to enhance research and innovation in the United States contains a proposal for a strong, permanent Federal tax incentive for R&D that the Coalition strongly endorses. Specifically, the National Innovation Act includes among its key provisions a permanent research tax credit, an increase in the Alternative Incremental Research Credit rates and a new alternative simplified research credit. By proposing this strong and permanent R&D credit, the bill sponsors recognize that an effective Federal incentive to businesses will result in more U.S. investment, jobs, innovation and economic growth.

Unfortunately, the credit expired on December 31, 2005. Despite the broad bipartisan support for extending and strengthening this vital tax incentive, businesses currently cannot anticipate a future credit extension when estimating future R&D costs. As we approach the end of the first quarter of 2006, we are beginning to see the adverse financial impact this is having. Companies are required to calculate their financial statement effective tax rates for periods after December 31, 2005, without any benefit from the credit, thus increasing their effective tax rates, which translates into lower reported earnings.

Moreover, longer-term research funding and hiring decisions also are being affected by the uncertainty that exists. In the pending Tax Relief Extension Reconciliation Act (H.R. 4297) both the House and Senate demonstrated strong support for extending the credit and for making changes in the law that will help make the credit a more powerful incentive. We urge you to act soon on the longest possible extension of the R&D tax credit with the modifications that are included in the tax bills as a first step toward the ultimate goal of a strong, permanent R&D credit.

Importance of Innovation

Before turning specifically to the R&D tax credit proposal, we want to talk briefly about the broader importance of innovation to job growth, economic vitality, and increased standards of living.

Economists agree that, in the long-run, productivity growth is the principal source of improvements in living standards. There is consensus that the productivity

growth in recent years has been driven by the combination of accelerated technical progress and the resulting investments in capital assets, research and development, human capital, and public infrastructure. In order to continue this pattern of growth the focus of public policy must be on providing continued incentives to companies that invest, innovate, and create the new capital and knowledge that drive the U.S. economy.

In 2001, Federal Reserve Board Chairman Alan Greenspan told the Senate Budget Committee, “Had the innovations of recent decades, especially in information technologies, not come to fruition, productivity growth during the past five to 7 years, arguably, would have continued to languish at the rate of the preceding twenty years.”⁵

U.S. businesses and Federal policymakers should continue to work together to promote policies that will foster those same high levels of growth for decades to come.

Without a growing economy Americans’ standard-of-living, and our ability to support the needs of our aging population, will be in jeopardy. Faced with a static or decreasing workforce as U.S. demographics shift, U.S. lawmakers must focus on encouraging technological developments to increase productivity, enabling a smaller workforce to support a growing population of retirees.

It will take the continued support of both public and private investment in research and development to foster the level of innovation needed to keep the United States economically competitive. Research confirms, however, that private-sector R&D funding generally falls below the optimal level of spending necessary to provide maximum benefits to the overall economy. Corporate research is high-risk, long-term and limited by the “free rider” problem in economics. The benefits of R&D will not fully accrue to those businesses conducting the research, so there must be an additional incentive for businesses to undertake the costly and risky investment in additional research that benefits the public good. Thus, it makes public policy sense for the U.S. Government to do all it can to encourage companies to further increase R&D spending in the United States.

Foreign jurisdictions also have recognized the value and importance of R&D investments and the high-quality jobs that flow from that investment. Governments around the world are competing for corporate R&D investment to help create a better economic future for their citizens.

Research Incentives

According to the OECD,¹ “Support to business R&D remains a central feature of innovation policies across the OECD, especially as governments aim to boost business R&D spending. With the exception of several Eastern European countries, direct government support to business R&D has declined, both in absolute terms and as a share of business R&D, and greater emphasis is being placed on indirect measures, such as tax incentives for R&D.”

Between 2002 and 2004, Belgium, Ireland, and Norway established new R&D tax incentive regimes, bringing to 18 the number of OECD countries employing tax incentives for R&D. Canada, which offers a 20-percent flat tax credit for R&D spending, continues on its mission of inducing U.S. companies to locate R&D operations in that country. The United Kingdom also developed an R&D tax incentive for large firms, complementing the incentives currently provided for small firms. Countries are also making efforts to stimulate entrepreneurship and boost R&D activities in small and medium-sized enterprises (SMEs) by, for instance, supporting venture capital and providing preferential support to SMEs.

