THE RELATIONSHIP BETWEEN BUSINESS AND RESEARCH UNIVERSITIES: COLLABORATIONS FUELING AMERICAN INNOVATION AND JOB CREATION

HEARING

BEFORE THE

SUBCOMMITTEE ON RESEARCH AND SCIENCE EDUCATION

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

HOUSE OF REPRESENTATIVES

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Wednesday, August 1, 2012

THE RELATIONSHIP BETWEEN BUSINESS AND RESEARCH UNIVERSITIES: COLLABORATIONS FUELING AMERICAN INNOVATION AND JOB CREATION

WEDNESDAY, AUGUST 1, 2012

U.S. HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON RESEARCH AND SCIENCE EDUCATION,
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY,
Washington, D.C.

The Subcommittee met, pursuant to call, at 10:06 a.m., in Room 2318 of the Rayburn House Office Building, Hon. Mo Brooks [Chairman of the Subcommittee] presiding.

RALPH M. HALL, TEXAS
CHAIRMAN

EDDIE BERNICE JOHNSON, TEXAS
RANKING MEMBER

U.S. HOUSE OF REPRESENTATIVES

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

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Subcommittee on Research & Science Education Hearing

The Relationship Between Business and Research Universities: Collaborations Fueling American Innovation and Job Creation

Wednesday, August 1, 2012
10:00 a.m. to 12:00 p.m.
2318 Rayburn House Office Building

Witnesses

Mr. William D. Green, Executive Chairman, Accenture, Boston, Massachusetts

Dr. Ray O. Johnson, Senior Vice President and Chief Technology Officer, Lockheed Martin Corporation, Bethesda, Maryland

Dr. John S. Hickman, Director, Global University Relations and Life Sciences, Deere and Company, Moline, Illinois

Dr. Louis Graziano, Director, University R&D Strategy, Sustainable Technologies & Innovation Sourcing, The Dow Chemical Company, Spring House, Pennsylvania

Ms. Jilda Diehl Garton, Vice President for Research and General Manager, Georgia Tech Research Corporation, Georgia Institute of Technology, Atlanta, Georgia

U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON RESEARCH AND SCIENCE EDUCATION

HEARING CHARTER

The Relationship Between Business and Research Universities: Collaborations Fueling American Innovation and Job Creation

Wednesday, August 1, 2012
10:00 a.m. - 12:00 p.m.
2318 Rayburn House Office Building

1. Purpose

On Wednesday, August 1, 2012, the Committee on Science, Space, and Technology Subcommittee on Research and Science Education will hold a hearing to examine partnerships and collaborations between industry and research universities, as a follow-up to the June 27, 2012 hearing, *The Role of Research Universities in Securing America's Future Prosperity: Challenges and Expectations*. The hearing will provide an opportunity to explore the necessary relationships between industry and research universities. It will examine the challenges and opportunities they face in fueling the research necessary for American economic prosperity and ensuring that universities are adequately preparing the future workforce to meet the needs of industry.

2. Witnesses

Mr. William D. Green, Executive Chairman, Accenture, Boston, Massachusetts

Dr. Ray O. Johnson, Senior Vice President and Chief Technology Officer, Lockheed Martin Corporation, Bethesda, Maryland

Dr. John S. Hickman, Director, Global University Relations and Life Sciences, Deere and Company, Moline, Illinois

Dr. Lou Graziano, Director, University R&D Strategy, Sustainable Technologies & Innovation Sourcing, The Dow Chemical Company, Spring House, Pennsylvania

Ms. Jilda Diehl Garton, Vice President for Research and General Manager, Georgia Tech Research Corporation, Georgia Institute of Technology, Atlanta, Georgia

3. Overview

- U.S. businesses and industry have moved away from conducting fundamental, or basic, scientific research and development in-house. This shift has led to a greater reliance on the

Nation's research universities for this research and to provide the backbone for the science, technology, engineering and mathematics workforce essential for U.S. prosperity.

- Today, collaborations between industry and universities take a number of diverse forms and exist for a number of reasons, including conducting basic research, transferring this research into applied technologies, and growing and supporting a qualified workforce.

- On June 14, 2012, the National Academies released *Research Universities and the Future of America*, a report detailing ten recommendations for key stakeholders to ensure U.S. research universities maintain their capabilities and grow their strengths. Included as part of these recommendations was the need to strengthen partnerships between businesses and academia.

4. Background

On June 27, 2012, the Subcommittee on Research and Science Education held a hearing to examine the challenges faced by the Nation's research universities. As the 150th anniversary of the Morrill Act was celebrated across the country, the hearing provided Members of the Subcommittee an opportunity to reflect on the important role U.S. research universities play in educating the science, technology, engineering and mathematics workforce essential for U.S. prosperity and to review the National Academies report, *Research Universities and the Future of America*. These universities not only contribute to the academic researchers who work to move basic scientific research forward but also those who comprise the STEM related workforce in the country. At the hearing, witnesses and Members discussed the challenges facing these universities, including restricted budgets, rising costs, over-regulation or regulatory burden, and global competition. Today's hearing brings additional stakeholders to the table to discuss the recommendations as they relate to industry and how they affect the future of U.S. research universities.

The National Academies' Committee on Research Universities reconfirmed that a gap exists in industry research needs. Industry is shifting away from conducting its own transformational and translational research and development (R&D), that research which couples fundamental scientific breakthroughs with technological innovation, and is turning to relationships with academic institutions for this R&D support.

> Corporate practices for the funding and performance of basic research have shifted. Financial pressures have led to the disappearance of large industrial laboratories in many industries and, therefore, to new strategies for obtaining the productive knowledge that allows for the innovation and development of new processes and products. Industry funding and performance of basic research has recently been wildly erratic, but over the long term, essentially flat. Meanwhile university-performed research and industry-funded university research have grown. Corporate funding for basic research has increased on campuses creating both new opportunities for research and commercialization and challenges such as the management of conflict of interest.[1]

[1] *Research Universities and the Future of America*, National Academies Press, 2012, p.94-95.

In order to sustain U.S. growth in these areas, industry and academia are finding more ways to partner in both transformational and translational R&D. The Nation's research universities work to sustain the science, technology, engineering and mathematics workforce essential for U.S. prosperity. These universities produce not only the academic researchers who work to move basic scientific research forward but also those trained to transition from basic to applied technologies and the overall STEM-related workforce for the country.

Research universities play a critical role in our Nation's R&D enterprise. In 2009, academic institutions performed over half (53 percent) of the Nation's total basic research, a percent that has risen steadily in recent decades. [2]

According to the 2012 NSF Science and Engineering Indicators:

- In 2010, four percent of the U.S. workforce (about 5.5 million people) worked in occupations classified as science and engineering (S&E). This is an increase from the five million S&E workers in 2003.
  - 1.55 million individuals were employed in engineering occupations in 2010, an increase from 1.49 million engineers employed in 2004;
  - Nearly 629,000 individuals were employed as life and physical scientists in 2010, an increase from the 549,000 life and physical scientists employed in 2004;
  - 3.11 million individuals were employed as computer specialists in 2010, an increase from the 2.81 million computer specialists employed in 2004; and
  - Nearly 1.9 million individuals were employed as technical workers in 2010, an increase from the 1.5 million technical workers employed in 2004.

- In 2008, just over 33,000 S&E doctorates were awarded by U.S. academic institutions, approximately 26 percent more than in 1997. The number of employed S&E doctorate holders rose from 517,000 in 1997 to 648,000 in 2008, an increase of 25 percent.

- Expenditures for research performed in academic institutions have almost doubled in the decade, rising from $30 billion in 2000 to almost $55 billion in 2009 in current dollars.

- The amount of R&D performed by business rose from nearly $192 billion in 2000 to nearly $267 billion in 2008, an increase of 39 percent in current dollars. [3]

Industry-academic relationships may include support for students and a future workforce, collaborations on basic fundamental questions, or coordination transitioning an idea or technology from the laboratory. These partnerships are motivated by the objectives and restrictions of both the industry and university involved. The University-Industry Demonstration Partnership (UIDP), convened by the National Academies, evaluated the different types of partnerships that occur between industry and universities and categorized the relationships into several areas: student-oriented engagement; involvement with researchers; access to resources; involvement with centers of expertise and schools; or economic development. According to

[2] *Science and Engineering Indicators 2012.* National Science Board. Arlington VA: National Science Foundation (NSB 12-01). 2012. http://www.nsf.gov/statistics/seind12/start.htm. p.4-4.
[3] Ibid. p.8-78, 80-86, 104, 78, 102, and 100

UIDP, "Partnerships within these categories can be strategic, to some degree, and where there is a particularly deep relationship between parties, participation across all categories may occur concurrently."[4]

Research Universities and the Future of America

The ability of the United States to remain a world leader in science and technology relies greatly on the strength and success of our universities. In 2009, Representatives Ralph Hall and Bart Gordon and Senators Lamar Alexander and Barbara Mikulski requested the National Academies work to produce a report identifying the top ten actions needed to be taken in order to maintain the excellence of U.S. research and doctoral education. The request expressed concern that America's research universities were "at risk" and asked the National Academies to assess the future of research universities by asking what Congress, the federal government, state governments, research universities and others can do to ensure future success of these institutions, which now face an array of challenges, from unstable revenue streams and antiquated policies and practices to increasing competition from universities abroad. In response, the National Research Council convened a committee of leaders from academia, industry, government and national labs to draft the report which outlines various findings and recommends ten specific actions.[5]

The report identifies a set of specific challenges:

- Federal funding for university research has been unstable and, in real terms, declining at a time when other countries have increased funding for research and development (R&D).

- State funding for higher education, already eroding in real terms for more than two decades, has been cut further during the recent recession.

- Business and industry have largely dismantled the large corporate research laboratories that drove American industrial leadership in the 20th century (e.g., Bell Labs), but have not yet fully partnered with research universities to fill the gap at a time when the new knowledge and ideas emerging from university research are needed by society more than ever.

- Research universities must improve management, productivity, and cost efficiency in both administration and academics.

- Young faculty have insufficient opportunities to launch academic careers and research programs.

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[4] *Partnership Continuum: Understanding & Developing the Pathways for Beneficial University-Industry Engagement.* University-Industry Demonstration Partnership. http://sites.nationalacademies.org/xpedio/groups/pgasite/documents/webpage/pga_069334.pdf. p. 7

[5] *Research Universities and the Future of America.* National Academies Press. 2012, p.192.

- There has been an underinvestment in campus infrastructure, particularly in cyberinfrastructure that could lead to long-term increases in productivity, cost-effectiveness, and innovation in research, education, and administration.

- The cost of sponsored research is not fully covered by those who procure it, which means that universities have to cross-subsidize sponsored research from other sources.

- A burdensome accumulation of federal and state regulatory and reporting requirements increases costs and sometimes challenges academic freedom and integrity.

- Doctoral and postdoctoral preparation could be enhanced by shortening time-to-degree, raising completion rates, and enhancing programs' effectiveness in providing training for highly productive careers.

- Demographic change in the U.S. population necessitates strategies for increasing the success of female and underrepresented minority students.

- Institutions abroad are increasingly competing for international students, researchers, and scholars. [6]

According to the Report, America's research universities have emerged as a major national asset in light of the Nation's economic goals among other things. The Report lists ten specific actions that should be taken to secure the future for these universities, several of which relate to industry and its role. Of particular note is the recommendation that specifically encourages the relationship between industry and universities (Recommendation 3); the recommendations that require industry engagement for implementation (Recommendations 8 and 9); and the recommendations that may affect the way industry conducts its business (Recommendations 4 and 10).

All ten of the recommendations are designed to accomplish the following three broad goals:

- *Revitalize the partnership.* The first four actions will strengthen the partnership among universities, federal and state governments, philanthropy, and the business community in order to revitalize university research and speed its translation into innovative products and services.

- *Strengthen institutions.* The next three actions will streamline and improve the productivity of research operations within universities.

- *Build talent.* The final three actions will ensure that America's pipeline of future talent in science, engineering, and other research areas remains creative and vital,

[6] Ibid. p.4-5.

leveraging the abilities of all of its citizens and attracting the best students and scholars from around the world. [7]

The ten specific actions recommended to achieve the above goals are:

1. Within the broader framework of U.S. innovation and R&D strategies, the federal government should adopt stable and effective policies, practices, and funding for university-performed R&D and graduate education so that the nation will have a stream of new knowledge and educated people to power our future, helping us meet national goals and ensure prosperity and security.
   - The federal government should work to review and modify burdensome and inefficient policies and practices governing university research and graduate education.
   - As the economy improves over the next ten years, the federal government should invest in basic research and graduate education sufficient to produce the new knowledge and educated citizens the Nation needs to reach its goals.
   - In the President's annual budget request, OMB and OSTP should develop and present a federal science and technology budget that addresses priorities for sustaining a world-class U.S. science and technology enterprise. [8]

2. Provide greater autonomy for public research universities so that these institutions may leverage local and regional strengths to compete strategically and respond with agility to new opportunities. At the same time, restore state appropriations for higher education, including graduate education and research, to levels that allow public research universities to operate at world-class levels.
   - State governments should provide their public research universities with sufficient autonomy and agility to navigate an extended period with limited state support.
   - As state budgets recover from the current recession, states should work to restore and maintain per-student funding for higher education.
   - Federal programs designed to stimulate innovation and workforce development at the state level should be accompanied by incentives to stimulate and sustain state support for their public universities. [9]

3. Strengthen the business role in the research partnership, facilitating the transfer of knowledge, ideas, and technology to society, and accelerate "time-to-innovation" in order to achieve our national goals.
   - The federal government should continue to fund and expand research support mechanisms that promote collaboration and innovation
   - The federal government should make the R&D tax credit permanent and implement new tax policies that incentivize business to develop partnerships with universities.
   - The relationship between business and higher education should become more peer-to-peer in nature.

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[7] Ibid. p.4.
[8] Ibid. p.7.
[9] Ibid. p.9.

- Businesses and universities should work closely together to develop new graduate degree programs that address strategic workforce gaps for science-based employers.
- Collaboration among national laboratories, the business community, and universities should be encouraged.
- Universities should improve management of intellectual property to improve technology transfer. [10]

4. Increase university cost-effectiveness and productivity in order to provide a greater return on investment for taxpayers, philanthropists, corporations, foundations, and other research sponsors.
   - The Nation's research universities should set and achieve bold goals in cost containment, efficiency, and productivity in business operations and academic programs. Universities should strive to limit the cost escalation of all ongoing activities — academic and auxiliary.
   - University associations should develop and make available more powerful and strategic tools for financial management and cost accounting.
   - Working together with key stakeholders, universities should intensify efforts to educate key audiences about the unique character of U.S. research universities and their importance to state, regional, and national goals. [11]

5. Create a Strategic Investment Program that funds initiatives at research universities critical to advancing education and research in areas of key national priority.
   - The federal government should create a new Strategic Investment Program to support initiatives that advance education and research at the Nation's research universities.
   - Universities should compete for funding under these initiatives, bringing in partners that will support projects by providing required matching funds. [12]

6. The federal government and other research sponsors should strive to cover the full costs of research projects and other activities they procure from research universities in a consistent and transparent manner.
   - The federal government and other research sponsors should strive to support the full cost of research so that it is no longer necessary to subsidize sponsored grants by drawing on resources intended to support other university missions. Both sponsored research policies and cost-recovery negotiations should be developed and applied in a consistent fashion across all federal agencies and academic institutions. [13]

7. Reduce or eliminate regulations that increase administrative costs, impede research productivity, and deflect creative energy without substantially improving the research environment.
   - Federal policymakers and regulators (OMB, Congress, agencies) and their state counterparts should review the costs and benefits of federal and state regulations,

[10] Ibid. p.11.
[11] Ibid. p.12.
[12] Ibid. p.13.
[13] Ibid. p.15.

eliminating those that are redundant, ineffective, inappropriately applied to the higher education sector, or that impose costs that outweigh the benefits to society.
- The federal government should make regulations and reporting requirements more consistent across federal agencies. [14]

8. Improve the capacity of graduate programs to attract talented students by addressing issues such as attrition rates, time-to-degree, funding, and alignment with both student career opportunities and national interests.
   - Research universities should restructure doctoral education to enhance pathways for talented undergraduates.
   - Research universities and federal agencies should ensure that they improve education across the full spectrum of research university graduate programs.
   - The federal government should significantly increase its support for graduate education through balanced programs of fellowships, traineeships, and research assistantships provided by all science agencies that depend upon individuals with advanced training.
   - Employers that hire master's and doctorate level graduates should engage more deeply in research university programs by providing advice on needed curriculum and utilizing tools like internships and student projects. [15]

9. Secure for the United States the full benefits of education for all Americans, including women and underrepresented minorities, in science, mathematics, engineering, and technology.
   - Research universities should engage in efforts to improve education for all students at all levels in the United States.
   - Research universities should assist efforts to improve the education and preparation of those who teach science, technology, engineering, and mathematics (STEM) subjects in grades K-12 and strive to improve undergraduate education.
   - All stakeholders (federal government states, local school districts, industry, philanthropy, universities) should take urgent, sustained, and intensive action to increase the participation and success of women and underrepresented minorities across all academic and professional disciplines. [16]

10. Ensure that the United States will continue to benefit strongly from the participation of international students and scholars in our research enterprise.
    - Federal agencies should ensure that visa processing for international students and scholars who wish to study or conduct research in the United States is as efficient and effective as possible, consistent with homeland security considerations.
    - To ensure that a high proportion of non-U.S. doctoral researchers remain in the country, the federal government should streamline the processes for these researchers to obtain permanent residency or U.S. citizenship.
    - The federal government should proactively recruit international students and scholars. [17]

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[14] Ibid. p.15.
[15] Ibid. p.16.
[16] Ibid. p.18.
[17] Ibid. p.19.

Chairman BROOKS. The Subcommittee on Research and Science Education will come to order.

Mr. Lipinski, the Ranking Member, is not yet here but we are going to go ahead and proceed without him inasmuch as we do have two other Members of the minority party present. When Mr. Lipinski does arrive, then if we have already passed the point at which he makes his opening statement, we will give him the opportunity to do so. If we haven't reached that point, well, then he will make his opening statement in the normal course of events.

Good morning, everyone. Welcome to today's hearing entitled "The Relationship Between Business and Research Universities: Collaborations Fueling American Innovation and Job Creation. The purpose of this hearing is to examine partnerships and collaborations between industry and research universities.

In front of you are packets containing the written testimony, biography, and truths-in-testimony disclosures for today's witnesses.

I now recognize myself for five minutes for an opening statement.

We are pleased to welcome this distinguished panel of witnesses to examine partnerships and collaborations between industry and research universities. I look forward to working with my fellow Members of this Subcommittee to learn more about these important relationships.

The fundamental basic research taking place at U.S. research universities is essential to the future prosperity of our Nation. Collaboration between business and academia helps fuel research necessary for American innovation and helps prepare a workforce that meets the needs of industry. Both are critical components to future economic prosperity and job growth.