In 2004, the European Commission requested the International Bureau of Fiscal Documentation to carry out an information survey on the current tax treatment of research and development expenditures in the 25 EU Member States and the United States and Japan. A stated purpose for this study was to provide information that would enable the European Commission to find an incentive to increase the R&D spending within the Member States that would be competitive with other countries such as the United States and Japan.²

The Federal R&D tax credit, according to many government and private sector experts, has been a proven, effective means of encouraging increased research and development activity in the United States. Other countries are looking at our system and actively trying to compete for U.S. business’ R&D investment.

¹ OECD Science, Technology and Industry (STI) Outlook 2004.

² International Bureau of Fiscal Documentation, *Tax Treatment Of Research & Development Expenses*, December 2004, 230 pages. http://europa.eu.int/comm/taxation_customs/resources/documents/eu_rd_final_rep_dec_2004.pdf.

There is a significant body of evidence produced by the General Accounting Office, Bureau of Labor Statistics, National Bureau of Economic Research, and others that concludes that the R&D credit represents a very sound investment in U.S. economic growth.³

In 1998, Coopers & Lybrand (now PricewaterhouseCoopers) completed a study, *Economic Benefits of the R&D Tax Credit*, which dramatically illustrates the significant economic benefits provided by the credit. According to the study, making the R&D credit permanent would stimulate substantial amounts of additional R&D in the United States, increase national productivity and economic growth almost immediately, and provide U.S. workers with higher wages and after-tax income.

It is clear that the current R&D tax credit reduces the cost of investing in additional U.S.-based research for companies that qualify under the current formulation. For these companies that undertake that research, that assistance can often mean the difference between a project getting the green light or being put back on the shelf. The fate of that additional research project not only matters to the researchers, and technical personnel who would be hired to do the research, but it also matters to the unrelated small or medium-size company that might be hired to help take a product to market. Often, the discussion of the R&D tax credit centers on large companies that claim the credit. What has been overlooked, unfortunately, are those companies that don't claim the R&D credit, but whose livelihoods are linked to the products and services developed as a result of this additional research. Technology-based productivity increases benefit all businesses—even businesses that do no R&D.

As an example, consider Ace Clearwater Enterprises, Inc., a Torrance, California company, that makes many of the component parts that are used by large aerospace companies. When the large companies do more R&D in new and improved products and need to build and test more prototypes, Ace Clearwater does more business and hires more people. As R&D increases, so too does the need for suppliers, manufacturers, and ultimately a host of others when products are finally taken to market. Those firms and their employees are spread out in every community and every state and their contribution to economic prosperity is vital. These firms may not be the first thing that comes to mind when you hear about the R&D tax credit, but they certainly are among the first beneficiaries of increased investments in research and could be the first casualties if those levels of investment decline or move offshore.

Currently, companies of all sizes, across a wide range of industries and in every state claim the R&D tax credit. A 2004 study⁴ by Washington Council Ernst & Young, showed that the credit is highly beneficial to small firms. According to this study, in 2000:

- Nearly 16,000 companies claimed the R&D credit.
- More than 4,500 firms with assets of *less* than \$1 million (25 percent of all firms) claimed the credit. For the smallest firms in the study, those with assets between \$1,000 and \$99,000, on average the value of the credit claimed equaled 9.4 percent of their assets.
- Employees of companies in the manufacturing, services, retail and wholesale trade, construction, and real estate sectors were among the greatest beneficiaries of that investment.

If we want to maintain and improve that track record, it is important for Congress to adopt the changes proposed in the National Innovation Act that would—on a permanent basis—maintain the traditional credit, increase the Alternative Incremental Credit (AIRC) rates and provide for an Alternative Simplified Credit (ASC) in order to induce even more research-intensive businesses to undertake additional U.S.-based research spending.

History of the R&D Tax Credit

Congress first enacted the R&D credit in 1981 to provide an incentive for companies to increase their U.S. R&D activities. The Federal R&D tax credit is available

³See, e.g., Hall, Bronwyn H. and John Van Reenen. "How Effective Are Fiscal Incentives for R&D: A Review of the Evidence." Working Paper 7098. Cambridge, MA, National Bureau for Economic Research, April 1999; U.S. General Accounting Office (GAO), *Tax Policy and Administration: Review of Studies of the Effectiveness of the Research Tax Credit*, May 1996, 26 pages.; Office of Technology Assessment, Congress of the United States, *The Effectiveness of Research and Experimentation Tax Credits*, OTA-BP-ITC-174, September 1995, Washington, D.C., 65 pages.

⁴Koch, Cathy. *Supporting Innovation and Economic Growth: The Broad Impact of the R&D Tax Credit*, Washington Council Ernst & Young, April 2004, 15 pages. http://www.nam.org/s_nam/bin.asp?CID=155&DID=230921&DOC=FILE.PDF.

only for research done in the United States. The bulk of the qualified expenditures are the salaries of workers directly involved in R&D.

The initial credit rate was equal to 25 percent of a company's incremental "qualified R&D expenditures" (QREs) in excess of a rolling base amount equal to average QREs for the prior 3 years. Currently, the credit rate is 20 percent of a company's QREs and the base amount calculation is linked to the taxpayer's gross receipts.

The original credit was scheduled to expire at the end of 1985. Recognizing the importance and effectiveness of the R&D credit, Congress decided to extend it and has extended it on ten subsequent occasions. In addition, the credit's focus has been narrowed by further limiting both qualifying activities and eligible expenditures—increasing the credit's incentive leverage. With each extension, the Congress indicated its strong bipartisan support for the R&D credit.

In 1996, Congress added the elective Alternative Incremental Research Credit (AIRC) to the statute, making the credit available to R&D-intensive industries that could not qualify for the credit under the regular formula. The AIRC adds flexibility to the credit to address changes in business models and R&D spending patterns that are a normal part of a company's life cycle.

In 1999, the credit was extended until June 30, 2004, and a modest increase in the AIRC rates was adopted to bring the AIRC's incentive effect more into line with the incentive provided by the regular credit.

Most recently, in 2004, as part of the Working Families Tax Relief Act of 2004 (Pub. L. 108–311), the credit was seamlessly extended for the period beginning July 1, 2004 through December 31, 2005. This seamless extension was particularly important, as it ensured there was no disruption in ongoing research projects.

The Current Credit Needs To Be Strengthened and Made Permanent

In order to maximize its incentive effect, the R&D credit should be permanent. Research projects cannot be turned off and on like a light switch and generally represent multi-year commitments; if corporate managers are going to take the benefits of the R&D credit into account in planning future research projects and future hiring needs, they need to know that the credit will be available to their companies for the years in which the research is to be performed. Research projects have long horizons and extended gestation periods. Furthermore, firms generally face longer lags in adjusting their R&D investments compared, for example, to adjusting their investments in physical capital. The 12-month gap in the credit from July 1995 to June 1996 reduced the business community's willingness to plan based on assumed future extensions of the temporary credit.

In the normal course of business operations, R&D investments take time and planning. Businesses must search for, hire, and train scientists, engineers and support staff, and in many cases invest in new physical plants and equipment. There is little doubt that some of the incentive effect of the credit has been lost over the past twenty-four years as a result of the constant uncertainty over the continued availability of the credit. This must be corrected so that the full potential of its incentive effect can be felt across all sectors of our economy.

In order to provide for the maximum potential for increased R&D activity, and for the government to maximize its return on tax dollars invested in the credit, the practice of periodically extending the credit for short periods, and then allowing it to lapse, must be changed by making the R&D credit permanent.

Although the current statutory incentive is effective for many companies, many others that spend significant amounts on R&D in the U.S. get little or no benefit. Consequently, a simple extension of present law will provide insufficient incentive to maintain or increase their R&D spending in the United States. Moreover, the R&D inducements outside the U.S. will look relatively more favorable to these taxpayers.