As we discussed in a previous Subcommittee hearing in June, the National Academies report entitled "Research Universities and the Future of America: Ten Breakthrough Actions Vital to Our Nation's Prosperity and Security," asserts that "business and industry have largely dismantled the large corporate research laboratories that drove American industrial leadership in the 20th century, such as Bell Labs, but have not yet fully partnered with research universities to fill the gap at a time when the new knowledge and ideas emerging from university research are needed by society more than ever." This report asserts an important role for industry to play in maintaining the strength of the Nation's research universities. The report also asserts that "business is the channel through which basic ideas developed in research universities reach the marketplace."

The report recommends that America strengthen businesses' role in research partnerships, reform graduate education, and reduce regulatory burden for U.S. research universities as part of its 10 stated actions to support the future of United States research universities. Today, we will hear from witnesses representing industry and academia and learn more about what these collaborations hold for the stakeholders and students, how they take shape and evolve, and if and how they can continue to be strengthened.

I look forward to learning more from our witnesses, and how this Subcommittee and Congress can institute policies which help rather than hinder industry and research universities.

Thank you again to our witnesses for taking the time to be with us today.

And the Chair now recognizes Mr. Lipinski from the great State of Illinois for an opening statement.

[The prepared statement of Mr. Brooks follows:]

PREPARED STATEMENT OF CHAIRMAN MO BROOKS

Good morning. We are pleased to welcome this distinguished panel of witnesses to examine partnerships and collaborations between industry and research universities. I look forward to working with my fellow Members of this Subcommittee to learn more about these important relationships.

The fundamental basic research taking place at U.S. research universities is essential to the future prosperity of our Nation. Collaboration between business and academia helps fuel research necessary for American innovation and helps prepare a workforce that meets the needs of industry. Both are critical components to future economic prosperity and job growth.

As we discussed in a previous Subcommittee hearing in June, the National Academies report, *Research Universities and the Future of America: Ten Breakthrough Actions Vital to Our Nation's Prosperity and Security*, asserts that "business and industry have largely dismantled the large corporate research laboratories that drove American industrial leadership in the 20th century, such as Bell Labs, but have not yet fully partnered with research universities to fill the gap at a time when the new knowledge and ideas emerging from university research are needed by society more than ever." The report asserts an important role for industry to play in maintaining the strength of the Nation's research universities. The report also asserts that "business is the channel through which basic ideas developed in research universities reach the marketplace."

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I look forward to learning more from our witnesses, and how this Subcommittee and Congress can institute policies which help rather than hinder industry and research universities. Thank you again to our witnesses for taking the time to be here with us today.

Mr. LIPINSKI. I thank you, Chairman Brooks. Thank you for holding this hearing. And thank you, witnesses, for being here this morning.

I would like to give a special thanks to Dr. Graziano for being here today after agreeing to testify just three days ago and to Chairman Brooks and his staff for their flexibility in adding Dr. Graziano as a witness.

I could not have selected a more apt hearing title myself. Norman Augustine, the former CEO of Lockheed Martin, likes to describe scientific research as the engine of a thought-based economy. To paraphrase him further, if your plane is too heavy to fly, you don't toss out the engine. I couldn't agree more, which is why even in these tight budget times I continue to believe that we must sustain our investments in scientific research, which means sustaining our investments in our world-class research universities.

But it takes more than just the engine to fly a plane. It takes a system of components working together. In this case, the path from the lab bench to innovation and job creation depends on a complicated network of private companies, scientists, universities, venture capitalists, startups, and entrepreneurs. And today, as the most important question that we are facing is where are the jobs

going to come from in America today and in the future, I think innovation is the key. It is something I have focused on since even before the recession started, since I have been on this committee for the past 7–1/2 years is we need to promote innovation in this country, and we have great research universities, national labs, fantastic research, the best in world, going on. We need to do a better job of turning that research into innovation and into jobs.

At the June 27 hearing that the Subcommittee held, we heard from several university leaders representing a diverse set of research universities about the nature of their partnerships with industry and their efforts to promote entrepreneurship on their own campuses. At a July 16 field hearing in Chicago, we heard from research faculty and experienced entrepreneurs how the NSF Innovation Corps Program is helping to drive entrepreneurship and commercialization of university research.

I am pleased that today we get to hear about some of the same issues from the perspective of business leaders whose companies actively partner with research universities, as well as the head of a research corporation at a major research institute.

One of the topics I would like to explore further is the role of the federal science agencies such as the National Science Foundation in facilitating and contributing to university-industry partnerships and to hear from witnesses about what is working well and where we can make improvements. The Federal Government can use many mechanisms to promote collaboration between the business and university communities. These include tax incentives such as R&D tax credit, direct support for university-based research centers that require or encourage industry partners, or convening university and industry stakeholders around areas of shared interest. These also include programs such as NSF is Innovation Corps, an education program which helps federally funded research innovations transition from the university lab into a profitable company.

While limited partnerships around easily definable milestones are valuable and should continue, our ultimate goal is to promote the creation of innovation ecosystems within which universities, businesses, research institutes, and other stakeholders build and sustain long-term and mutually beneficial collaborations.

In the last hearing, university leaders talked about the need to move more collaboration closer to this kind of peer-to-peer relationship. I would be interested in hearing the perspective of today's panel on that issue.

Finally, I would like to hear from our witnesses their thoughts on STEM education, and in particular how their companies can better partner with universities to ensure that they are producing graduates with the skills, including the soft skills, that meet the needs of today's industries.

I think the data on the supply and demand for STEM workers is variable enough that is difficult to generalize across all sectors of our economy or all levels of education. But as leaders from large companies with significant STEM workforce needs, you are well positioned to help us understand current and future demand in your respective industries.

Once again, I thank all of the witnesses for being here this morning and I look forward to your testimony. Thank you.

[The prepared statement of Mr. Lipinski follows:]

PREPARED STATEMENT OF RANKING MEMBER DANIEL LIPINSKI

Thank you Chairman Brooks for holding this hearing, and thank you to the witnesses for being here this morning. And I'd like to give a special thanks to Dr. Graziano for being here today after agreeing to testify just three days ago, and to Chairman Brooks and his staff for their flexibility in adding Dr. Graziano as a witness.

I could not have selected a more apt hearing title myself. Norm Augustine, the former CEO of Lockheed Martin, likes to describe scientific research as the "engine of a thought-based economy." To paraphrase him further, if your plane is too heavy to fly, you don't toss out the engine. I couldn't agree more, which is why even in these tight budget times I continue to believe that we must sustain our investments in scientific research, which means sustaining our investments in our world-class research universities.

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At the June 27 hearing we heard from several university leaders representing a diverse set of research universities about the nature of their partnerships with industry and their efforts to promote entrepreneurship on their own campuses. At a July 16 field hearing in Chicago we heard from research faculty and experienced entrepreneurs how the NSF Innovation Corps program is helping to drive entrepreneurship and commercialization of university research.

I am pleased that today we get to hear about some of the same issues from the perspective of business leaders whose companies actively partner with research universities, as well as the head of a research corporation at a major research institute.

One of the topics I'd like to explore further is the role of federal science agencies such as the National Science Foundation in facilitating and contributing to university-industry partnerships, and to hear from witnesses about what's working well and where we can make improvements. The federal government can use many mechanisms to promote collaboration between the business and university communities. These include tax incentives such as the R&D tax credit, direct support for university-based research centers that require or encourage industry partners, or convening university and industry stakeholders around areas of shared interest. These also include programs such as NSF's Innovation Corps, an education program which helps federally funded research innovations transition from the university lab into a profitable company. While limited partnerships around easily definable milestones are valuable and should continue, our ultimate goal is to promote the creation of innovation ecosystems within which universities, businesses, research institutes, and other stakeholders build and sustain long-term and mutually beneficial collaborations. In the last hearing, university leaders talked about the need to move more collaboration closer to this kind of peer-to-peer relationship. I'd be interested to hear the perspectives of today's panel on that issue.

Finally, I'd like to hear from our witnesses their thoughts on STEM education, and in particular how their companies can better partner with universities to ensure that they are producing graduates with the skills, including the soft skills, that meet the needs of today's industries. I think the data on the supply and demand for STEM workers is variable enough that it is difficult to generalize across all sectors of our economy, or all levels of education. But as leaders from large companies with significant STEM workforce needs, you are well positioned to help us understand current and future demand in your respective industries.

Once again, I thank all of the witnesses for being here this morning and I look forward to your testimony.

Chairman BROOKS. Thank you, Mr. Lipinski.

If there are other Members who wish to submit additional opening statements, your statements will be added to the record at this point.

Chairman BROOKS. At this time, I would like to introduce our witness panel for today's hearing. Our first witness will be Mr. William D. Green, Executive Chairman for Accenture. In addition to chairing the Board of Directors, Mr. Green works closely with the leadership team on Accenture's long-time—excuse me—long-term

business strategy. He has served on Accenture's Board of Directors since its inception in 2001. From September 2004 through December 2010, Mr. Green served as Accenture's Chief Executive Officer. He assumed the additional role of Chairman in 2006. Thank you, Mr. Green.

Our second witness is Dr. Ray O. Johnson, Senior Vice President and Chief Technology Officer for Lockheed Martin Corporation. As an officer of the corporation and a member of the Executive leadership team, Dr. Johnson guides Lockheed Martin's technology vision and provides corporate leadership in the strategic areas of technology and engineering. Dr. Johnson currently chairs the United States Council on Competitiveness, Technology Leadership, and Strategic Initiative.

Our third witness is Dr. John S. Hickman, who is the Director of Global University Relations and Life Sciences for Deere and Company. The Global University Relations group is developing and sustaining a global network of university relationships to support Deere and Company's strategic business objectives. Prior to joining John Deere, Dr. Hickman worked as a faculty member at Kansas State University specializing in soil management and environmental quality.

Our fourth witness is Dr. Louis Graziano, Director of University Research and Development Strategy for Sustainable Technologies and Innovation Sourcing for the Dow Chemical Company. In 1981, Dr. Graziano joined with Rohm and Haas Company in Philadelphia, Pennsylvania, and held research management positions in adhesives, biocides, and codings. In 2005, he took a leadership role in external technology building collaborations and partnerships with universities, federal agencies, and industry partners. Dr. Graziano continued in that role when Rohm and Haas was acquired by the Dow Chemical Company in 2009.

Our final witness, who happens to—I have just discovered—come from my hometown is Ms. Jilda Diehl Garton, Vice President for Research and General Manager of the Georgia Tech Research Corporation for the Georgia Institute of Technology. Georgia Institute of Technology is a comprehensive university which reported over $655 million in research expenditures for fiscal year 2011. Ms. Garton is responsible for the financial and business affairs of Georgia Tech Research Corporation, including technology transfer and research contracting. Ms. Garton joined Georgia Institute of Technology in 1998.

As our witnesses should know, spoken testimony is limited to five minutes each, after which the Members of the Committee will have five minutes each to ask questions.

I now recognize our first witness, Mr. William Dr. Green. And Mr. Green, thank you for being here, and you are recognized for five minutes.

STATEMENT OF MR. WILLIAM D. GREEN, EXECUTIVE CHAIRMAN, ACCENTURE

Mr. GREEN. Thank you and good morning, Chairman Brooks, Ranking Member Lipinski, and the entire Subcommittee, for the opportunity to testify before you today on a subject that I am extremely passionate about.

I am the Executive Chairman of Accenture. I previously served as its CEO. I have been with Accenture for 34 years starting directly out of college. I also recently had the honor of serving as a member of the Committee on the National Research Universities of National Research Council.

I am testifying today in my capacity of the Chairman of the Board of Accenture to discuss the relationship between business and our national research universities, which is critical to the future prosperity and security of our Nation. I will also discuss my own experience at Accenture and I will draw upon the work of the Committee on Research Universities that I believe is so profoundly important.

Accenture is a global management consulting and technology services company with over 250,000 employees serving clients in 120 countries. We are proud that more than 37,000 of those employees are based here in the United States, and last year, we hired more than 5,000 people in the United States, many of whom came to us directly from college campuses.

Representative Hultgren knows about our investment and talent in human capital since he recently visited our training facility outside of Chicago. Each year, we send 25,000 employees to train at this particular facility. In fiscal year 2011 we spent close to $50 million on that training. Congressman Lipinski, I am sure, knows about our work with city colleges in Chicago and the Skills for Chicagoland's Future that we are involved in a great deal.

Accenture has traditionally been one of the top college campus recruiters in the United States, hiring people with undergraduate and advanced degrees, and we thank Georgia Tech for their contributions to our company as well.

Global competitiveness is the key CEO issue, and having the talent to compete is what keeps CEOs up at night. The companies and the countries with the best talent win. I think we have learned that in the last few years. To sustain our standards of living—to lead, to ignite our economic growth engines—it is about talent, research, and innovation. It is that simple.

Our national research universities are our secret weapons. They are a national asset we have invested in for decades. Every country—and I have traveled to 40 or so countries in the last year or so—every country wants to build the capability we have. And we need to be gone when they get there. And gone means by investing and leveraging our research universities to fuel an economic renaissance that we have—the likes of which we have never seen before and taking full advantage of this incredibly precious asset.

We found a shortage of talent in this country, especially with people with background in the STEM areas. At the same time, there is very little recognition of the vast power and potential at our fingertips within these institutions across government, across society, and unfortunately, across business. And it is time that we seize that opportunity, particularly business.

The National Academy report provides a compelling review of the strengths and challenges of our research universities, the opportunities they confront moving forward. It also recommends 10 steps that state and Federal Government, universities, and businesses can take to strengthen our country's university research.

There were three really broad goals in there. First, strengthening the partnerships among universities, federal, state governments, philanthropy, and business. Second, improving the productivity and administrative operations in research and education within the universities, how they operate themselves, how do we get more value for money? And finally, ensuring that America's pipeline of future STEM talent remains creative and vital, leveraging the abilities of all its citizens and attracting the best students and scholars from around the world.

There were four major recommendations in there that very much focused on business, accelerating strategic partnerships and more collaboration to reduce the time to innovation. Reforming and creating new graduate degree programs were business helps shape the outcome we want not for the jobs of today but for the jobs of tomorrow. Focusing on the STEM pathways and diversity to get a bigger percentage of our people engaged in these exciting disciplines. And lastly, focusing on the international students and scholars, the people we train that are some of the world's best that we can allow them to be here and contribute to our economy.

People with graduate degrees drive research and development in profound ways. The Commission on Pathways through Graduate School and Into Careers, on which I also served, has incredible, you know, direction on improving the role and the collaboration between business and our research universities broadly.

I would just talk for a minute about Accenture's university partnerships. At Accenture we collaborate with major research initiatives in a variety——

Mr. BROOKS. Excuse me, Mr. Green, we are about a minute over on your 5-minute allotment. If you could please wrap up, we would appreciate it. We do have your full testimony in writing as a part of our record.

Mr. GREEN. I shall do that right now.

Mr. BROOKS. Thank you.

Mr. GREEN. Accenture is a company that lives by talent, 5,000 people hired in the United States. The best people that are in the best companies are the ones that win, and we have invested hundreds of millions of dollars in the research infrastructure. And what we need to do as a company and with other companies is to do more to make a difference, to harvest the unique asset that we have.

Thank you, Chairman.

[The prepared statement of Mr. Green follows:]

Statement of

William D. Green

Executive Chairman of the Board, Accenture

and

Member, Committee on Research Universities
Board on Higher Education and Workforce
Policy and Global Affairs
National Research Council
The National Academies

before the

Subcommittee on Research and Science Education
Committee on Science, Space, and Technology
U.S. House of Representatives

THE RELATIONSHIP BETWEEN BUSINESS AND RESEARCH UNIVERSITIES
Collaborations Fueling American Innovation and Job Creation

August 1, 2012

Good morning, and thank you Chairman Brooks, Ranking Member Lipinski and the entire subcommittee for the opportunity to testify before you today on a subject I am extremely passionate about.

My name is William Green, and I am the Executive Chairman of Accenture. I previously served as Chief Executive Officer from September 2004 to December 2010. I have been with Accenture for more than 34 years, and during my tenure as CEO, our global employee population doubled.

I also recently had the honor of serving as a Member of the Committee on Research Universities of the National Research Council.

I am testifying today in my capacity as Chairman of the Board of Accenture to discuss the relationship between business and our national research universities, which is critical to the future prosperity and security of our nation. In addition to discussing this issue with you based on my own experience at Accenture, I will draw upon the work of the Committee on Research Universities, which is detailed in its report, *Research Universities and the Future of America: Ten Breakthrough Actions Vital to Our Nation's Prosperity and Security*.

Accenture is a global management consulting and technology services company with over 250,000 employees serving clients in more than 120 countries. We are proud that more than 37,000 of those employees are based here in the United States, and last year, we hired more than 5,000 people in the U.S., many of whom came to us directly from college campuses.

Accenture has traditionally been one of the top college campus recruiters in the United States, hiring people with undergraduate and advanced degrees.

Accenture's business is helping companies and organizations improve their performance and competitiveness. We serve most of the global *Fortune* 500 companies, and I am privileged to see firsthand how critical skills, knowledge, technology and innovation are as the essential differentiators in competitiveness, high quality jobs and rising standards of living.

Global competitiveness is the key CEO issue, and having the talent to compete is what keeps CEOs up at night. The companies -- and the countries -- with the best talent win.

To sustain and enhance our standards of living -- to lead, and to ignite our economic engines to win -- it is about talent, research, and innovation.

Our national research universities are our secret weapons. They are a national asset we have invested in for decades. In fact, last year, I traveled to more than 40 countries. Every country wants to build national assets like we have, and they will. We must aggressively leverage this national asset to fuel our economic renaissance. Our universities are underutilized and underleveraged. We have a strength here we must utilize.

We have a profound shortage of talent, especially people with a background in science, technology, engineering and mathematics -- the STEM disciplines that are so critically important today. We have little recognition of the vast power and potential at

our fingertips with these institutions, across government, society, and business. It is time to seize this opportunity!

National Academy of Sciences Report

The NAS report – *Research Universities and the Future of America* – provides a compelling review of the strengths and challenges of our research universities and the opportunities and threats they confront as they move forward.

It also recommends 10 strategic steps that the federal government, state governments, universities and business can take to strengthen our country's university research. The recommendations are designed to accomplish three broad goals:

(i) strengthen the partnership among universities, federal and state governments, philanthropy and business in order to revitalize university research and speed its translation into innovative products and services;

(ii) improve the productivity of administrative operations, research and education within universities; and

(iii) ensure that America's pipeline of future talent in science, engineering and other research areas remains creative and vital, leveraging the abilities of all of its citizens and attracting the best students and scholars from around the world.

Several of those recommendations focus on the need to develop new, enhanced partnerships between universities and business to prepare the next generation of talent,

build an innovation-driven economy, ignite our economic engines, and create new jobs with rising wages and standards of living.