For example, many taxpayers are no longer able to qualify for the traditional credit because their sales increased significantly in the intervening years, or they entered into an additional line of business that generated additional gross receipts but performed little R&D, or they became more efficient in their R&D processes and were able to spend less to perform the same R&D activity.

In 1996, the addition of the AIRC at significantly reduced rates partially addressed this issue for many companies. It is time to take the next step by both increasing the AIRC rates and providing for an Alternative Simplified Credit (ASC) calculation that will improve the credit's incentive value for increased research activity and job creation in the United States.

The U.S. business community needs a stable, consistent, and improved R&D credit that will strengthen its incentive value, stimulate the Nation's economic growth and sustain the basis for ongoing global technology. We urge the Congress to enact the Hatch-Baucus proposal in 2006.

Proposed Changes to Current Law

In addition to the need for permanency for the R&D credit, changes to the statute need to be made in order to maximize the credit's incentive value. In order to extend an incentive for U.S.-based R&D to more companies, Congress should adopt the Alternative Simplified Credit (ASC). The ASC is an elective credit that equals 12 percent of the excess of current-year qualified research expenses (QREs), over 50 percent of the taxpayer's average QREs for the prior 3 years. These credit and base amounts are designed to provide an effective credit rate comparable to that provided on average by the traditional credit. Importantly, the ASC is calculated without reference to gross receipts, a feature of the traditional credit that, as discussed above, has left many research-intensive companies unable to qualify for the credit.

While the new ASC may provide a greater incentive for many AIRC companies over time, AIRC firms should be given a more meaningful incentive to continue and increase their research activities in the United States as they assess the value of the new regime. In order to move closer to the incentive value provided by the traditional credit, Congress should increase the AIRC rates to 3 percent, 4 percent and 5 percent, respectively, which will bring those rates in line with the levels envisioned when the AIRC was originally proposed in 1996.

While the ASC increases the incentive value of the credit for certain businesses, it is equally important to avoid disrupting the current incentive for companies that benefit under the traditional credit and AIRC. The traditional credit, in its current form, provides a strong incentive for many companies that continue to increase R&D activities in the United States at an equal or higher rate than revenue. For companies whose R&D investments continue to increase, the traditional credit calculation may yield a higher credit amount for that company than under the new ASC.

Overall, the introduction of an elective new credit calculation is intended to provide a comparable incentive to other companies engaged in research that have been unable to qualify for the traditional credit—while avoiding penalizing those companies that have responded to the incentives provided by the traditional credit by significantly increasing their U.S.-based R&D spending.

Conclusion

Private sector R&D in the United States stimulates investment in innovative products and processes that greatly contribute to overall economic growth, increased productivity, new and better U.S. jobs, and higher standards of living in the United States. By creating an environment favorable to private sector R&D investment in the United States, Congress can encourage companies to site new research projects here and maintain and attract the high-skill, high-wage jobs associated with those projects in the United States. Investment in R&D is an investment in U.S. jobs. A strong, vibrant, and permanent R&D credit is essential for the competitiveness of U.S. companies, as many foreign countries have chosen to offer direct financial subsidies and reduced capital cost incentives to “key” industries.

The R&D Credit Coalition applauds the Senate Commerce Committee, and all the co-sponsors of the National Innovation Act, for your commitment to fostering American innovation. The Coalition will continue to work with you on effective Federal policy, like a strong, permanent R&D tax credit, that fosters economic growth through support of private sector investments in innovation.

Thank you for the opportunity to present these views.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. GORDON H. SMITH TO THE PANEL

Question 1. My Manufacturing Technology Competitiveness Act authorizes funding for the National Institute on Standards and Technology. Can you explain how technology advancements and services performed by the National Institute of Standards and Technology benefit your industry?

Question 1a. In your view, how would industry be impacted without these programs and services performed by the National Institute of Standards and Technology?

Answer from Deborah L. Wince-Smith. The Council on Competitiveness disagrees with the assertion that manufacturing is a lost cause in the United States. Advances in manufacturing technology and processes will be critical to our ability to glean value and wealth creation from new ideas. The research that the National Institute on Standards and Technology performs in these areas is vitally important, as breakthroughs in nanotechnology and biotechnology, to name two emerging areas, are ready to be commercialized.

Just as the Federal Government must lead in the area of support for long-term basic research, so can it lead in the research into manufacturing processes. Industry would be negatively affected by the elimination of NIST programs in this area.

Answer from Dr. Craig R. Barrett. NIST research and development has played, and continues to play, an important role in major scientific and technological advances. NIST research has enabled major breakthroughs in materials, testing, and scanning tunneling microscopy. The NIST labs are relied upon by industry for accuracy, reliability, and cooperative international scientific research. This research has extended to assisting our industry with nano-scale manufacturing of semiconductor devices, and various technologies that will be critical to next-generation extreme ultraviolet photo-lithography (EUV), which will be critical to our ability to continue shrinking the size of circuits upon chips.

It is not an overstatement to say that industry would be crippled in its ability to compete without the programs and services provided by NIST labs. In many areas, there are simply no private sector substitutes for the work done by NIST and if it did not exist, industry would be forced to find other venues for the accomplishment of some major research goals, which would in many cases (of necessity) be located outside the U.S. Although our industry participates in research in non-U.S. geographies, the proximity of U.S. laboratories to domestic manufacturing centers, and the opportunities for U.S. employees to interact with American research specialists in U.S. laboratories, is a key element of maintaining our competitive posture. This is why we at Intel have been fighting so hard to preserve these critical programs.

Answer from Dr. John E. Kelly. The National Institute on Standards and Technology (NIST) has historically been a key part of Federal programs that seek to advance competitiveness of U.S. industry. IBM has benefited particularly from NIST's work in the creation of voluntary open industry standards that enable innovation across many sectors. NIST recently convened an industry meeting on the important issue of creating interoperable solutions for healthcare and manufacturing.

We also have encouraged NIST and other relevant Federal agencies to undertake programs that will reorient Federal research and development investment to include the emerging field of services science, management and engineering (SSME) where individuals apply technology to solve complex problems in the industrial sector.

Question 2. My bill also includes authorizations for the Manufacturing Extension Partnership Program (MEP). Can you explain how assistance from MEP has supported your industry?

Question 2a. In your view, how would industry be impacted without support from MEP?

Answer from Deborah L. Wince-Smith. A key recommendation in the Council's report *Innovate America*, is for the Manufacturing Extension Partnership Program (MEP) to focus on innovation and advanced technologies—in other words retool for the technologies of the future. If done successfully, and indications are that NIST is headed in this direction, MEP can be a valuable tool for America's manufacturing capability.

An MEP program focused on innovation and forward-looking technologies could be a valuable tool for industry.

Answer from Dr. Craig R. Barrett. MEP centers have not had a major direct impact upon Intel, as we are of a size and financial strength that the "start-up business guidance" nature of the services that MEP centers provide are not directly needed by Intel. However, many of our industry partners—particularly the smaller supplier firms and channel vendors—have benefited from the services of MEP centers. Overall, American business has been strengthened by the contribution of MEP centers.

Question 3. My bill includes a provision to authorize funding for the Advanced Technological Program that supports high-risk, cutting-edge technologies. Can you explain how this program has benefited your industry?

Question 3a. In your view, how would industry be impacted without the type of support provided by this program?

Answer from Deborah L. Wince-Smith. The Council is a membership organization with over 120 members representing companies, universities and labor organizations. Many of our members have participated in and support the Advanced Technology Program (ATP). The ATP program seeks to bridge the gap—known as the Valley of Death—between basic research and product commercialization. Our report, *Innovate America*, contained several proposals to try and address this problem including greater university-industry collaboration and communication; expansion of angel investor networks; and the creation of state or local seed-investment funds.

Speaking generally, it is increasingly critical to America's economic growth that we have mechanisms in place—financial and logistical—to move ideas from the lab to the marketplace.