Some highlights of the recommendations include:

#3 Accelerate Strategic Partnerships with business collaboration on research

- Improve time to innovation
- Create an "outcomes multiplier"
- Leverage assets and funding

8 Reform/Create new Graduate Degree programs. Business involvement to:

- Define Business Human Capital needs
- Shape curriculums to fill skill gaps
- Prepare for "jobs of the future"
- Create more "inspiration" of career potential
- Improve attrition rates

#9 STEM Pathways and Diversity

- Help institutions improve outcomes

#10 International Students and Scholars

- advocacy for attracting and keeping them

Pathways Through Graduate School and Into Careers

People with graduate degrees drive research and development which fuels U.S innovation and job creation. The Commission on Pathways through Graduate School and Into Careers, on which I served, urges increased attention to the issue of preparing graduate students for the broad array of careers available in the 21st century.

Among other things, the report specifically recommends enhancing professional development and training opportunities for graduate students, and increasing collaboration between higher education and business/industry.

I urge business leaders, as well as policymakers, to maintain investments in our graduate education system, so that investments are aligned with talent development to address key state and national needs and priorities.

Training the Next Generation of Business Leaders

The NAS report found that businesses and universities should work closely together to develop talent. Again, talent is the great differentiator in the 21st century. Firms with the best talent win. Nations with the best talent lead. Our research universities have an excellent track record in turning out the talented individuals who have driven innovation over the last 50 years, by building the country's academic bench strength and supplying U.S. industry with the best, brightest and most innovative people. However, we must do more.

Experiments with graduate education, such as the professional science masters (PSM) program, have shown that deeper collaboration between graduate programs and

employers are able to address both the career aspirations of students and the strategic workforce needs for science-based employers.

As the report urges, employers – businesses, government agencies and non-profits – that hire masters and doctorate level graduates should more deeply engage with the programs being developed by research universities. They should provide internships, student projects, advice on curriculum design and real-time information on employment opportunities.

Businesses should seize opportunities to incentivize early stage research collaboration with universities. Over the last several decades, industry has largely dismantled the large corporate research laboratories that drove American industrial leadership in the 20th century (e.g., Bell Labs), but it has not yet fully partnered with research universities to fill the gap. Nor has it adequately partnered with university programs to help produce the advanced graduates that industry needs.

Let me take just a minute to discuss some of Accenture's partnerships with universities, which have proven to be highly rewarding.

Accenture's University Partnerships

At Accenture, we collaborate on major research initiatives in a variety of ways. For example, through the Accenture Institute for High Performance, we've teamed with research institutions on the performance of American companies in the global economy, the implications of new information technologies on business and how to address the U.S. talent gap. These collaborative programs help us bring the best new thinking into

our research, forecasting and technology, which we can apply to our own business and to finding solutions to mission-critical problems for U.S. business.

The Institute has also conducted research with individual faculty to create specific deliverables such as tools for use in capability development, articles, data analysis and presentations at Accenture workshops. We have teamed on specific client engagements, including hiring faculty to serve as subject matter experts, and we have hired interns from graduate programs to participate in ongoing research projects at the Institute.

The Institute maintains an extensive network of relationships with individual faculty and research centers as a result of its publications. It provides peer reviewers in numerous academic publications and participates in professional societies and meetings, such as the Academy of Management, the Strategic Management Society, the Marketing Sciences Institute, the International Consortium for Executive Development Research and the Institute of Electrical and Electronics Engineers (IEEE). In addition, the Institute maintains a small number of close working relationships with faculty who serve as Institute Fellows.

Over the past five years, Accenture has had relationships with faculty and research centers at Harvard, Massachusetts Institute of Technology (MIT), Wharton, Carnegie Mellon, the University of Chicago, and the University of Virginia, among others.

At MIT, we have a joint research venture in the area of analytics to solve complex problems. At Harvard University, we are currently participating in a joint research and writing project on CEOs' perspectives on global talent management. At Babson

College, we are working on analytics strategy, which has led to the publication of two best-selling books and the formation of a new Analytics Business at Accenture.

In the area of cyber security, a popular topic with governments and the business community, Accenture funded and collaborates with the International Cybersecurity Center at George Mason University.

Accenture has also had a relationship that has lasted more than 10 years with the Software Engineering Institute (SEI) at Carnegie Mellon University. SEI is a Federally Funded Research & Development Center (FFRDC) that was established in 1984. Its focus is on software engineering-based improvements.

Developed by SEI, the Capability Maturity Model Integration for Development, CMM-DEV, in particular, is one of the most used quality models in the world and is the de facto standard for software development improvement. Accenture was one of SEI's earliest business partners and began implementing its models with clients in the mid-1990s.

Today, our partnership with SEI continues. A number of Accenture employees are certified appraisers and instructors, our business teams provide some client consulting related to implementation of SEI products, and we have also used the standards and models created by SEI for our own corporate benefit. Accenture is one of the largest users of the standards in the world, and we currently apply them to our largest delivery centers.

Mr. Chairman, as you know, our nation faces many business and economic challenges. Successfully meeting those challenges requires us to have a laser focus on

repurposing and leveraging our unique educational assets and research engines. Much of our past economic success and improved standard of living in the U.S. can be attributed to collaboration between government and our research universities.

By deepening and enhancing that collaboration, and aligning our businesses closely with them, we can ignite our next economic renaissance, creating innovation-driven, globally-competitive companies and jobs with rising wages that support improved standards of living.

Thank you for this opportunity to address the subcommittee on these issues so critical to our nation and our future.

Chairman BROOKS. Thank you for bearing with our time limitations.

At this point, the Chair will recognize our second witness, Dr. Ray O. Johnson, for five minutes.

Dr. Johnson, thank you for sharing your insight with us today.

STATEMENT OF DR. RAY O. JOHNSON,
SENIOR VICE PRESIDENT AND
CHIEF TECHNOLOGY OFFICER,
LOCKHEED MARTIN CORPORATION

Dr. JOHNSON. Thank you, Mr. Chairman. Good morning.

Chairman Brooks, Ranking Member Lipinski, distinguished Members of the Committee, I thank you for this opportunity to participate in today's hearing. On behalf of the 62,000 engineers, scientists, and IT professionals at Lockheed Martin and the greater population of 120,000 employees, we appreciate this opportunity to discuss the relationship between business and academia. With your permission, I will submit a prepared statement for the record and now offer a brief summary. Thank you, sir.

As Senior Vice President and Chief Technology Officer at Lockheed Martin, I guide the Corporation's technology vision and provide corporate leadership in the strategic areas of technology and engineering across a portfolio of more than 4,000 programs. I am extremely proud of the work of my colleagues and our university partners.

University collaboration is an inherent part of our company's innovative culture. We proactively develop and maintain relationships with universities and academic institutions globally. Our goal is to facilitate, encourage, and enable utilization of university research and the resultant insertion of the university technology in our programs and products. For 2012, we plan to make research and development contributions to universities of approximately $20 million.

While we invest in a wide variety of technical domains, we are increasingly concentrating our efforts in fewer, larger partnerships with universities in strategic areas such as nanotechnology, advanced materials, and cybersecurity. Some of our relationships span literally decades. Others are more recent. What you will see throughout is our pursuit of game-changing innovations, not inventions, not evolutionary improvements. We work with universities because their inventions become the basis for our innovations. They help us reach critical milestones in the delivery of affordable solutions to our customers.

Our collaboration with universities extends beyond research and development to talent acquisition. Lockheed Martin is a large employer of entry-level talent, recruiting close to 1,800 full-time intern and co-op students annually. Over 75 percent of our skill needs are for technical talent. To meet those needs, we have established relationships of mutual benefit with over 100 U.S. colleges and universities. We develop relationships with faculty, staff, and student organizations throughout—through activities such as curriculum development, classroom presentations, advisory board participations, and scholarships. We seek partnerships with institutions known for academic excellence, diversity, and research expertise. These

schools also are often the top universities where we sponsor research.

For all the benefits the university collaboration provides, Lockheed Martin, like many companies in the present economic reality, is aggressively reducing costs. This reality is putting increased pressure on research funding. Sponsored research generally advances knowledge within a domain in the form of research results, papers, and presentations. The positive financial implications of this work often occur over time horizons that stretch far beyond immediate sales forecasts. Sometimes, university research is necessarily reduced when weighed against more critical expenses that have more near-term impact.

There is also a perception that university research agreements are exceptionally difficult to negotiate, specifically with regard to intellectual property or IP rights. Generally, we are able to negotiate the rights we need while still allowing the university the freedom to pursue its own activities. However, we have noticed an increased reluctance from universities to grant IP rights to certain research sponsors.

Despite these challenges, industry, including Lockheed Martin, has and will continue to play an important role in the future of university research. Businesses will continue to make investments as they look to diversity into new markets and domains.

The National Academy of Sciences report that we are discussing today offers several important recommendations to help overcome the existing challenges and enable even greater collaboration. There are three recommendations that we consider among the top priorities. They are recommendation one, concerning the adoption by the Federal Government of stable and effective polices, practices, and funding for university-performed research and development; recommendation three on the strengthening of the business role and the research partnership facilitating the transfer of knowledge, ideas, and technology to society; and recommendation nine on securing the full benefits of education for all Americans in science, technology, engineering, and math.

Important is the federal reestablishment of the research and development tax credit, preferably a permanent and enhanced R&D credit when research is performed in the United States, the highly skilled scientists and engineers along with the institutions are maintained and strengthened. However, other countries have introduced strong incentive specifically directed toward research conducted within their borders.

In our opinion, these three recommendations would provide some of the most significant impacts as—and they are attainable. Having consistent policy would provide a stable backdrop for research. Providing for a permanent research and development tax credit would enable companies to make investments in U.S. universities driving wealth and job creation through innovation. Helping students realize their full potential through science, technology, engineering, and math education would guarantee our Nation the next generation of researchers that we so desperately need.

In closing, I want to reiterate my appreciation for the opportunity to join you here today. The Committee is addressing extremely important issues that not only impact American busi-

nesses, but they also have the potential to benefit every person in our country as innovation benefits us all.

Thank you.

[The prepared statement of Dr. Johnson follows:]

Testimony of Dr. Ray O. Johnson
Senior Vice President and Chief Technology Officer
Lockheed Martin Corporation
August 1, 2012

House Subcommittee on Research and Science Education

"The Relationship Between Business and Research Universities; Collaborations Fueling American Innovation and Job Creation"

2318 Rayburn House Office Building

Chairman Brooks, Ranking Member Lipinski, and Members of this Subcommittee:

Thank you for the opportunity to participate in today's hearing. On behalf of the 62,000 engineers, scientists, and IT professionals at Lockheed Martin principally engaged in the research, design, development, manufacture, integration, and sustainment of advanced technology systems, products and services, and the greater population of 120,000 employees, we appreciate this opportunity to discuss the relationship between business and academia.

My name is Dr. Ray O. Johnson, and I am the Senior Vice President and Chief Technology Officer at Lockheed Martin. As an Officer of the Corporation and a member of the executive leadership team, I guide the Corporation's technology vision and provide corporate leadership in the strategic areas of technology and engineering across a portfolio of more than 4,000 programs.

This year, Lockheed Martin celebrates its Centennial anniversary – a one-hundred year legacy of discovery, invention, and innovation that have had a lasting impact on our society...from man's first attempts at flight...to systems for controlling the world's air traffic...to our earliest exploration of space.

Against that backdrop, it is fitting to discuss the tremendous value of the collaboration between business and universities. These relationships lead to the development of new innovations that have a profound impact on our lives and create jobs in this country.

To begin, I would like to share how Lockheed Martin approaches our relationships with universities.

We proactively develop and maintain relationships with universities and academic institutions globally to facilitate, encourage, and enable utilization of university research and the resultant insertion of university technology in Lockheed Martin programs and products. For 2012, we plan to make research and development contributions to universities of approximately $20 million.

While we invest in a wide variety of technical domains, we are increasingly concentrating our efforts in fewer, larger partnerships with universities focusing on the strategic areas of Energy, Nanotechnology and Advanced Materials, Logistics and Sustainment, Cyber Security, and Healthcare.

University collaboration is an inherent part of our Company's innovative culture. Some of our relationships literally span decades, as is the case of the University of Maryland. In 1944, one of our Company's founders, Glenn L. Martin made a gift of $1.7 million to the University with the funds targeted for aeronautical sciences. A second gift, totaling $800,000, followed the next year. These gifts helped the University construct engineering facilities and provide full-time instruction in aeronautical sciences. In fact, one of our heritage companies, the Glenn L. Martin Company, hired the University's first master's level graduate in aeronautical sciences, Mr. Dale Scott.

Over the years, the relationship with the University of Maryland has only intensified. We have hired thousands of Maryland graduates, and many Lockheed Martin executives have served on the school's Boards, including our former, current, and incoming chief executive officers. I currently serve on the Board of Visitors for the Clark School of Engineering. Our investments have helped the school expand its resources; as you walk around the campus, you will see the Lockheed Martin name on several buildings, labs, and rooms.

We entered into a new chapter of our relationship in 2010 with the signing of a strategic agreement that provides the framework for current and future cooperation. The agreement has three target areas. They are the establishment of Centers of Collaboration, the joint pursuit of business opportunities, and enhanced research and development. Our initial commitment is $1 million per year for three years. The focus for much of our work is on cyber security, logistics and sustainment, and energy.

In addition, we are working with nearly two-dozen other U.S. institutions on a number of initiatives, ranging from complex systems and software to energy and sustainability.

One of the areas of greatest university investment for Lockheed Martin is nanotechnology. Since 2007, we have strategically invested in the research, development, and manufacturing of next generation advanced materials and nanotechnology solutions. Through these initiatives, we are advancing the 21st century materials revolution.

As part of these efforts, we entered into a multi-year, multi-million dollar partnership with Rice University in 2008, focused on nanotechnology research. Through this partnership, we created the *Lockheed Martin Advanced Nanotechnology Center of Excellence at Rice University*, otherwise known as LANCER. We are working together today to leverage the science behind nanotechnology in order to produce materials that are more capable, more affordable, and easier to manufacture than ever before.

Our efforts through LANCER are concentrated on materials and composites that can have significant benefits for people, systems, vehicles, and aerospace platforms. Based on the success of this work over the past five years, we are currently in the process of expanding LANCER to a consortium with other institutions to facilitate regional economic development from a broader base of both public and private cooperative investments.

This work is part of a much larger set of Lockheed Martin-led nanotechnology initiatives that have enabled us to develop carbon nano-reinforced polymer materials that are being applied, for example, on the Juno spacecraft. In addition, we are in the beginning stages of establishing an industry-led, multi-sector Carbon Nanostructures Consortium. This Consortium is part of a broader effort, the Materials Genome Initiative, announced by the White House as an ambitious challenge to double the speed and cut the cost of discovering and deploying new advanced materials in the U.S. to revive and revolutionize American manufacturing.

With an investment of $5 million over five years, in 2009, Lockheed Martin became a Sustaining Member of the MIT Energy Initiative, which has an ambitious goal of transforming how the nation produces and consumes energy. The Initiative supports a portfolio of diverse, high-impact energy research projects. We direct a majority of the investment to targeted research in the areas of alternative energy, energy storage and distribution, as well as energy efficiency and management.

I would also like to discuss Orion – a program that this Subcommittee knows well. Lockheed Martin is proud to be a partner with NASA. The Orion program has a planned goal of committing $18 million for historically African American colleges or universities and minority institutions, depending on program budget allocations. Lockheed Martin is also partnered with the University of Texas-El Paso, the nation's largest Hispanic serving university. Students there have performed design and analysis of some crew module structures and mechanisms, and they have also designed and manufactured test fixtures.

This work is exciting for Lockheed Martin and for the students. It inspires these students to consider science and engineering careers. It is interesting to note that in the first week following the Orion award in August 2006, Lockheed Martin and our major teammates opened 1,300 job requisitions for related positions. We received 33,000 responses from qualified individuals, a large percentage of them new college graduates.

The aforementioned are just a few examples of our work with universities; you will see a consistent theme throughout. We are looking for game-changing inventions, not evolutionary improvements, which we can develop into revolutionary innovation. We work with universities because their inventions become the basis for our innovations; they help us reach critical milestones in the delivery of affordable solutions to our customers.

By working with universities, we increase our ability to be innovative by partnering with some of the nation's most renowned thinkers; many with perspectives that are different than our own. Diversity is crucial to innovation, a diverse working group breeds diverse thinking, which is a critical component of invention and innovation.

To begin the research selection process, we share our corporate strategic technology interests with the universities. Based on these strategic interests, the universities bring their research ideas forward. Then Lockheed Martin technical teams meet with the university researchers to select the most promising proposals for funding. This expert-to-expert collaboration leads to research partnerships, which are the most effective way of turning inventions into innovations.

Our collaboration with universities extends beyond research and development to talent acquisition and workforce development.

Lockheed Martin is a large employer of entry-level talent, recruiting close to 1,800 full-time, intern, and co-op students annually. Over 75% of our skill needs are for technical talent. The skills most in demand are computer science, systems engineering, and electrical, computer, mechanical, and aerospace engineering.

To meet those needs, we develop relationships with faculty, staff, and student organizations through activities such as curriculum development, classroom presentations, advisory board participation, sponsorship of senior design competitions, support of student projects and activities, scholarships, and financial support. Through these activities, we have established relationships of mutual benefit with over 100 U.S. colleges and universities. We seek partnerships with institutions known for academic excellence, diversity, and research expertise. Additionally, these schools are often the top universities where we sponsor research.

In terms of curriculum tailoring, we support over 100 advisory boards at universities nationwide. Some examples include our work at UCLA on mechanical and aerospace engineering, at Purdue University on cyber security, and at Texas A&M University on electrical engineering.

In addition, we have supported academic sabbaticals and teaching partnerships with several universities, such as the University of Colorado, Drexel University, and Villanova University.

We also maintain a volunteer staff of technical university liaisons. These senior Lockheed Martin technical experts tend to be university alumni that have a passion for maintaining strong ties between Lockheed Martin and their alma mater.

For all of the benefits that university collaboration provides in terms of research and talent, Lockheed Martin, like many companies in the present economic reality, is aggressively reducing costs. This reality is putting increased pressure on research funding.

Sponsored research generally advances knowledge within a domain in the form of research results, papers, and presentations. The positive financial implications of this work often occur over time horizons that stretch far beyond immediate sales forecasts. Sometimes, university research is necessarily reduced when weighed against more critical expenses that have more near-term impact.

There is also a perception that University Research Agreements are exceptionally difficult to negotiate, specifically with regard to Intellectual Property, or IP, rights. Generally, we are able to negotiate the rights we need while still allowing each university the freedom to pursue its activities. However, we have noticed an increasing reluctance from universities to grant IP rights to research sponsors. As companies across the United States reduce their research investments, universities are seeking other sources of income to compensate, and some universities appear to regard IP as a source of future licensing revenue or the foundation for spinning off potential start-up companies. Consequently, in rare occasions, we are not able to come to agreement over the rights that we need to make the financial investment in a given area of research. For some companies, though, this growing IP struggle may have the unintended consequence of reducing corporate appetites for collaborative research, thus stranding high-potential ideas.