Answer from Dr. Craig R. Barrett. The ATP program has gone through a number of structural and mission changes over the past 5 years which have strengthened its focus on breakthrough technologies and research that might falter in the absence of the financial partnering that the ATP program is intended to provide. Many in our industry (such as IBM) strongly support the ATP program and have found it to be very beneficial to the supporting technologies and companies that contribute to semiconductor technology development. Intel *per se* has not been a major participant in the ATP program.

Question 4. I am told that companies in all types of industries needs more workforce education and training in order to be successful and competitive. Do you support the Advanced Technological Education program?

Question 4a. Do you find these authorization levels to be appropriate?

Question 4b. Do you think more needs to be done to support workforce training and education?

Answer from Deborah L. Wince-Smith. The intent of the Advanced Technological Education program to support education and training for the high-tech workforce is certainly an important goal and critical to successfully developing a highly-skilled workforce.

I am not familiar enough with the program to comment on the authorization levels.

Certainly workforce training and education needs to be a high priority in an innovation-based economy. Close collaboration between academia and industry to ensure we are training people with the skills they will need for the jobs of the future is an important first step.

Answer from Dr. Craig R. Barrett. I believe that workforce training and education is vital to our competitive future. Intel has devoted substantial resources to assisting in the strengthening of teachers' skills in the use of computing technology in the classroom through its "Teach to the Future" program. Over 300,000 teachers in the U.S. have benefited from participation in this program.

I have strongly supported steps to ensure that teachers who provide math and science instruction in our public schools truly have the background and training to be effective instructors in those areas. In that context, we strongly support the educational testing and teacher improvement initiatives that are contained in the President's American Competitiveness Initiative.

With regard to the Advanced Technological Education program, this NSF program has proved to be of great value in strengthening the ability of our community colleges to prepare students to work in the high-technology industries. I support the extension of this program to all institutions of higher education. The appropriate authorization levels for such programs are in the discretion of Congress and I have no opinion on that.

Question 5. The potential impact of nanotechnology on the economy and our quality-of-life is truly revolutionary. In addition to the U.S., countries in Europe and Asia are also making tremendous advances in this emerging technology. I have introduced a bill with the goal of bringing advances in nanotechnology to commercialization. Do you think this type of effort will help enhance U.S. innovation and competitiveness?

Question 5a. From your perspective, what should we do to further advance nanotechnology and its application in commercial products?

Answer from Deborah L. Wince-Smith. Similar to my answer on the ATP program, I would only say that the process of commercialization of new technologies and ideas is of critical importance to America's long-term competitiveness. The Council on Competitiveness has convened an advisory group of experts from the public and private sectors on the future of manufacturing to try and tackle these and related issues and I welcome the chance to continue this discussion with you and the other members of the Committee.

Answer from Dr. Craig R. Barrett. I believe that all efforts should be made to foster nanotechnologies, particularly advanced nanoelectronics manufacturing techniques, which are essential to the future viability of "Moore's Law." Congress has directed a major investment in these technologies through the National Nanotechnology Initiative.

With regard to commercialization, two points: first, one very important thing that can be done to enhance commercialization is to preserve the advances in the ability of federally-owned and/or operated laboratories (such as DOE labs and NIST labs)

to license research breakthroughs through the mechanics of the Bayh-Dole Act, which dramatically expanded the ability of the Federal labs to foster commercialization of advances brought forth from those labs. Second, a major challenge to our ability to effectively commercialize these technologies are current IP licensing strategies being pursued by a number of major universities, which have the effect of restricting the ability of the private sector to obtain exclusive use rights to technological breakthroughs which result from jointly sponsored research. If these barriers are removed, I believe that there would be no substantial impediments to commercialization of nanotechnology developments. Hearings on this topic would be helpful to focus attention on remedial steps.

Question to Dr. Craig Barrett

Question. Dr. Barrett, in your testimony, you recommended that Congress adopt policies that will “develop an infrastructure that will support real economic growth,” including what you called “full metal jacket broadband.” I’ve announced my intention to introduce a bill that would promote broadband deployment. One element of my bill will authorize the use of Universal Service Funds to build broadband networks. Do you support this approach?