Despite the aforementioned challenges, industry has and will continue to play an important role in the future of university research. Businesses will continue to make investments as they look to diversify into new markets and domains. University research provides fundamental scientific and technological knowledge that underlie breakthroughs – the inventions. Businesses will likely continue to grow both their talent pools through targeted talent acquisition and their knowledge and capabilities through strategic, sponsored research. Research is fundamental to innovation, economic development, and maintaining national security.

The National Academies report titled "*Research Universities and the Future of America*" offers several important recommendations to help overcome the existing challenges and enable even greater collaboration among business and universities. We would like to address the three recommendations that we consider among the top priorities.

Recommendation #1. We strongly endorse the adoption by the federal government of stable and effective policies, practices, and funding for university-performed R&D and graduate education. Innovation can be a fragile process, and budget constraints and uncertainties can cause significant delays, sometimes derailments, and the loss of technical talent. By having a secure financial backdrop, researchers can focus on their research, and we continue to produce the science, technology, engineering, and math, or STEM, graduates that are vital to our economic security.

Recommendation #3. We strongly endorse the need to strengthen the business role in the research partnership, facilitating the transfer of knowledge, ideas, and technology to society and accelerating the "time-to-innovation" in order to achieve our national goals.

Especially important is the federal re-establishment of the research and development tax credit, preferably a permanent and enhanced R&D Credit. The United States has long led the world in science and technology by nearly any measure, from the disproportionate number of Nobel Prizes awarded to scientists working domestically to the preeminence of American military hardware. This leadership generates high-skill, high-wage jobs, both for those who perform the research and those who manufacture the products derived from the research and development. When R&D is performed in the U.S., the highly skilled scientists and engineers along with the institutions, including universities that train and develop this workforce, are maintained and strengthened. However, other countries have introduced even stronger incentives or outright subsidies specifically directed toward R&D activity within their borders.

As the Committee is aware, the current credit expired, along with other business tax extenders, at the end of 2011. The uncertainty and unpredictability that result from the temporary status of the R&D Credit in the United States further dampens its effectiveness as an inducement to engage in long-term R&D projects. The lapse or extinguishment of this tax credit could have a chilling impact on research investments at the university level.

Recommendation #9. We strongly support securing for the United States the full benefits of education of all Americans, including women and underrepresented minorities, in science, technology, engineering, and math. My own childhood experiences emphasize for me the importance of this recommendation.

For example, as a teenager, I enjoyed putting together kits that contained all of the components for a piece of electronics. The projects were very satisfying to me, because I was able to build my own clock or television.

Those projects increased my love of science and mathematics – so much so that I went on to earn a Ph.D. in electrical engineering. As with students today, these hands-on activities helped me move from the theoretical side of technology, taught in the classroom, to the practical side, learned by doing.

On a personal level, my hope is that children across the country – especially those from underrepresented groups – are exposed to science, technology, engineering, and math, and that they are excited by what they can achieve with a STEM education.

On a professional level, there is generally an increasing competition among employers for skilled technical U.S. talent. As I mentioned earlier, Lockheed Martin is one of the largest employers of entry-level technical talent in the U.S. We need to ensure the development of the next generation of engineers, computer scientists, researchers, and technologists. However, demand for this expertise exceeds the supply by 2.5 to 1. I have a growing concern that countries that produce a greater number of STEM graduates will challenge the United States' competitiveness. Part of how you address concerns about competitiveness is to make sure we are developing a workforce that is simply the best.

As I indicated earlier, the report has many important recommendations. In our opinion, the three that I discussed would provide some of the most significant impacts and they are attainable. Having consistent policies would provide a stable backdrop for research. Providing for a permanent R&D tax credit would enable companies to make investments in U.S. universities, driving wealth and job creation through innovation. Helping students realize their potential through science, technology, engineering, and math education would guarantee our nation the next generation of researchers that we so desperately need.

In closing, I want to reiterate my appreciation for the opportunity to join you today. The Committee is addressing extremely important issues that not only impact American business, but they also have the potential to benefit every person in our country, as innovation benefits us all.

Chairman BROOKS. Thank you, Dr. Johnson.

The Chair now recognizes our third witness, Dr. John S. Hickman.

Dr. Hickman, five minutes.

STATEMENT OF DR. JOHN S. HICKMAN, DIRECTOR, GLOBAL UNIVERSITY RELATIONS AND LIFE SCIENCES, DEERE AND COMPANY

Dr. HICKMAN. Good morning and thank you.

I am the Director of Global University Relations and Life Sciences at Deere & Company, and I am pleased to have this opportunity to share our perspectives on collaborations with research universities and how that impacts both people and innovation at Deere.

Deere & Company is a leading global manufacturer of agricultural, construction, forestry, turf care equipment. Our strategic direction reflects on the very important role that innovation is going to play in addressing two important challenges for the world—how to feed a population growing in size and affluence and, at the same time, develop the infrastructure required to support massive urbanization.

Regarding innovation, we are seeing the rise of smart machines, equipment that is monitored and directed by computers, global positioning systems, sensors, and actuators to ensure safer and more efficient operation. Simultaneously, we see an increase in frugal innovation or value innovation that is very important to our company. Frugal engineering requires a very intensive focus on the customer so you precisely deliver the features that they need at a price the customers can afford to pay.

Now, no one company has all the resources to develop, maintain, support the innovation being demanded by industry. Especially moving in the future, we understand the need to partner with others such as universities. Aside from the role that research universities play in innovation, research universities are very important in attracting and developing employees and understanding at times our customers' local needs both today and into the future. All of these critical—are considered critical success factors helping us meet our global business aspirations.

Deere formed a Global University Relations Initiative in 2011. The initiative is to develop and sustain alignment among the strong university relationships currently in place today and guide direction for those universities we are going to need globally moving into the future. And research universities play a very important role in this initiative.

We have a broad reach of R&D activities—innovation activities at U.S. research universities. Historically, the majority of our research efforts have been with faculty and colleges—or students, excuse me—faculty and students in the College of Engineering. However, research activities occur across many parts of campus. Many of our research projects would be classified as sponsored research. They have comprehensive legal agreements but there are other types of research activities including professional service agreements, consulting agreements, memberships in consortiums, equipment loans, research gifts, and grants.

At Deere, we really like to focus on the complementary benefits we can achieve through our collaborations with universities, so the win-wins we can achieve for both parties. Industry plays a very important role in advising universities as to the relevance of research and workforce development. In being able to address both current and future business needs is part of that win-win. We encourage our employees at John Deere to make sure that they engage in the university in reviewing curriculums, serving on advisory councils and advisory boards, participating in federal grants, getting in the classrooms, and so on. At some universities we have a physical presence right on or very near campus. One example of that is our John Deere Technology and Innovation Center that is located in Champaign, Illinois.

Where we expect to have significant research activities with the university, we try and negotiate a Master Research Agreement between Deere and the university. That Master Research Agreement addresses the various IP publication confidentiality, all the sort of difficult legal issues and makes forming subsequent research projects a very simple process moving forward. The long period of time to negotiate a research agreement is the most frequently mentioned challenge associated with university-industry relationships.

We are also members of a couple of organizations or forums with organizations that can help us specifically address collaboration opportunities and the dynamics of industry-university relationships. Two organizations are convened by the National Academies, and they include the Government University-Industry Research Roundtable and the University-Industry Demonstration Partnership. These organizations have a variety of materials that can help out, including continuums and research guidebooks. Researchers from industry and universities have gotten together to develop these materials. Such organizations help us focus on the opportunities rather than the challenges associated with these relationships.

And again let me reiterate Deere's appreciation for this opportunity to appear before the Committee today and I would be pleased to address your questions later in the hearing. Thank you very much.

[The prepared statement of Dr. Hickman follows:]

Statement of

Dr. John S. Hickman
Director, Global University Relations and Life Sciences
Deere & Company

Before the

Subcommittee on Research and Science Education
Committee on Science, Space and Technology
U.S. House of Representatives

For the Hearing on

The Relationship Between Business and Research Universities: Collaborations Fueling American Innovation and Job Creation

1 August 2012

Good morning.

My name is John Hickman, and I am the director of Global University Relations and Life Sciences with Deere & Company.

I am pleased to have this opportunity to share Deere & Company's perspectives on our collaboration with U.S. research universities and how that impacts both people and innovation in the company.

Deere & Company is a leading global manufacturer of agricultural, construction, forestry and turf care equipment, and provides advanced products and services, including financial services, to customers whose work is linked to the land - those who cultivate, harvest, transform, enrich and build upon the land to meet the world's dramatically increasing need for food, fuel, shelter and infrastructure. We are headquartered in Moline, Illinois, with sales in over 100 countries and more than 60,000 employees globally. Founded in 1837, this year Deere is celebrating its 175th anniversary of delivering innovative products of superior quality built on a tradition of integrity.

The world faces two major challenges in coming decades: How to feed a population growing in size and affluence and, at the same time, how to develop the infrastructure required to support massive urbanization. Deere is strongly and uniquely positioned to help our customers meet both challenges by providing premier equipment solutions. In so doing, we are supporting a higher quality of life around the world. We find our passion – and our purpose – in helping customers do their life's work more profitably and more productively.

Our products help our customers use the land to do their work in intelligent and sustainable ways. Our research and development efforts are aimed at creating the high-quality equipment solutions which customers can rely on to run their businesses – allowing them to be more productive and more profitable. And the need for technology solutions has never been greater. We spend over $1 billion a year – around 4 percent of sales -- to develop products that set the standard for productivity and value.

Deere's strategic direction over the coming years will reflect the increasingly large role that relatively new technologies play in our businesses. All industries are seeing the rise of smart machines, equipment that is monitored and directed by computer systems to ensure safer and more-efficient operation. In agriculture, those smart machines are being brought together with remote sensor networks and farm management systems to create integrated solutions that are changing how agriculture is done.

In turf care, construction, and forestry, too, smart machines are increasing efficiency and automating fleet management. Deere and others use GPS positioning devices, embedded sensors, and actuators to provide agriculture and construction industry customers better site-specific information.

It's clear as we expand into new markets, we cannot conduct business and innovation activities as usual. We can't simply take existing products and de-spec or retrofit them for new customers. There is yet another kind of technology that is having a big impact on our business. It has been called frugal engineering or value engineering. Most commonly done in the developing economies where resources are scarce, value engineering is an approach in which design and manufacturing decisions are made in favor of keeping product cost extremely low.

It is not just a way to cut costs, however. It is, instead, a way to intensely focus innovation on the customer, delivering precisely the features needed to get the job done at a price customers can afford to pay. Using the principles of value engineering will not only help us develop customer solutions in developing economies, but also will help us control our own costs to build a better business.

The pace of growth and the breadth of application of these fundamental technologies make it clear that no one company has the resources to develop, maintain, and support all of the hardware and software applications being demanded in even one industry. To fulfill our commitment to those linked to the land, Deere understands the needs to partner with others such as universities, companies, governments and others to develop and deliver long-lasting, intelligent equipment solutions. Our collaborations with research universities play an important role in delivering such innovation.

Delivering customer value through innovation is one of several factors that Deere has identified as critical success factors. Collaborations with research universities also play a role in additional critical success factors, particularly attracting and developing employees and understanding our customer's local needs both today

and into the future. For Deere, these benefits of collaborations with U.S. research universities that help meet our business aspirations and the aspirations of our customers will lead to innovation and job creation for decades to come.

Deere formed a Global University Relations initiative in 2011 to develop and sustain strategic alignment among the strong university relationships currently in place and guide direction for future relationships globally that help accomplish Deere's business objectives. The focus of this initiative is to address and leverage all functions and purposes for university collaborations including:

- Access to talent
- Access to innovation
- Support for locally-focused customer understanding
- Employee development for future success and employee retention
- Political support for business development
- Support for philanthropic objectives

The Global University Relations strategy will support all functions of the business, be driven by metrics, and focus on establishing university strategies in global growth regions. A long-term objective is to have a global footprint of university relationships that mirrors our global business footprint. Today our university relationships, especially R&D university relationships, are heavily concentrated in the United States and Germany and do not reflect our current and especially future global sales reach.

Each of the participants was asked to consider the following topics / questions in their testimony:

Please provide an overview of Deere & Company's research efforts in coordination with U.S. research universities.

Deere has a broad reach of R&D activities at U.S. research universities.

- Historically, the majority of our research efforts have been with faculty and students in colleges of engineering. Many engineering disciplines are represented in these research activities. However, research activities also occur in agriculture, forestry, business, information technology, and some other disciplines.
- Research activities with universities represent span a wide range of technology development. Some projects are more developmental in nature and would not expect to appear in commercial products for many years. At the other end of the range, some university research involves activities such as material testing and can be completed nearly immediately upon initiation.
- There are a variety of different types of research projects with universities. Many research projects are sponsored research projects with agreements covering many IP, publication, confidentiality, and other terms. Other types of research activities include professional service agreements, faculty consulting, consortium memberships, equipment loans or transfers, and research gifts or grants.

- The size of research projects with universities varies from multi-million dollar multi-year sponsored research projects to memberships in niche consortiums ranging from harsh environment electronics for the vehicle industry to R&D in workforce effectiveness.

Based on your experience, what is the role of industry in the future of U.S. research universities, and why is this role important?

Industry plays an important role in advising universities as to the relevance of research and workforce programs in addressing current and future business needs. Specific examples include:

- Engagement activities such as curricula reviews, serving on advisory boards, attending or presenting workshops & seminars, supporting government proposals, guest lectures, hosting visiting faculty, serving on MS & PhD committees, co-authoring publications, and developing collaborative outreach programs provide a win-win to both parties. Historically, Deere has experienced good engagement with U.S. research universities, especially in colleges of engineering.
- Industry activities with university partners should address all facets of U.S. research universities including research, teaching, extension, and economic development activities.
- Business can also play a role in industry – university relationships through memberships in organizations that specifically address these relationships such as the Government University Industry Research Roundtable (GUIRR) and the University Industry Demonstration Partnership (UIDP).

Why does Deere & Company work with U.S. research universities? How do these arrangements take shape and progress?

As discussed in our introductory comments, Deere recognizes the importance of collaborations with U.S. research universities in helping meet our critical success factors around innovation, attracting and developing talent, and local customer understanding. Examples of how such arrangements take shape and progress include:

- We utilize our Global University Relations initiative (described above) to develop and sustain strategic alignment among the strong University relationships currently in place and guide direction for future relationships.
- Where possible, we try and focus university research activities at those universities where we can also leverage other company activities on campus such as recruiting or employee development.
- We try and negotiate a Master Research Agreement between the university and Deere at those universities we expect will have significant research activities. The Master Research Agreement addresses various IP, publication, confidentiality, and other issues and makes the agreement process of establishing a new research relationship relatively simple.
- At some universities, Deere has a presence on or very near research universities. Examples include the John Deere Technology Innovation Center in Champaign Illinois and our European Technology Innovation Center in

Kaiserslautern, Germany. We also have isolated cases of individual employees housed on university campuses. Such co-location provides excellent access to university resources and as well as companies and organizations located in university research parks. Physical presence on or near university campuses also fosters an environment and workforce focused on innovation.

- Deere's access to U.S. research university innovation cannot always be measured by our specific university projects. Deere is not often the first in line to commercialize a university innovation. The university innovation may move from the university laboratory to the research park to a third-party supplier before reaching and utilized by Deere.

How do collaborations with research universities affect research and workforce development at Deere & Company? How do they affect the universities and students engaged in the collaborations?

Research and workforce development at research universities typically have mutually beneficial relationships. Industry research activities often influence curriculums to better reflect contemporary business needs. Other aspects of such collaborations include:

- Research collaborations are often as much about "people" as they are about the specific intellectual property development or research results. Research collaborations help maintain peer-to-peer relationships between university and industry researchers and provide a glimpse into our future workforce.
- Exposure to industry via research collaborations will often begin in undergraduate curriculums, senior capstone classes, and an increasing number of student research organizations. These opportunities also provide excellent exposure to potential talent.
- Research universities also provide opportunities to develop existing industry workforce through advanced and professional degree programs. These include company sponsored degree programs like EMBA or professional engineering advanced degrees, employees attending professional development or certification programs at universities, and programs where university faculty come to Deere locations and conduct training. Deere employees often initiate their own degree programs through our tuition aid benefit program.

What are the major challenges facing Deere & Company in terms of its ability to partner and collaborate with universities and the outcomes derived through these collaborations?

At Deere, we like to focus on the complementary benefits of working with universities and creating a win-win from our collaborations. As our Global University Relations initiative matures, we intend on measuring the benefits that accrue to both parties to the best of our ability and acting upon those results. That being said, there are a number of challenges that are frequently discussed in university - industry relationships.

- A challenge frequently mentioned by industry and universities is the long period of time to negotiate a research agreement. As mentioned earlier, we try and negotiate a Master Research Agreement between the university and Deere at

those universities we expect will have significant research activities. The Master Research Agreement makes the agreement process of establishing a new research relationship relatively simple.

- An excellent resource for contract guidelines and general research industry relationship guides is University Industry Development Partnership (UIDP) organization. The UIDP "Researcher Guidebook" addresses key challenges in university industry collaborations from both perspectives including managing expectations, developing proposals, budgeting, compliance, confidential information, consulting, and intellectual property concerns.
- Internally within Deere, we also plan to develop internal toolkits (some based off UIDP resources) to help streamline our internal processes and assure we are in internal compliance with our university activities.
- Immigration issues associated with foreign nationals attending U.S. research universities is another commonly mentioned challenge, especially in engineering where a significant number of graduate students hold temporary visas.

In light of the release of the National Academies report, Research Universities and the Future of America, please comment on the strengths and weaknesses of the recommendations.

Numerous recommendations from the National Academies report, Research Universities and the Future of America resonate positively with Deere as they do with other businesses and universities. The recommendations reflect the importance of research universities not only in innovation, but also in educating and training the current and future workforce in the United States and around the world. As discussed earlier, Deere considers these as critical success factors needed to meet our business aspirations and the needs of our customers. The recommendations also address funding, productivity improvements, and other factors that will help sustain a competitive leadership position that U.S. research universities have enjoyed in recent history.

Two of the recommendations included items of specific interest to Deere in even a broader context, the federal Research & Development Tax Credit and policies that enable U.S. employers to seek and retain high-skilled workers, including those trained at U.S. research universities.

- The R&D tax credit allows U.S. manufacturers like Deere to establish research centers in the U.S. as well as research collaborations with universities. These create high quality engineering positions for U.S. employees. These positions also create additional positions related to the support of the engineering centers. As a global company, we have research and development activities in many different locations around the world. There is clearly strong global competition to attract R&D jobs and centers. The R&D tax credit helps create a level playing field with foreign competition allowing for competitive pricing of our products. Deere supports the extension of the R&D tax credit in the U.S. because we believe it helps companies to remain globally competitive.
- Deere supports policies that enable U.S. employers to seek and retain high-skilled workers, including those trained at U.S. research universities. Legislation to remove the per country cap in our legal immigration employment-based (EB)

green card system is important to Deere because it would improve our ability to utilize the talents and skills of many highly-qualified EB applicants from large countries. Instead of creating new jobs and products here, the per country cap encourages highly-skilled workers to take their talents to foreign competitors abroad. In short, removing this cap will help keep U.S. manufacturers competitive in a global marketplace.

We expect the recommendations will provide for future discussion at university – industry meetings. We look forward to continued discussion alongside universities and others via our memberships in organizations such as the Government University Industry Research Roundtable (GUIRR) and the University Industry Demonstration Partnership (UIDP).

Let me again reiterate Deere's appreciation for this opportunity to appear before the Committee today. I would be pleased to answer your questions.

Thank you.

Bio

Dr. John S. Hickman
Director, Global University Relations and Life Sciences
Deere and Company

Dr. Hickman is Director of Global University Relations and Life Sciences at Deere & Company. The Global University Relations group is developing and sustaining a global network of university relationships to support Deere's strategic business objectives. Dr. Hickman also directs and provides leadership to Enterprise life science and STEM (Science Technology Engineering and Math) efforts.

Dr. Hickman is a native of Indiana, obtaining a Bachelor of Science Degree at Purdue University in Natural Resources and Environmental Sciences. He obtained his MS and Ph.D. at Oregon State University in Soil Science. He worked for 10 years as a faculty member at Kansas State University specializing in soil management and environmental quality before joining Deere in 1994.

Chairman BROOKS. Thank you, Dr. Hickman.
I now recognize our fourth witness, Dr. Louis Graziano.
Dr. Graziano, you have five minutes.

STATEMENT OF DR. LOU GRAZIANO, DIRECTOR, UNIVERSITY R&D STRATEGY, SUSTAINABLE TECHNOLOGIES & INNOVATION SOURCING, THE DOW CHEMICAL COMPANY

Dr. GRAZIANO. Thank you.
Chairman Brooks, Ranking Member Lipinski, and Members of the Subcommittee, my name is Lou Graziano and I am the Director of University R&D Strategy at—for Dow Chemical. Thank you for the opportunity to discuss our views on the university-industry partnership and its role in America's future today.

Dow believes that our relationship with academic partners is critical to our success and to the success of our partner institutions as well. A vibrant collaborative environment ensures that the greatest minds of industry and academia come together to solve the technological challenges that face society today and in the future. We believe that the most effective way to have a successful university partnership is to focus on a limited number of academic partners. This allows the partners to achieve a depth of understanding of each other's strategy and needs and thus allows us to grow together in ways that could not be realized with a less committed relationship.

To this end, Dow has increased its investment and programs with leading U.S. universities with a $25 million-per-year commitment over ten years. The investment is currently being distributed among 11 U.S. institutions. DOW took this step to strengthen research in traditional scientific fields important to the future of the company and the future of the Nation. Our collaborations take many shapes and their beginnings vary. Some might suggest that it all starts with an idea, but the real genesis starts with the recognition of a problem such as achieving breakthroughs in solar energy conversion efficiency and the articulation of the problem. It is precisely this reason that we take a strategic approach to our university partnership model. The depth of our relationships helps us recognize the relevant problems of today and then combing our capabilities to build the ideas that will solve those problems. A deeper relationship results in a higher quality collaboration.

The three important outcomes we seek in our collaborations include the discovery of advanced technologies that are relevant to the industrial and society problems we face today and in the future; the development of excellent talent at the Nation's institutions of higher learning, and the assurance that our partners remain strong in the disciplines that are essential to healthy, sustainably advantaged manufacturing sector to secure America's economic future; and providing new avenues of support to our partners, ensuring that they benefit not just from our funding but also from the collaboration of scientific minds and the advanced knowledge we bring to the table with respect to other important issues such as safety, such as sustainability and intellectual property protection.

The resources Dow expends in the research collaboration includes many intellectual exchanges, training seminars on a number

of topics, joint workshops, and onsite visits. This provides the graduate researchers perspectives that cannot always be achieved in a research laboratory setting. These activities help tomorrow's workforce get a broader understanding of industrial challenges and the scale at which industry operates.

In addition, our academic partners witness firsthand our approach to portfolio analysis, project selection and prioritization, a critical learning for a successful business entity and a successful nation.

Intellectual property is often noted as a challenge to successfully executing collaborations. It remains a challenge today, and in many cases, collaborations abroad provide a more industry-friendly atmosphere for partnerships. However, Dow has worked hard to overcome these barriers. The committed partnerships that we have built helped us create a more cooperative environment and allowed us to establish strong academic programs in many areas, including advanced electronics, new polymer platforms, and energy efficient separation processes, to name a few.

Another challenge in maintaining the research focus and discipline once a collaboration is in place. The real close interaction that we expect of our own scientists who are leading the industrial side of the partnership, that helps us maintain that discipline. This is a significant resource expenditure at Dow and one which we feel is essential to achieving a true collaborative environment with our partners.

The National Academies report highlights many key features of an improved research university system. Of note is the recommendation for better business-university engagement. At Dow, we are playing a major role in ensuring the business-university relationship creates a true peer-to-peer environment and encourage progress in this direction. We applaud any efforts to find better ways to support fundamental research that encourages industrial interaction.

Another issue in the report is the retention of foreign students trained in the United States. Many graduate students come from overseas to get their training in the United States and many of these students benefit from a system which leads the world in critical thinking and problem-solving. We recommend reducing barriers that remain—to remaining in the United States after a young professional's education is completed. In this way, the Nation can ensure we are maximizing our return on education investment.

Thank you once again for providing me with the opportunity to address the importance of the university-industry partnership in ensuring innovation and economic prosperity for our Nation's future.

I am happy to answer any questions. Thank you.

[The prepared statement of Dr. Graziano follows:]

Testimony of

Louis Graziano, Ph.D.

Director, University R&D Strategy

Sustainable Technologies and Innovation Sourcing

The Dow Chemical Company

Before the

Subcommittee on Research and Science Education

Of the Committee on Science, Space and Technology

"The Relationship between Business and Research Universities: Collaborations Fueling American Innovation and Job Creation"

August 1, 2012

Dow is pleased to offer the following testimony to the Subcommittee on the important topic of Industry-university collaboration.

About Dow and Innovation

Dow was founded in Michigan in 1897 and is one of the world's leading manufacturers of chemicals, plastics and advanced materials. We supply more than 3,300 products to customers in approximately 160 countries, connecting chemistry and innovation with the principles of sustainability to help provide everything from fresh water, food, and pharmaceuticals to insulation, paints, packaging, and personal care products. About 21,000 of Dow's 46,000 employees are in the US, and Dow helps provide health benefits to more than 34,000 retirees in the U.S.

Dow is committed to sustainability. We have improved our environmental performance (including on greenhouse gas emissions), and we are committed to do even better in the future. Our ambitious 2015 sustainability goals (http://www.dow.com/sustainability/) underscore this commitment.

Dow has a 110-year history of product and technical innovation that rivals business leaders in any industry – now with strategic focus on four "Mega" markets: Energy, Health & Nutrition, Transportation & Infrastructure and Consumerism. By harnessing the power of innovation, Dow has continued to reduce its global footprint, provide solutions for the world's most pressing challenges and fuel business success.

Dow believes that manufacturing is the lifeblood of U.S. economic growth. While in the early stages of a renaissance in the U.S., there is still the need for a sustained effort to reverse the decline manufacturing has experienced over the recent decades. A reinvigorated US manufacturing sector has the potential to positively address each of these challenges. The Advanced Manufacturing agenda we advocate includes a broad suite of policy recommendations. In addition to energy, trade, and tax policy changes, we strongly advocate for a keen focus on education and innovation.

Dow partners with universities, government institutions and members of the scientific community around the world to inspire and accelerate new ideas and technologies that address world challenges. The company invests over $1.6 billion annually on R&D, a figure greater than the budgets of all the chemistry programs in all American universities combined. The Company employs over 5,500 people in the R&D organization – recruiting the best and brightest candidates from strategic universities to create an R&D culture where highly intelligent and educated people in a variety of disciplines can pursue profound discoveries and lucrative careers.

A measure of the success of our innovation culture is that approximately one-third of Dow's annual revenue comes from products introduced in the past five years.

The U.S. faces a critical workforce shortage in STEM-related fields. To make matters worse, the World Economic Forum ranks the U.S. 51st in the quality of its math and science education. We advocate for improvements to the quality of STEM education at all levels – preschool through post-secondary. Our vision is to advance interest in, access to, and quality of STEM education to develop an innovative and competitive workforce and create a knowledgeable society that values science and technology.

Dow has four main principles in education:

- **Learning** – Engaging, hands-on learning as a model to build, support and grow the STEM pipeline
- **Teaching** – Improving teachers' skills through mentoring and formal training
- **Working** – Using key partnerships to create the workforce of the future
- **Advocacy** – We will advocate for high-performing teachers, and hands-on, STEM- based curricula through partnerships

Following are Dow's responses to the specific questions posed by the Subcommittee:

Based on your experience, what is the role of industry in the future of U.S. research universities, and why is this role important?

Dow believes that our relationship with our academic partners is critical to our success, and to the success of the institutions with whom we partner. We are always refining those relationships to ensure all parties are maximizing their return on the investment in intellectual and financial resources that are needed to achieve strong results. A vibrant collaborative environment ensures that the greatest minds of industry and academia come together to solve the technological challenges that face society today and in the future.

At Dow we believe that the most effective way to have a successful university partnership program is to concentrate our resources at a limited number of academic partners. This philosophy allows the partnership to achieve a depth of understanding that results in a stronger understanding of each others' strategy and needs, and thus allows us to grow together in ways that could not be realized with a less committed relationship. To this end Dow has increased its investment in programs with leading U.S. universities with a $25 million/year commitment over ten years. The investment is being distributed among 11 U.S. institutions. We believe it is important that Dow take this step to strengthen research in traditional scientific fields important to the future of Dow, and to the future of our nation.

Why does Dow work with U.S. research universities? How do these arrangements take shape and progress?

Our collaborations take many shapes, and their beginnings vary. Some might suggest that it all starts with an idea. But the real genesis starts with the recognition of a problem and the articulation of that problem. It is precisely for this reason that we take a strategic approach to our university partnership model. The depth of our relationships helps us recognize the relevant problems of today together, and then combine our complimentary capabilities to build the ideas that will solve those problems. The deeper our relationship is, the better we will understand each other, and the better we understand each other and the problems that are important to us, the higher quality our collaborations are.

Dow's investment in our strategic academic partners;

1. enables the discovery of advanced technologies that are relevant to the industrial and societal problems we face today, and will face in the future,
2. ensures that our institutions of higher learning remain strong in the disciplines that are essential to a healthy, sustainably advantaged manufacturing sector, so that the scientific and business leaders of tomorrow can secure America's economic future, and
3. provides new avenues of support to our partners , ensuring that they benefit not just from the funding we provide, but from the collaboration of scientific minds and the advanced knowledge we

bring to the table with respect to other important issues such as safety, sustainability and intellectual property protection.

How do collaborations with research universities affect research and workforce developme11t at Dow? How do they affect the universities and students engaged in the collaborations?

The benefits of partnership to both the industrial and academic partners are many, and go well beyond the dollar amount of the funding provided. The resource Dow expends in a typical research collaboration includes many intellectual exchanges, training seminars on a number of topics, and on-site visits. This provides the graduate researchers perspectives that cannot always be achieved in a research laboratory setting. These activities help tomorrow's workforce get a broader understanding of industrial challenges, and the scale at which industry operates. In addition, our academic partners witness firsthand our approach to portfolio analysis, project selection and prioritization, a critical learning for a successful business entity and a successful nation.

What are the major challenges facing Dow in terms of its ability to partner and collaborate with universities and the outcomes derived through these collaborations?

Intellectual property is often noted as a challenge to successfully executing collaborations. It remains a challenge today and in many cases collaborations abroad provide a more industry friendly atmosphere for partnerships. However, Dow has worked hard to overcome these barriers, and the strategic relationships and committed partnerships that we have built between Dow and academia have helped us create a more cooperative environment, and allowed us to establish strong academic programs in many areas including advanced electronics, leading edge renewable energy, new polymer technologies and energy efficient industrial separation processes. Another challenge can be maintaining the research focus and discipline once a collaboration is in place. The close interaction we expect of our own scientists who are leading the industrial side of the partnership helps us maintain that discipline. This is a significant resource expenditure at Dow, and one which we feel is essential to achieving a true collaborative environment with our partners.

In light of the release of the National Academies report, *Research Universities and the Future of America*, please comment on the strengths and weaknesses of the recommendations.

The NAS report highlights many key features of an improved research university system. Of note is the recommendation for better business/university engagement. At Dow we believe we are playing a major role in ensuring the business/university relationship creates a true peer-to-peer collaborative environment and encourage progress in this direction. In addition, many graduate students continue to come from overseas to get their training in the U.S. Many of these students benefit from a system which leads the world in critical thinking and problem solving, and we applaud the recommendations to reduce barriers to those people we train, to remain in the U.S. after their education is completed.

We are pleased to have been invited to address the important role that industry-university partnerships play in American scientific innovation, and their critical contribution to the advancement of our nation's economic growth and job creation.

Attachment I

Examples of Dow Innovation in Commercial Application

- ❖ Solutions from Dow help to make the world safer, healthier, cleaner and more sustainable. The breadth and depth of our portfolio illustrate why Dow is uniquely qualified as the ultimate "go-to" innovation partner in the industry:

  • FORMASHIELD™ Formaldehyde Abatement Technology from Dow Coating Materials empowers functional paint that helps to improve indoor air quality by trapping formaldehyde gas.

  • Dow AgroSciences' Omega-9 Oils have removed more than 1 billion pounds of trans and saturated fat from the American diet, while Dow Wolff Cellulosics' products are enabling the production of gluten-free and fat-reduced burgers.

  • GREAT STUFF PRO™ Window & Door Insulating Foam Sealant closes the gap between framework and rough window and door openings, helping to prevent drafts and maximize energy efficiency (25 to 40 percent of a home's energy loss is from air infiltration through gaps and cracks).

  • PASCAL™ Technology from Dow Polyurethanes is a new polyurethane insulating system that can boost the energy efficiency of appliances as much as 10%, without impacting design or production costs.

  • Dow Electrical and Telecommunications is meeting the growing demand for more sustainable options in wiring applications with DOW ECOLIBRIUM™ Bio-Based Plasticizers. Made from renewable content, the phthalate- and lead-free plasticizers offer the same great performance while reducing greenhouse gas emissions by 40% compared with existing PVC compounds.

  • SUSTAIN™ Polyolefin Solutions from Dow Elastomers give manufacturers a fully recyclable, phthalate-free option that has the resilience and rebound to hold up to the thousands of times we open and close our refrigerator doors, avoiding waste of energy and ensuring maximum performance for refrigerators and freezers.

  • SENTRICON™ Termite Colony Elimination System from Dow AgroSciences is used to protect American national treasures, such as the White House, the Statue of Liberty and Independence Hall (Philadelphia), against termite attacks. The SENTRICON™ System is the only termite control product ever to receive the U.S. EPA's Presidential Green Chemistry Challenge Award – a top honor awarded for innovation and environmentally responsible chemistry.

Dow is delivering today key breakthrough technologies and innovations that are making a difference to address some of the world's leading challenges. In 2011, we commercialized a number of game-changing technologies across our portfolio:

  • REFUGE ADVANCED™ is a blend of 95 percent SMARTSTAX™ corn seed and 5 percent refuge (non-genetically modified) seed that farmers can plant across their entire field, meaning

there is no need to plant a separate, structured refuge for corn pests. REFUGE ADVANCED™ simplifies achieving higher whole-farm yield potential by providing growers maximum convenience with the first-ever opportunity to plant a single-bag refuge solution for corn.

• ENLIGHT™ Polyolefin Encapsulant Films help solar module manufacturers reduce their conversion costs and get more powerful performance from their designs, as it enables more power to be generated over the life of the solar panel. Dow's innovative encapsulant films improve cell protection, resulting in better reliability and electrical efficiency, and potentially extending the service life of photovoltaic modules.

• EVOQUE™ Pre-Composite Polymer Technology improves the particle distribution and light-scattering efficiency of titanium dioxide (TiO2), the primary white pigment used in paint. This innovation leads to increased hiding efficiency and facilitates paint making with up to 20 percent lower TiO2 requirement.

• ENLIST™ Weed Control System is a unique combination of chemistry and herbicide-tolerant technology in elite corn, soybean and cotton germplasm. This new technology leverages the strengths of proven 2,4-D products to manage resistant and hard-to-control weeds with exceptional efficacy and favorable environmental profile. Dow AgroSciences has also developed COLEX-D™ Technology, featured in the Enlist herbicide solutions, which represents the latest formulation science and proprietary manufacturing processes that will provide the benefits of ultra-low volatility, minimized potential for drift, decreased odor and improved handling characteristics.

• Before natural gas goes to market, it must be treated to remove acid gas contaminants. Serving the needs of the gas treating market for more than 65 years, Dow is proud to offer UCARSOL™ Shale Specialty Solvents, a series of specialty amine blends formulated specifically for the unique needs of shale gas. Since the launch in Q2 2011, the UCARSOL™ Shale-H product line has secured margins of 57% and YTD sales of $1.2MM.

• With a commitment to "reinvent the roof" for the 21st century, Dow introduced the DOW POWERHOUSE™ Solar Shingle to U.S. markets (starting in Colorado) in October, 2011 - rolling into targeted states through 2012. The POWERHOUSE™ Solar Shingle is a revolutionary new roofing product that combines the performance and protection of a conventional asphalt roof with an integrated photovoltaic (PV) system that powers the home. It is designed to install, look and function in a way that has never been done before.

Attachment II

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Dow Commits $25 Million per Year to Advance Research & Development in Leading U.S. Universities

10-Years Commitment Will Accelerate Research and Stimulate Collaborative Innovation with 11 Top Universities

NEW YORK – October 4, 2011 – The Dow Chemical Company (NYSE: DOW) has increased its investment in programs with leading U.S. universities with a $25 million per year commitment for 10 years. The investment will be distributed among 11 institutions to strengthen research in traditional scientific fields important to Dow and to the nation's future.

"As a major employer of scientific and engineering talent, Dow is committed to the development of the 21st century workforce, which will work to solve society's most pressing challenges while cultivating a more competitive U.S. marketplace. Excellence in scientific education and the development of innovative solutions go hand-in-hand," said Andrew N. Liveris, Dow's Chairman and Chief Executive Officer. "We are pleased to partner with academia to ensure that a vital pipeline of talent and research is available to fuel the discoveries and solutions of tomorrow."