Answer. I definitely agree with your goal of ensuring that high-quality, affordable, and universal broadband service is essential to our Nation’s global competitiveness. With respect to the question regarding Universal Service Funds, we believe that if broadband pays into USF, then broadband should be eligible to be a recipient of USF.

Our position is that Universal Service Funds should be raised from a comprehensive, fixed charge on end-users in a competitively-neutral manner based on numbers or connections (two of the funding mechanisms referenced in the “Broadband for America Act of 2006”). Intel does not support collection methodologies based on total telecommunications revenues (another funding mechanism referenced in the “Broadband for America Act of 2006”).

The funding and distribution methodologies for universal communications service programs should be efficient and fair. We believe that this can only be achieved by reforming the explicit and implicit Universal Service Funds now in existence, including the intercarrier compensation regime. An efficient funding and payment system would be sustainable, competitively and technologically-neutral and minimize the suppression of demand.

Therefore, while Intel has supported investment tax credit and Rural Utility Service funding for rural broadband, we prefer that rural and other high-cost programs be designed to be competitively and technologically-neutral.

I commend you, Senator Smith, for your efforts on the USF issue—a topic that is incredibly complex and involves many trade-offs. We would welcome the opportunity to discuss this multifaceted and complicated issue in more detail or answer any additional questions that the Senator might have.

On a related issue, I want to thank you for including the provision on TV “white spaces” in your bill. Intel believes that opening this unused spectrum to unlicensed devices would enable the deployment of valuable new wireless broadband services such as WiMAX in rural and other under-served areas, as well as innovative wireless networking solutions in the home and office. These new wireless broadband devices would benefit consumers across the country and help the Nation meet its broadband goals—thus helping to ensure continued U.S. technological leadership and economic development.

Question to John E. Kelly III

Question 1. Dr. Kelly, you noted in your testimony that the Internet “is rapidly becoming the planet’s operational infrastructure . . . linking people, cultures, businesses and institutions, as well as billions—ultimately trillions—of devices.”

I believe that our communications policies must match the marketplace reality you have described. My proposed broadband legislation will update our laws to promote video competition, broadband universal service, wireless broadband and municipal broadband. Has Congress done enough to promote broadband deployment?

Question 1a. Would you support legislation of the type I have outlined?

Answer. We support efforts by Congress to encourage greater broadband penetration. IBM, however, has not taken a position on specific legislation.

THE NATIONAL ACADEMIES
Washington, DC, May 31, 2006

Hon. GORDON H. SMITH,
Senate Committee on Commerce, Science, and Transportation,
Washington, DC.

Dear Senator Smith:

Thank you for your questions following the Senate Commerce hearing held on March 15. Although important questions, I'm afraid they fall beyond the boundaries of the testimony I was offering on behalf of the National Academies on its report *Rising Above the Gathering Storm*. Many of the questions are about the National Institute of Standards and Technology (NIST) and we did not focus on this agency in our report. As a consequence, the questions you ask are beyond my knowledge of the agency. In addition, because of their tax-exempt status, the National Academies are not permitted to endorse legislation.

I can tell you that the National Academies did release its annual report assessing NIST in 2005. The Board that assessed NIST indicated the following:

"The Board is very impressed with the technical quality of NIST's intramural work. NIST carries out in a superb fashion an absolutely vital role in supporting as well as facilitating the further development of the technological base of the U.S. economy. Its personnel and scientific programs are, by scientific measures, among the best in the world and its explicit and continuing attention to the needs of its customers keeps it alert to the changing technological environment to which it must be responsive."

You might wish to have your staff pursue your questions further with this board. A good point of contact would be Jim McGee, Director, National Academies Board on NIST Assessment. Should you wish to include in the hearing transcript that I provided the above quotation from prior National Academies' work, which would be fine.

Thank you for your interest and my apologies that I could not be more responsive to your questions.

Sincerely,

NORMAN R. AUGUSTINE,
Chair,
Committee on Prospering in the
Global Economy of the 21st Century.

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