Identified by their excellence in science and engineering education, research and willingness to collaborate with industry, the following 11 universities will benefit from Dow's investment: The California Institute of Technology; The University of California at Santa Barbara; The University of Minnesota; The University of Illinois at Urbana-Champaign; Georgia Institute of Technology; The Pennsylvania State University; The University of Wisconsin; Northwestern University; The University of California at Berkeley; Carnegie Mellon University and The University of Michigan.

Each university partnership has been designed to build off of its unique strengths — its faculty, facilities, institutes and infrastructure. Areas of research include: catalysis, process development, and new materials for application in electronics, energy, transportation, and consumer applications. Dow's investment will support faculty, students and infrastructure, enabling a critical mass of resources to address some of the world's leading challenges.

News Release

Chairman BROOKS. Thank you, Dr. Graziano.

At this point, the Chair recognizes our final witness, Ms. Jilda Diehl Garton for five minutes.

Ms. Garton?

STATEMENT OF MS. JILDA DIEHL GARTON, VICE PRESIDENT FOR RESEARCH AND GENERAL MANAGER, GEORGIA TECH RESEARCH CORPORATION, GEORGIA INSTITUTE OF TECHNOLOGY

Ms. GARTON. Thank you. Chairman Brooks, Ranking Member Lipinski, and Members of the Subcommittee, I am honored by your invitation to present this testimony and by the opportunity to discuss collaborations between America's research universities and private industry. I will address your questions about the National Research Council report from my perspective as a research officer in a university with a long history of industry engagement and one that has a strategic vision and plan that infuses innovation and entrepreneurship across everything we do.

Georgia Tech is a comprehensive public university with 21,000 undergraduate and graduate students and we are proud to be the graduates of more engineers than any other U.S. university. Georgia Tech has long been a university that is engaged with industry. Of that $655 million, 14 percent of our research funding comes from private industry with new awards from industry totaling over $88 million last year. Of the 407 invention disclosures my office has received last year, 103 of those resulted from industry-sponsored research. Our students are an active part of the research and discovery process, and in fact 70 percent of our invention disclosures named one or more students among the inventors.

But just as we innovate in our research programs, we also try to innovate in our business processes. We have created a series of sponsored research agreements that tailor the terms of collaboration, including intellectual property terms to the needs of both parties in the collaboration and we target these to the specific level of technical development, of the research project that we are undertaking, and to the needs of both parties. Our White and Gold Agreement and our TRL 3–6 Agreement are both described in my written testimony.

At Georgia Tech, we have several new programs that focus on accelerating innovation for the creation of new ventures as well. We have our GT:IPS program, which is a facilitated and streamlined licensing program and our FlashPoint Program, which builds on lean startup methodologies and provides professional development for entrepreneurs.

NSF recently announced that Georgia Tech will be a node for its I–Corps Program. The Georgia Tech node will serve the Southeast region and beyond and builds on existing programs in the Enterprise Innovation Institute and the Advanced Technology Development Center, which is the Nation's oldest and largest university-based business incubator.

The main challenges facing Georgia Tech's research efforts are not unique to our institution. The NRC report addresses the major challenges of dealing with limited resources, increasing regulation, and increasing reporting requirements. If we could reduce the ad-

ministrative burden for our research investigators, we could—they could complete their groundbreaking working more quickly and innovations could be commercialized more quickly.

As a research administrator with over 22 years of experience in higher education, I can tell you that the call for consistent and full recovery of all research costs, including facilities and administrative costs and the cost of research compliance would, if implemented, bring a predictability and a stability to the research enterprise that would be very welcome. And it would also foster better compliance regimes.

I should note that the NRC report calls for full support of research costs by all sponsors, including industry, and rarely, in my experience, does private industry object to paying full and indirect costs.

Finally, recommendation three in the NRC report suggest strengthening research partnerships and suggests actions by the Federal Government, businesses, and universities to foster innovation. When endeavoring to accelerate in innovation, it is critical to recognize that there is a considerable distance between an invention and an innovation. Federally funded research at universities is largely and properly directed toward fundamental research where inquiry leads to new insights to form the bases of transformational new ideas. These are generally early-stage technologies.

The Federal Government has a role in helping to fund proof-of-concept in the initial stages of translational research. Programs like NSF's I–Corps and NIH's NCATS program fill the niche. Proposals like those offered by Congressman Lipinski to permit SBIR funds to be used for proof-of-concept research would extend the availability of federal funds already intended for the creation of new ventures to this early critical stage. These federal programs contribute to an ecosystem that brings business professionals, investors, and inventors together in an environment that is conducive to entrepreneurship. However, it is companies that provide the investment in development that allows innovations that originated under federally funded research to become commercially viable new technologies that can have a positive impact on people's lives. Over 80 percent of Georgia Tech's licensed inventions are license to existing industry.

Finally, in summary, university-industry engagement is important in meeting our country's need for new technologies and innovations and for training scientists, engineers, and the workforce to lead innovation in the future. The NRC's report offers actions that would strengthen this partnership and the research enterprise.

I look forward to discussing these actions further and I would be happy to answer any questions you might have.

[The prepared statement of Ms. Garton follows:]

The Relationship between Business and Research Universities: Collaborations Fueling American Innovations and Job Creation

Chairman Brooks, Ranking Member Lipinski, and members of the Subcommittee on Research and Science Education, I am honored by your invitation to present this testimony and by the opportunity to discuss collaborations between America's research universities and private industry. These collaborations simultaneously fuel innovation, spur economic growth, and help students gain both the technical skills and ability to carry innovation forward as they leave the institution and enter the workforce.

My name is Jilda Diehl Garton, and I serve as the vice president for research and general manager of the Georgia Tech Research Corporation of the Georgia Institute of Technology. The Research Corporation was founded in 1937 as Georgia Tech's contracting entity. One of the oldest such organizations in the United States, the Research Corporation serves the faculty in all aspects of research administration, contract negotiation, and technology transfer.

I will address the subcommittee's questions regarding the recommendations offered by the National Research Council (NRC) in *Research Universities and the Future of America: Ten Breakthrough Actions Vital to Our Nation's Prosperity and Security*[1] from my perspective as a research officer in a university with a long history of industry engagement, which also has a Strategic Vision and Plan[2] that infuses innovation and entrepreneurism across both its research and curriculum. The NRC's recommendations have a resonance for those of us at Georgia Tech who negotiate with our counterparts in industry to develop collaborations, who are also engaged in technology transfer, and who work alongside faculty to build programs for research and education while also seeking efficient and effective processes to meet our obligations for stewardship of federal, state, sponsor and institute resources. Before addressing the specific recommendations in the NRC report, I will describe Georgia Tech and its research enterprise and how Georgia Tech is engaged with industry in research, education, and innovation.

An Overview of Georgia Tech and a Detailed Look at its Research Enterprise

The Georgia Institute of Technology is a comprehensive public research university that has its main campus in Atlanta, Georgia, along with research and educational operations around the world. It is a unit of the University System of Georgia. The Institute opened its doors in 1885 as Georgia was transitioning from an agrarian economy to a more industrial economy on the heels of the Industrial Revolution. With a focus on science and technology, Georgia Tech's mission from its founding has been aligned with industry. During World War II Georgia Tech engaged in advanced technological research for the United States military and for defense industries. After the war, the Institute grew from a regional institution to a national leader with a global focus on the newly emerging information economy. Today Georgia Tech is a comprehensive university with 21,000 undergraduate and graduate students from across the United States and more than 125 countries. Over the past decade, overall research expenditures have doubled, totaling over $655 million in 2011 alone, while federal research expenditures increased nearly 200 percent in that same

[1] Committee on Research Universities; Board on Higher Education and Workforce; Policy and Global Affairs; National Research Council. The National Academies Press at http://www.nap.edu/catalog.php?record_id=13396

[2] Georgia Institute of Technology Strategic Vision and Plan. www.gatech.edu/vision

timeframe. Georgia Tech now ranks among the top ten in research expenditures among universities without a medical school. New awards kept pace in 2012 and grew by 12.7%. About 14% of Georgia Tech's research funding comes from private industry; new awards from industry in fiscal year 2012 totaled over $88 million. Georgia Tech Research Corporation receives more than 400 invention disclosures each year. In the most recent fiscal year, Georgia Tech filed 143 non-provisional patent applications and had 79 patents issued. The Research Corporation holds the third largest patent portfolio in the State of Georgia. During this last fiscal year 142 technologies were transferred and 12 new companies were formed based on technologies licensed by the Research Corporation.

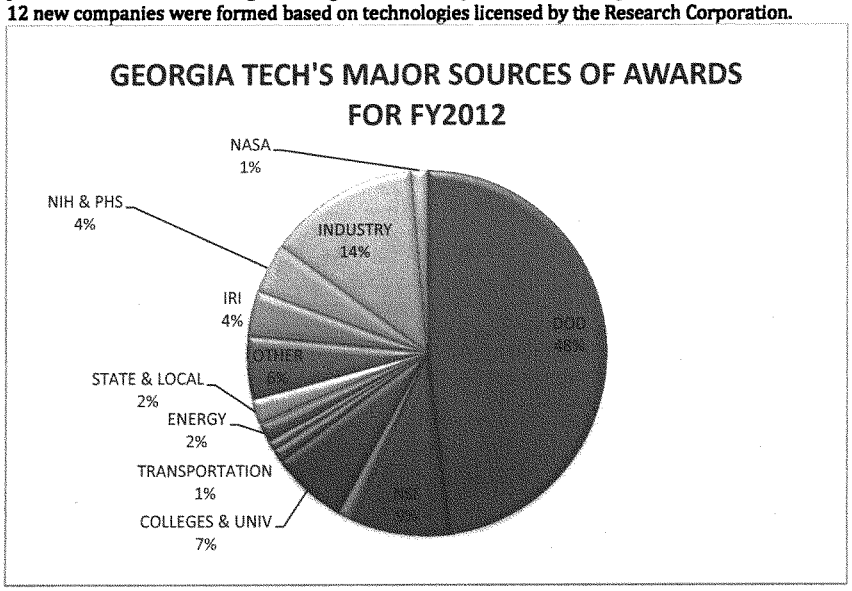

Figure 1

Georgia Tech is organized in six colleges: Engineering, Sciences, Computing, Architecture, the Ernest Scheller Jr. College of Business, and the Ivan Allen College of Liberal Arts, plus the Georgia Tech Research Institute (GTRI), the applied research arm of Georgia Tech. GTRI is a college level unit with more than 1,500 research staff and unique laboratory facilities on and off the main campus.

Georgia Tech has 1,075 academic faculty. The Institute has three strategic objectives for its research: to create transformative opportunities; to strengthen collaborative partnerships; and to enhance economic development as a benefit to the State of Georgia and society in general. Georgia Tech is creating an infrastructure to accelerate the commercialization process and is working to make it easier for Institute researchers to better collaborate with business and industry. Georgia Tech's research takes place in the following core research areas:

- Big Data
- Bioengineering and Bioscience

- Electronics and Nanotechnology
- Manufacturing, Trade, and Logistics
- Materials
- National Security
- Paper and Science Technology
- People and Technology
- Public Service, Leadership, and Policy
- Robotics
- Sustainable Infrastructure and Energy
- Systems

Georgia Tech's culture is one of collaboration with its partners in other academic institutions, government, and industry. In 2000, Georgia Tech and Emory University, a private institution also located in Atlanta, created a joint department, the *Wallace H. Coulter Department of Biomedical Engineering at Georgia Tech and Emory*. The joint graduate and undergraduate degree programs are now ranked second in the nation in biomedical engineering, according to the 2012 *U.S. News & World Report*[3]. Focused on training leaders in biomedical engineering, the Coulter Department comprises highly collaborative innovators who emphasize translational and interdisciplinary research and bring these into the educational program. Georgia Tech and Emory are the recipients of a gift from the Wallace H. Coulter Foundation that funds translational research for biomedical device inventions developed by faculty in the Biomedical Engineering Department. Another example of Georgia Tech's culture of collaboration is its relationship with Children's Healthcare of Atlanta. The Institute currently has 125 collaborations with Children's to develop new products and processes that will create economic opportunity and improve quality of life.

The Enterprise Innovation Institute (EI^2) at Georgia Tech, a comprehensive, university-based program focused on business and economic development assistance, brings together new and established Georgia Tech programs to help industry, entrepreneurs, economic developers, and communities become more competitive through the application of science, technology, and innovation. Working closely with the Georgia Tech Research Corporation, EI^2 identifies and supports key innovations with the potential to significantly impact local, state, and national economies. During Fiscal Year 2011, EI^2 helped Georgia manufacturing companies reduce operating costs by $35 million, increase sales by $191 million, and create or save 950 jobs through the services of the Georgia Manufacturing Extension Partnership program. This program is funded by the National Institute of Standards and Technology Manufacturing Extension Partnership (NIST-MEP), the State of Georgia and industry clients. The Georgia Technology Procurement Assistant Center aids companies in becoming vendors of goods and services to the federal government.

Georgia Tech also operates the oldest and largest business incubator in the United States, the Advanced Technology Development Center (ATDC), which was established in the 1980s to provide a range of services and facilities for entrepreneurs to launch and build new companies. Recognized for its excellence by Forbes in 2010[4], ATDC has graduated approximately 400 new companies — companies that have helped create millions of dollars in tax revenues for the Georgia economy and that have collectively raised more than a billion dollars in outside financing. In 2011, companies affiliated with the ATDC program reported revenues totaling more than $1.3 billion and some 5,571

[3] 2012 U.S.News & World Report rankings

[4] http://www.forbes.com/2010/04/16/technology-incubators-changing-the-world-entrepreneurs-technology-incubator_slide_9.html

jobs. Since 1999, companies associated with the ATDC have attracted nearly $2.5 billion in investment.

Georgia Tech's comprehensive efforts also include research, education, and outreach programs at twenty-five locations around the state. And Georgia Tech is part of a statewide innovative ecosystem that is attracting companies and new opportunities to Georgia. Attracting major companies, like GE Energy and NCR, was a team effort involving Georgia Tech as well as the Georgia Department of Economic Development, the Georgia Research Alliance, the governor's office, the legislature, various Chambers of Commerce, and university partners.

Innovation and entrepreneurism are also hallmarks of Georgia Tech's undergraduate educational programs. Georgia Tech seeks to have all its students complete a research experience, whether through problem-based learning, capstone courses, or individual research projects. Students at Georgia Tech are an active part of research and discovery and, in fact, over 70% of invention disclosures name one or more students among the inventors.

This year Georgia Tech marks the 100th anniversary of its Cooperative Education Program, a five-year accredited, academic program in which students alternate semesters of full-time study with semesters of full-time, paid employment directly related to their major. It is currently the largest optional program in the United States with approximately 2,700 participating students employed by more than 1,000 businesses and organizations around the world. This program provides our students with real-world experience and gives them a competitive advantage upon graduation. In fact, many are hired by their co-op employers after they graduate.

Bringing research opportunities to a diverse population of students helps provide the nation with a much larger skilled workforce. Georgia Tech produces more engineering graduates than any other university in the nation. Georgia Tech is number two in the nation in doctoral degrees in engineering awarded to African American and Hispanic students, and number two in bachelor's degrees in engineering awarded to African American and female students.

Georgia Tech also has a commitment to continuing education in support of working professionals and industry. Offering both traditional and online courses, Georgia Tech supports educational and economic progress regionally and worldwide. In an average year, Georgia Tech's professional education programs serve more than 3,000 companies and 13,000 individuals.[5]

How Georgia Tech Works with Industry in the Conduct and Application of Research

Georgia Tech interacts with industry across the spectrum of engagement, as it implements a strategy focused not just on basic research, but on leading-edge, use-inspired research with potential for economic development. Teams of faculty, graduate students, economic development experts, and professional staff collaborate to accelerate the maturation and transition of technology. Industry scientists and engineers may be engaged with university researchers as visiting scholars.

[5] http://www.gtpe.gatech.edu/office-of-the-dean

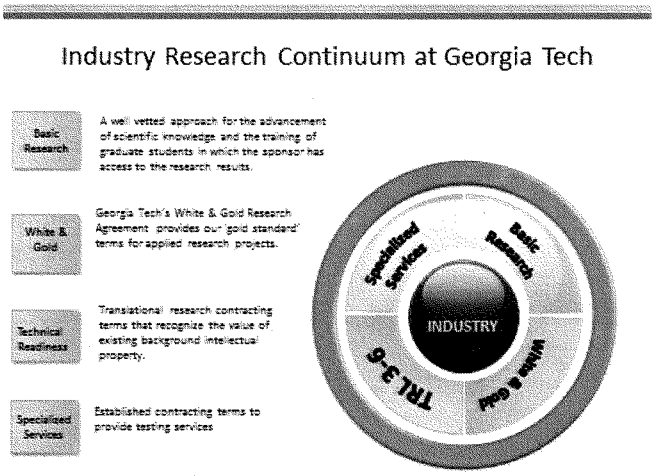

Figure 2

Georgia Tech Research Corporation's Office of Innovation Commercialization, Industry Contracting, and International Collaboration, (IC)3, has developed a series of agreements that align with the needs of both parties in industry-sponsored research. These agreements tailor the terms of the collaboration — including intellectual property terms — to the specific level of technological development. The White and Gold Master Agreement provides sponsorship of research with an emphasis on participation by graduate students and an assurance for the industry sponsor that it will have access to new inventions in relevant fields of use while preserving the opportunity for entrepreneurial technology transfer in other fields. With its name derived from the "technology readiness levels" often discussed by the Department of Defense, the TRL 3-6 Agreement is specifically designed for research engagements in which a sponsor has already licensed technology from Georgia Tech and is working with the university on translational research to bring the technology closer to a product. TRL 3-6 is well suited to those relationships in which sponsor-owned technology is the subject of the research. Specialized Services Agreements provide companies with access to the unique capabilities of the university that are necessary parts of technical development but not available in the commercial sector. Working on these projects for industry often provides practical experiences for students who are engaged in learning practicum in these facilities.

In addition to new contract vehicles, Georgia Tech has partnered with the State of Georgia and the federal government to build unique venues to support key industry sectors. The State has funded the Food Processing Technology Building, where translational research leads to industry innovations in food processing.[6] On May 30, 2012, The Wall Street Journal[7] reported on work generated here that synthesized sensor technologies, robotics, and control algorithms to build a

[6] http://www.fptd.gatech.edu
[7] http://online.wsj.com/article/SB10001424052702303879604577410433686070506.html

robotic deboning device that may revolutionize poultry processing while eliminating a common source of injury to workers.

Similarly, with the help of a construction grant from the National Institute of Standards and Technology, Georgia Tech is constructing a Carbon Neutral Energy Systems building designed to house pilot-scale collaborations that will bring together research universities and global energy companies for research into sustainable energy systems.[8] Such test-beds permit the integration of technologies and develop solutions that can be broadly adopted by industry. Google CEO Eric Schmidt, in a June 2010 CNN special on innovation, called such facilities crucial elements in technology transition and realizing economic development from potentially disruptive technologies.[9]

Georgia Tech will enhance its ability to provide a significant competitive edge and an economic boost to Georgia's growing biomedical research industry through the addition of its new Engineered Biosystems Building. An extension to Georgia Tech's existing Life Sciences Complex, the 200,000-square-foot facility is scheduled for completion in 2015. It is expected to generate additional opportunities for enhanced partnerships with industry. Such partnerships are expected to shorten the time between research and commercialization, bringing medical treatments more quickly from the lab to the patient, while also making Georgia more competitive in the biomedical arena. The facility is a joint investment, with the State of Georgia providing $59 million in state funds and Georgia Tech contributing $34 million in institutional and private funds.

Efforts to improve the climate for collaborations between universities and businesses are not limited to campus efforts. The University-Industry Demonstration Partnership[10] (UIDP) is an organization of universities, companies, and national laboratories who meet to discuss contracting and intellectual property issues, develop more nuanced understandings of publication and technology transfer preferences, and find solutions that are based on principles and good practices. Growing from a 2005 meeting of like-minded universities and companies that came together in the University-Industry Congress, the UIDP has enabled participants to understand one another's perspectives and develop contracting practices that respect the unique missions of academic institutions and industry sponsors of research. UIDP is now an activity of the Government University Industry Research Roundtable. With funding from the National Institutes of Health, National Science Foundation and Defense Threat Reduction Agency, UIDP has made significant contributions to building understanding. Its work is accessible in the *Guiding Principles, Contract Accords, and Researcher Guidebook* and other publications[11] as well as in webinars and Contract Negotiation Workshops. The Georgia Tech Research Corporation has been a member and participant since UIDP was first formed; I have the honor of being the group's immediate past-president.

Why Partnerships with Industry Are Important to a Research Institution

Industry partnerships are important because they add a real-world dimension to university research and education by offering insight into relevant problems, access to technologies and facilities and for university researchers, and funding, as well as learning opportunities and future

[8] http://www.gatech.edu/newsroom/release.html?nid=48988
[9] http://www.youtube.com/watch?v=UsxMxXXp-dA
[10] http://sites.nationalacademies.org/pga/uidp/index.htm
[11] http://sites.nationalacademies.org/PGA/uidp/PGA_055253

employment for students. Georgia Tech is actively engaged with large and small companies across the research spectrum. With 602 agreements in fiscal year 2012, private industry accounts for 14 % of Georgia Tech's sponsored research. Through sponsorship of research, company funding allows the university to expand research programs and support more graduate student projects. These research programs frequently lead to licensable new inventions. Of the 407 invention disclosures received by Georgia Tech Research Corporation in fiscal year 2012, 103 resulted from industry-sponsored research.

Long-term collaborations are an important feature of productive university-industry relationships. Boeing selected Georgia Tech as one of its 16 suppliers of the year in 2012, citing basic and applied research that have increased knowledge and understanding of fluid flow, advanced manufacturing technology, advanced design and advanced aircraft technology. In announcing the award, Jack House, vice president of Supplier Management for Boeing Defense, Space & Security and leader of Boeing's companywide Supplier Management program, said, "In today's challenging business environment, an agile supply chain that continuously delivers excellent performance is critical."[12]

Businesses are the entities that bring new technologies into public use through commercialization of new products based on these inventions and discoveries. They are the licensees of technologies that arise from Georgia Tech's basic research whether funded by the federal government or state or institutional funds. Over 80% of Georgia Tech's licensed inventions are licensed to existing industry. Industry relationships allow Georgia Tech to meet its obligations under the Bayh-Dole Act to ensure that the public benefits from inventions made in the course of federally funded research. Such inventions are often early-stage discoveries that must overcome any number of technical hurdles before they become viable products or services. Often companies fund translational research to overcome these hurdles through sponsored research that is conducted by the university. It is these companies that provide the investment in translational research that allows innovations that originated under federally funded research to become commercially viable new technologies that can have a positive impact on people's lives. Each year Georgia Tech creates, on average, a dozen new companies based on technologies licensed by the Georgia Tech Research Corporation. Existing companies may invest in start-up companies providing additional pathways for technologies to be developed. As will be discussed later, advancing technologies to a more investible and less risky level of technical readiness prior to licensing would likely lead to reduced time to adoption and a greater likelihood of success.

Universities are part of the R&D supply chain for U.S. companies, providing transformational technologies as well as incremental solutions to increase productivity and sustainability or solve other challenging problems. And, of course, research universities provide the skilled workforce companies require. Most of the companies that sponsor research at Georgia Tech also recruit and hire the Institute's graduates, who often become leaders of innovation within the company. And, industry funding supports research that is conducted by faculty and graduate students, enabling students, through stipend support and tuition remission, to complete their studies.

The Responsibility of the Nation's Research Universities in Encouraging Participation in Scientific Research

Research and education at research universities are inextricably intertwined. Graduate education with its requirements for engagement in original research and publication of scholarly work is the

[12] http://boeing.mediaroom.com/index.php?item=2227&s=43

signature responsibility of research universities. However, providing research opportunities at the undergraduate level is also the responsibility of research universities as they allow students to experience discovery, which ignites a passion for research. Problem-based learning helps students develop ideas and technologies within their disciplines and in interdisciplinary research. And it increasingly provides a venue for companies to explore disruptive concepts by engaging students through design courses supported by industry participation. Industries often provide access to company problems and in some cases financial support. Time and again, company representatives have expressed to Georgia Tech that experiential learning helps students gain the teamwork, communication, project management and decision-making skills that are necessary for successful, innovative careers within companies.

Bringing real-world challenges into the educational process also engages some of the nation's brightest minds in solving some of our country's greatest problems. At the graduate level, for example, activities such as the General Electric Smart Grid Challenge[13] at Georgia Tech provide funds for teams of students to take on a particular challenge of national significance. GE Energy provides smart grid related problem statements, and cross-functional teams of students collaborate to achieve technically feasible and economically viable solutions. Teams develop a simulation to demonstrate their solutions, and winning teams receive cash prizes. Students receive stipend and tuition support as graduate research assistants while participating in the team. In the process, students develop potential innovative solutions to problems in power distribution to benefit society.

It is essential in all areas of science and engineering and at all levels that students gain experience and an understanding of research methods, design, and the interpretation of results in order to sustain technical progress in industries that are increasingly driven by innovation. Often the best time to experiment with technology development and entrepreneurship is in school, especially if coaching and mentoring are available to help students overcome challenges or even recognize the inevitable failures. Understanding how to take discoveries to innovation requires an entrepreneurial spirit, whether working within a company or creating a new venture. Creating opportunities for students to gain that experience is an important component of encouraging participation in scientific research.

One program that provides coaching and mentoring in technology development is the InVenture Prize @ Georgia Tech, a faculty-led innovation competition for undergraduate students that helps them bring innovation and entrepreneurship to life. Students work independently or in teams to develop and present inventions that will be judged by experts. A number of InVenture Prize technologies have begun as individual or team efforts in problem-based learning and design courses. The final round of the competition is shown live by Georgia Public Broadcasting. Significant cash prizes are given for first and second place and to a "people's choice" winner. Georgia Tech Research Corporation files a U.S. patent application for the first and second place winners. This year's winners include Re-hand, a software assisted home-use hand assessment and rehabilitation device; Stylii, a precise and pressure-sensitive capacitive stylus; and CardiacTech, a chest retractor for bypass surgery. All these inventions are now in commercial development.

In Recommendation 10, "ensure that the United States will continue to benefit strongly from the participation of international students and scholars in our research enterprise," the National Research Council demonstrates the need to facilitate participation by international students in

[13] http://www.ece.gatech.edu/research/labs/GE_Smartgrid/

research in U.S. universities. Specifically, NRC recommends ensuring that visa processing for foreign students is as efficient and effective as possible consistent with national security concerns. In a recommendation that is perhaps more significant, the report also suggests that the United States should consider offering permanent residency to foreign-born students who earn doctoral degrees in areas of national need from accredited U.S. universities. The effect of such policies would be to ensure that the U.S. continues to draw talent from the entire world. About 40% of Georgia Tech's faculty and graduate students were not born in the United States, which is consistent with national statistics. Vilcek and Cronstein[14] found that 30% of the United States' winners of the Nobel Prize between 1901 and 2005 were foreign-born. At Georgia Tech we hear from companies recruiting students that a more straightforward pathway to permanent residency and citizenship would facilitate their ability to sustain programs of innovation. From my own observation, I can tell you that foreign-born students who are inventors are often interested in entrepreneurial technology transfer and will form businesses based on their inventions. It is good economic development strategy to retain those new businesses in the United States and, for those of us in state institutions, in the local geographic region.

Novel Techniques Georgia Tech Is Employing to Encourage Innovation and American Competitiveness

It is paramount for research universities to continue to provide a venue for exploring and realizing disruptive innovation for students, industry and society. The risks associated with failure are typically less severe in an academic setting than in industry, where concerns about profits and losses often inhibit the pursuit of disruptive ideas. Within the university environment, the investment cost is often significantly less, healthy competition between ideas is culturally acceptable, and students and faculty are predisposed to disruptive thought. The balance sought by Georgia Tech is to engender and support a culture that blends this high risk, discovery-focused research with the early identification of the commercial potential of discoveries.

Georgia Tech inaugurated two novel programs in 2011 that focus on accelerating innovation through the formation of new ventures, which are often based on technologies licensed by the Georgia Tech Research Corporation. The first, Georgia Tech Integrated Program for Start-ups (GT:IPS™), consists of two components: GT:IPS™ Facilitation and the GT:IPS™ License. GT:IPS™ Facilitation is a graduated program of support, information, and education for new company founders, while the GT:IPS™ License offers the same terms to all Georgia Tech startups in the same field and provides the startup with transparency into GTRC's processes. GTRC undertook the project with a commitment to developing a license that would be accepted by the Georgia Tech community, be used without reservation by attorneys representing Georgia Tech startups, and be accepted by a large spectrum of investors and future business partners of our licensees. With that goal in mind, the Office of Technology Licensing engaged multiple law firms specializing in new venture formation and financing in an iterative process to finalize the GT:IPS™ license.

FlashPoint is a professional development program in *start-up engineering*, a term coined to connect Georgia Tech's engineering heritage with its strategic focus on innovation. FlashPoint offers entrepreneurial education and access to experienced mentors, experts, and investors in an exciting, immersive, shared-learning, open workspace. Based on lean start-up methodologies similar to those used by Y Combinator and other programs, this is the first such program based in a

[14]A Prize for the Foreign-born, Jan Vilcek and Bruce N. Cronstein, The FASEB Journal vol. 20 no. 9 1281-1283, July 2006

university. With support from an angel fund established by local investors, FlashPoint is working with its second cohort. An example of a FlashPoint graduate is a new company called Pindrop Security. Pindrop Security offers a patent-pending technology to prevent phone-based fraud by identifying key attributes of any phone call to create a "phone fingerprint," which allows banks and other financial institutions to authenticate calls.

On July 18, 2012, the National Science Foundation (NSF) announced that Georgia Tech will be a founding network node for its Innovation Corps (I-Corps) program, which aims to develop scientific and engineering discoveries into useful technologies, products and processes. The I-Corps program is an important bridge that connects NSF-funded scientific research and basic science and engineering discoveries with technology development to meet societal needs. Leveraging experience and guidance from established entrepreneurs and a targeted curriculum, I-Corps participants, a faculty investigator and an entrepreneurial lead drawn from the university learn to identify valuable product opportunities that can emerge from academic research. Georgia Tech's I-Corps node will serve the southeast region and beyond.

The Invention Studio, opened in 2008, has provided a multidisciplinary space for undergraduate students to approach engineering problems in unconventional ways without concerns of failure. Comprising three separate rooms, this 1,000-square-foot, "free to use" studio is run by nearly 50 undergraduate volunteers from the Georgia Tech Maker's Club. Companies such as Coca-Cola, Ford, John Deere, Autodesk and Caterpillar have helped support the studio due to their keen interest in hiring students who possess practical engineering skills and have the ability to create innovative solutions. Two finalists of the 2011 InVenture Prize, AutoRhexis, an innovate device for cataract surgery, and Velociryder, a motorized, self-balancing skateboard, developed their prototypes at the studio.

Major Challenges Facing Georgia Tech's Research Efforts Today

The main challenge facing Georgia Tech's research efforts is not unique to our Institute. Higher education is a highly regulated industry. While many regulations and reporting requirements are necessary, some place an additional burden upon research universities and, more specifically, the researchers who should be focusing their attention on improving the human condition. An example of overregulation can be found in the escalating requirements imposed by the Department of Defense for universities that conduct research using human subjects. Each university funded by the Department of Defense must execute addenda to its Federal-wide Assurance for Human Subjects Research which is filed in compliance with the Common Rule (45CFR 46). Each addendum is ***unique and specific to the branch of the military that funds the research or with which the university is engaged.*** Thus along with the Common Rule administered by the Public Health Service's Office of Human Research Protection and guidelines promulgated by the Food and Drug Administration, we now have separate rules for the U.S. Army, the U.S. Navy, and the U.S. Air Force. Along with the addenda come requirements for a second agency review of protocols and duplicative training — often involving the same on-line training modules — for all investigators. No doubt the Department of Defense has special concerns; however, it would be far more efficient to work within the common rule to ensure that university Institutional Review Boards adequately address those concerns and eliminate time consuming redundant review, duplicative training, and the costly record-keeping and reporting associated with it.

As discussed by NRC in *Research Universities and the Future of America*, the impact of redundant regulation is felt by faculty researchers as well as universities. In 2007 research conducted by the Federal Demonstration Partnership[15] it was revealed that university researchers across the nation are experiencing significant challenges related to the growing number of administrative and regulatory tasks they must perform for each of their research programs. Most notably, the study indicated that of the total time that faculty devote to research, 42% is spent on pre- and post-award administrative activities.

These statistics have genuine significance when considering the role of universities in fostering innovation. Scientists and engineers are spending an increasing amount of time outside of the lab, away from the work that could lead to the next cure for a life-threatening disease or new alternative energy source. If we could reduce their administrative burden, university researchers could complete groundbreaking work more quickly and it could be commercialized faster. This is a much better use of federal research dollars and those funds provided by other sponsors.

Recommendation 7 of the NRC Report calls for reducing or eliminating regulations that increase administrative costs, impede research productivity, and deflect creative energy without substantially improving the research environment. A framework for evaluating and revising regulatory regimes that apply to U.S. universities is described by the American Association of Universities (AAU) and the Council on Governmental Relations (COGR) in the paper *Reforming Regulation of Research Universities*[16]. AAU and COGR make the following recommendations for agencies promulgating regulations that affect U.S. university research. Quoting from AAU and COGR, regulatory authorities should:

- *Eliminate outright or exempt universities from regulations* [that should not apply to universities]
- *Harmonize the regulation across agencies to avoid duplication and redundancy*
- *Tier the regulation to levels of risk rather than assuming that one size fits all*
- *Refocus the regulation on performance-based goals rather than on process*
- *Adjust the regulation to better fit the academic research environment.*

It should also be recognized that all new regulations strain existing resources, especially staff. In many cases, additional staff are required to adequately address federal regulations. This presents a fiscal challenge for universities, especially public research universities that have experienced a dramatic decrease in state funding due to the global recession.

One of the biggest challenges Georgia Tech and peer universities face, now and in the foreseeable future, deals with limited resources. The economic environment has led to decreases in funding at federal, state and local levels. Over the past three years, Georgia Tech's state appropriation has decreased by almost $100 million, or approximately 31%. The Institute has been able to recover approximately $30 million through tuition increases and other sources. The $70 million difference is a significant portion of a $1.2 billion budget

State funding shortfalls are compounded by the inability of universities to fully recover facilities and administrative (F&A) costs due to the 26% cap placed on most federal research contracts. This funding is used to cover the cost of complying with regulations and other required administrative

[15] "Reduce Administrative Burden"" (editorial) Alan I. Leshner, Chief Executive Officer of the American Association for the Advancement of Science and Executive Publisher of "Science" SCIENCE Vol. 332, December 12, 2008

[16] Reforming Regulation of Research Universities. Tobin L. Smith, Josh Trapani, Anthony DeCrappeo, and David Kennedy. ISSUES IN SCIENCE AND TECHNOLOGY Summer 2011

and facilities support functions. The real cost associated with doing research often stretches well beyond the F&A funding available in a federal contract. The shortage often has to be filled by universities using other unrestricted funds. According to the Association of American Universities,[17] this constitutes an under-reimbursement and "drains not only university funds but faculty time." Inadequate F&A funding limits the ability of administrative support staff to assist researchers with administrative tasks. The burden is then shifted to researchers, who consequently lose valuable time in the laboratory or classroom. Providing needed resources and being judicious about regulations will help researchers have more time to innovate in ways that will improve lives, reshape industries, and help transform our world.

Recommendation 6 in the NRC Report addresses this risk directly when it says that the "federal government and other research sponsors should strive to cover the full costs of research projects and other activities they procure from research universities in a consistent and transparent manner." As a research administrator with more than 22 years of experience in higher education, I can tell you that the call for consistent and full cost recovery for direct costs and for facilities, administrative, and compliance costs is a recommendation that, if implemented, would bring predictability and stability to the research enterprise and would help foster better compliance regimes. Note that NRC calls for full support of research costs by federal and non-federal sponsors which, of course, includes industry. In my experience, most companies do not object to paying full F&A costs in sponsored research.

Comments on the Recommendations in the National Academies report, *Research Universities and the Future of America*

The ten action items in the National Academies report, *Research Universities and the Future of America*, each offer insights into the challenges and opportunities ahead for U.S. universities. In my view, Recommendation 3 is especially relevant to today's topic, *The Relationship Between Business and Research Universities: Collaborations Fueling American Innovations and Job Creation*, so I will focus my remaining remarks on this topic. Recommendation 3 calls on us to "strengthen the business role in the research partnership, facilitating the transfer of knowledge, ideas, and technology to society and accelerate the 'time to innovation' in order to achieve our national goals" and suggests specific actions for government, businesses, and universities.

When endeavoring to accelerate the time to innovation it is critical to recognize that there is a considerable distance between invention and innovation. The journey from discovery to development is often described in terms of technology readiness levels (Figure 3), which the Department of Defense formally defines as a progression from basic research to a system that is ready to deploy.

[17] "Renewing the Partnership: thoughts on the Current Status of American Research Universities" Association of American Universities November 16, 2009

Federally funded research at universities is largely — and properly — directed toward the first two levels, where inquiry leads to new discoveries about the fundamental nature of matter, energy and life that lead to new insights and form the basis of transformational new ideas. A university environment is the primary way these kinds of studies can occur. They increasingly rely on advanced experimental infrastructure, take place over many years, and require the specialized technical skills of university researchers.

Technology Readiness Levels 1 Through 6

1. Basic principles are observed and reported.
2. Technology concepts and applications are formulated and invention begins.
3. Analytical and experimental critical functions and characteristics proof of concept occurs. This is where "research and development" in the industrial sense begins.
4. Components are validated and integrated in the laboratory environment.
5. Components are validated in the relevant operating environment and fidelity and reliability are increased.
6. System and subsystem models or prototypes are demonstrated in a relevant environment.

Figure 3

Since the days of Vannevar Bush[18], the value of federally funded basic research has been recognized as an important driver of progress across every discipline. The conversion of discoveries in all disciplines to inventions that can be developed by business follows the same path from discovery and invention to proof of concept, prototyping and integration into commercially viable systems and products as shown in Figure 4. For good reasons, various metaphors invoking the image of a chasm are generally used to describe the step between basic and translational research, which is the beginning of product development. This is a difficult stage for three reasons: 1) such research is risky in the sense that the probability of technical failure is relatively high, 2) financial benefit is sometime in the future, and 3) the time to find funding and conduct the work is relatively short, with decisions about filing for non-provisional patent protection required in a timely manner. Reducing the risk of new technologies through proof of concept enables both universities and companies to make better decisions about pursuing development.

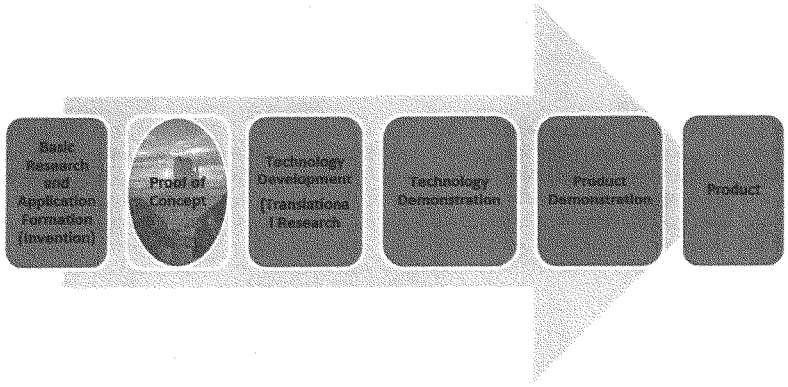

Figure 4

[18] Vannevar Bush (1945). *Science, the Endless Frontier: a Report to the President*. Washington, D. C.: U.S. Government Printing Office.

The federal government has a role in helping to fund development of technologies through proof of concept, thereby making them more investable, and in creating the ecosystem that first helps bring business professionals, investors, and inventors together in a environment conducive to entrepreneurship. Federally funded programs like the NSF I-Corp Program fill this gap. The National Center for Advancing Translational Sciences (NCATS) in the National Institutes of Health seeks to accelerate the transformation of laboratory discoveries into new therapies and fills this niche in health technologies. The Clinical and Translational Sciences Institutes bring research-performing institutions together to collaborate in developing new technologies and transferring technologies. Georgia Tech is part of the Atlanta Clinical and Translational Science Institute funded by NCATS. The Cures Accleration Network has flexibility in its funding programs, which are targeted toward reducing barriers to translation of technology and accelerating the development of cures. Proposals, like those offered by Congressman Lipinski, to permit Small Business Innovation Research funds to be used for proof of concept research would extend the availability of federal funds already intended for the creation of new ventures based on innovation to be used at this early, critical stage. In a letter dated February 2, 2012, to Francis Collins, M.D., Ph.D., director, National Institutes of Health, the Association of American Universities and the Association of Public Land-grant Universities expressed support for goals of the NCATS program and extension of SBIR funding to include proof of concept.

It is worth noting that programs that encourage technology transfer through new venture creation or engagement with industry in development of drugs and devices are burdened by increasingly complex regulations regarding investigators' Financial Conflicts of Interest. Georgia Tech and other research universties understand and appreciate the importance of disclosure and management of conflicts of interest that might interfere with any aspect of the design, conduct and reporting of research. However, as with other regulations, the imposition of new standards for reporting without resources for compliance requires that professional staff, systems development resources, and faculty time be diverted. It is important that such regulations be non-duplicative and scaled to the risk. The costs of proving compliance with conflict of interest regulations in these situations should be recognized as a cost of technology transfer.

Recommendation 3 suggests that universities, businesses, national laboratories and the federal government examine the pathways by which ideas, discoveries and inventions are developed and move out of universities and to business. Stephen E. Cross[19], executive vice president for Research at Georgia Tech, has suggested that rather than being a linear process it is a concurrent one with teams of faculty, graduate students, and application and economic development professionals engaged with business and industry to accelerate the maturation of technology and its transition to the marketplace. The value to business in working with research — other than the access to inventions and know-how — is that research universities, through their innovation processes, provide a venue to explore and realize "disruptive innovations outside the constraining and often bureaucratic confines of their profit/loss units."

Recommendation 3 also calls for universities to improve management of intellectual property to improve technology transfer. Programs such as GT:IPS™ and streamlined licensing processes at other universities demonstrate a commitment to seek best practices. New, more industry-friendly

[19] Stephen E. Cross, One Research University's Strategy for Supporting an Innovation Ecosystem, *Proceedings of the 2nd Annual International Conference on Innovation and Entrepreneurship,* July 2012.

agreements for research engagements, such as the White and Gold Agreement, similarly facilitate technology transfer by addressing the dissemination of intellectual property that might result from the research in the research agreement.

In summary, Recommendations 3, 5, 6, 9 and 10 offer suggestions that would enhance the ability of universities and businesses to collaborate in research and better educate a diverse and highly skilled workforce. These recommendations suggest ways to provide stable funding for research infrastructure and compliance as well as sensible and reliable regulatory regimes that would allow university researchers to focus on research and technology transfer. The research infrastructure of U.S. universities, supported in part by the federal investment in basic and applied research and funded by Facilities and Administrative Cost recovery, is a key element of this country's ability to sustain innovation. Regulatory reform that maintains legitimate protections and requirements for accountability, while eliminating duplication and redundancy, would make research more efficient. And finally, policies and funding mechanisms that enable universities and business — both existing industry and new ventures — to work together in translational research and proof of concept research would be welcomed.

Chairman BROOKS. Thank you, Ms. Garton.

I would like to thank the panel for their testimony.

Reminding Members that committee rules limit questions to five minutes, the Chair will at this point open the round of questions.

Normally, the Chair recognizes himself, but in this instance, I am going to defer my opening slot to Mr. Benishek of the great State of Michigan.

Mr. BENISHEK. Thank you, Mr. Chairman. I really appreciate it.

Well, this is a great opportunity for me. I was just at a—actually a community college yesterday that does concrete research in association with concrete business people in the City of Alpena. And that was—leads me to my first question is that how do these partnerships get started and how do you determine—I mean it sounds like from some of the testimony that it is like big research universities, you know, the big-time schools. And, you know, I have like five small universities in my district which, you know, they seem to have done some pretty decent research in this—in concrete development and research. And I mean how do I get, you know, my community colleges and, you know, four-year, two-year degree schools involved in this a little bit more? And is there more of a place for that? Does anyone have to comment?

Dr. GRAZIANO. I will be happy to comment. I don't have a real clear answer to say, well, this is how to do it. And you are right. We do concentrate on the larger research institutions for our R&D strategy because that is where we are looking at graduate students. But at the same time, we—I know we work—we have worked a lot with Delta College to help bring, you know, the not-advanced degrees into better training and better workplace opportunities.

As far as getting R&D funding there, I think the best way that we could probably do something like that is through the major universities. So let's say, for example, we have a research program, if we have something that makes sense in the area of, say, your concrete research that you were talking about, a project that could go through, say, University of Michigan or Michigan State University, could be subcontracted to the universities. So I think it is a matter of marrying up those capabilities so that we can say, hey, that aligns—what they are doing there aligns with some goal that we want to get at now. How do we make that connection——

Mr. BENISHEK. Right.

Dr. GRAZIANO. —to get a program underway that maybe can support that research in a way that aligns with our goals and what our needs are. Does that make some sense——

Mr. BENISHEK. Yeah, a little bit.

Dr. GRAZIANO. I think it is probably not exactly what you wanted to hear but——

Mr. BENISHEK. Well, I am going to send my people over to talk to you but——

Dr. GRAZIANO. That would be great.

Mr. BENISHEK. Ms. Garton, I had a question, too. You mentioned about the regulated nature of higher education and there were some barriers to research. Could you give me a couple of examples of things like that?

Ms. GARTON. Yes, sir. The—universities don't certainly object to regulation and to requirements to report the results of our research or to report how funds are used for research. What I think the problem is is where we have duplicative regulation or we have multiple reporting to different agencies. We report the same data to a number of different agencies and have sort of a duplicative reporting process. So the kinds of things that I would suggest that could probably be looked at and to reduce burden would be things like requirements by, for example, the Department of Defense to have multiple reviews of the same protocol by three different IRBs before the research can be conducted. That could probably be, you know, streamlined and improved so maybe one IRB could do that work.

Other things like the federal reporting requirement could be streamlined and be put into a logical sequence, which I think people are beginning to work on doing so that we don't have multiple reports, electronic reports that have to go in different formats to different agencies and require us to have different systems to report our results to three different agencies.

Mr. BENISHEK. Right. I just have one more question. You know, government funding plays a significant role in this initial research, and I support that and I also support the public-private partnerships. But I wanted to know what your opinion is as to determine when the time for the government funding is over and what parameters we should put on this R&D funding so that it transitions to more of a—when there is something actually economically viable, at what point does that occur. Mr. Hickman, do you have a—you seem to be nodding your head there. Do you have an idea there?

Dr. HICKMAN. The transition can occur at many different places. And at that time it is more likely that Deere will to take this research. We don't do as much fundamental basic research. We do more of applying various systems that we can put into an equipment solution for our customers. So the transition can occur at different times and it is one of the advantages of having those close relationships with universities. You may not always be first in line with the research lab, but we are there to find out about that transistion is and when it comes about.

Mr. BENISHEK. Anyone else have a comment in that regard? Mr. Johnson?

Dr. JOHNSON. I think the—one of the principle roles for federally funded research is to invest in high-risk, high-payoff research. And many of the problems that we face today as a Nation and in fact as the world, the fundamental solutions for those problems are not known and so the Federal Government does have a major role. And I think as this report pointed out, by having a closer collaboration between the invention-creators—that is in this case the universities in this discussion—and the innovators, that is the businesses—having that federal funding support that invention and then having a place for that to go through, the partnership will in fact do just what you ask, and that is turning the federal research dollars spent in high-payoff areas into outcomes through that university-industry partnership.

Mr. BENISHEK. I think my time is up. Thank you.

Chairman BROOKS. Thank you, Mr. Benishek.

The Chair now recognizes the Ranking Member, Mr. Lipinski, from the great State of Illinois.

Mr. LIPINSKI. Thank you, Mr. Chairman.

So many questions that I have, let me try to get into this quickly. I think one of the issues here—most of the time most hearings we talk sort of at a level a little higher and more general than might be good to help all of us to get a better understanding of, first of all, what exactly are these collaborations, these partnerships like? Is there a typical form these partnerships take? Does it depend on specific nature—does the specific nature depend on the situation, the objective? And we are also talking about at different points I know, say, research we were talking—well, basic research or something where it is getting more applied, so I think it might be helpful just to talk—let me start with Dr. Graziano. Could you give some examples of how these partnerships come together and what exactly these partnerships do? Because I can imagine them and I think that they—there are a lot of different types, but could you give some examples——

Dr. GRAZIANO. Sure.

Mr. LIPINSKI. —and how they come about.

Dr. GRAZIANO. Yeah, there is a lot of types and clear and foremost is—our goal is to really help develop talent. But some examples of how they come about—and we put a lot of effort into understanding the capabilities at our university partners and the directions they want to go in and understanding within our businesses what the priorities are for some of the real high-risk areas and trying to match those up so that we can see a good alignment for a partnership. The way they come about at that point is myself or somebody in our organization will make those connections to the university, say hey, we would like to talk about this area. Let's get together. And it just starts just like you want to just sit down and talk and see how things align and what you can do with each other.

Mr. LIPINSKI. Do you look at what is being done already at the university or do you choose the university first and then start talking about—how does that come about?

Dr. GRAZIANO. We pretty much look at what is being done at the university or what the really strong, really bright minds are doing there and see if those capabilities align with what we are doing. So they don't necessarily have something that is all developed and then we go in and say, hey, you already have this; here is a fee for service. But, look, we got some really bright stuff going on in general in this area of optical electronics. Let's talk about whether or not you can help us now come up with new lighting technologies for displays. And so we look at that general strength that they have and then try to shape something together.

In some cases, we try to leverage what is already being federally funded. The EFRCs, which are out there in the case of solar, we engaged Cal-Tech, University of Illinois, and UC Berkeley, who are all leading up one of those—one of the energy frontier research centers and said, hey, we see a way that we can engage with that. It is already stuff that is going on. You got some great work going. Now, let's see how can we start to take that fundamental research and build it out so that we can actually think about applying it

commercially down the road. And it is not just a matter of dumping it in. There are still many risks and challenges that have to be achieved to get that fundamental research and bring it to commercialization.

Mr. LIPINSKI. Are there other sort of types that anyone else wants to mention, types of partnerships besides what Dr. Graziano was describing

Dr. HICKMAN. We have a number of types of partnerships. They can involve service agreements where you are looking for an answer very quickly. They can involve consulting arrangements and memberships in consortiums. Quite often, universities will have specializations, sometimes very niche-related consortiums, where you can begin those relationships. These are excellent ways to begin learning what the capabilities are between universities and industry.

Mr. LIPINSKI. Anyone else?

I want to ask what is the role, then—and Dr. Graziano talked about EFRC—how much of this would be going on—I mean what—where do you see the importance of the role of federal funding in all of this? What if federal funding were lessoned or disappeared? How much of this work that you are doing—your partnerships, your collaborations with universities—how much would it take the place of any of that or could it to any extent or is it really the fact that is this research—federally funded research wasn't going on, you wouldn't have these opportunities that you have to make these partnerships. What is your opinion on—whoever wants to jump in.

Mr. LIPINSKI. Mr. Green?

Mr. GREEN. No, I mean I think—you know, sometimes we—you know, we miss the forest for the trees here. I mean what we are talking about is the opportunity to create a new economy. All right. And what we are talking about is the opportunity to have business closely engaged so that there is a good economic value in this research. And I think, you know, frankly, we need to double-down on the things we do federally funded but we also need to industrialize the process of business working with our universities in a consistent, predictable way because that is what is going to generate the economic renaissance. Because really—you know, what we have talked a lot about today is about the how you get there, but what we are solving for, right, our high-skilled jobs, rising standards of living, and an economic vibrance. And that is the trapped assets that we have in the universities that we need to exploit from the Federal Government and from industry.

Mr. LIPINSKI. Does the Federal Government have a role in helping to increase those——

Mr. GREEN. One of the——

Mr. LIPINSKI. —relationships?

Mr. GREEN. One of the things you mentioned, you know, you mentioned tax and so forth but you also mentioned convening and collaborating. I think the Federal Government has a profound role and in fact obligation and it is a missed opportunity not to try to take all these little point solutions, which are all good, but industrializes the state of mind for how the United States is going to regenerate economic activity with a bias towards innovation and differentiation.

Mr. LIPINSKI. Thank you. And I am way over time. I just want to say I appreciate—I want to congratulate Ms. Garton and Georgia Tech for the I–Corps node and I think that is another important way among many to promote entrepreneurism.

And I will yield back.

Chairman BROOKS. Thank you, Mr. Lipinski.

The Chair now recognizes himself for five minutes.

The National Academies report includes several recommendations for increased federal financial support. I find these recommendations illustrate a somewhat interesting perspective about the outlook for federal funding over the next several years given the situation that we are in. And I am going to have two comments and then I am going to ask you all to respond.

According to committee staff, expenditures for research performed in academic institutions have almost doubled in the past decade, rising from $30 billion in 2000 to almost $55 billion in 2009 in current dollars, which in current-dollar terms is roughly an 83 percent increase in funding over a nine-year period of time. The amount of research and development performed by business rose from nearly $192 billion in 2000 to nearly $267 billion in 2008, an increase of 39 percent in current dollars.

At the federal level—I am going to hammer on something that you all are probably already familiar with—we have record-setting deficits. We have had a 1.4 trillion and 1.3 trillion and 1.3 trillion back-to-back-to-back. This year, we have already blown through the $1 trillion deficit mark. White House projections for this fiscal year around 1.2 trillion. The White House is already projecting that next fiscal year starting October 1 will be another trillion-dollar deficit.

As a consequence, our total debt is ballooning. We blew through the $15 trillion debt mark in November of last year. We are soon going to blow through the $16 trillion debt mark this year. Entitlements have gone up considerably. Entitlements during the last fiscal year went up more than $100 billion in cost to American taxpayers. Debt service from fiscal year 2010 to fiscal year 2011 went up $25 billion. One of the adverse consequences of borrowing more money is that you have to pay more to the creditors in exchange for the higher debt that you have borrowed. Twenty-five billion, to put it in perspective, that is more than the entire Federal Government budget for NASA and that is roughly half of the entire federal budget for all of our transportation infrastructure needs—highways, roads, things of that nature.

So in this kind of context we can anticipate there is going to be stiffer competition for scarcer federal dollars going forward, and in that competition between, say, research universities and entitlement programs, do you have a judgment as to who should prevail? What is the best approach for our country going forward? What is the best approach for our economy going forward? And why do you have a judgment as to who should prevail?

Mr. Green, and then we will just work across.

Mr. GREEN. I guess, you know, I am a business person. I make a payroll, I run a tight ship, I think hard about economics. I do believe that our research capabilities are an untapped asset. I think a dollar spent on research—I mean you get a shovel-ready project, you get a swimming pool. You get a bridge. You get a research-

ready project, you can change how the world works and lives. I think our research institutions have an obligation to be more efficient and deliver more value for money. I think they have taken that on and it says that in the report.

But I think importantly, in terms of changing how the world works and lives, in terms of having an innovation economy, the return, you know, in shovel-ready is Hickman, 5X. The return in research-ready could be 1,000X. And as a business leader, I believe that profoundly and I think it can really energize the next renaissance in American economic activity.

Chairman BROOKS. Before I get to Dr. Johnson, let me add that I am from Huntsville, Alabama, which is the home of America's second-largest research park and we also have two fine universities that are engaged in basic research. So I agree with your point of view, Mr. Green. What I am looking for is ammunition or insight that can help us prevail in these kinds of debates and arguments going forward. And of course, if you disagree and think research universities should not be competitive with the entitlement programs, feel free to express that point of view, too, because we would love to fund all of them but we don't have enough money to do so.

Dr. Johnson?

Dr. JOHNSON. Thank you.

I think that, as the report points out, there can be increases in the efficiency, the partnership between academia and industry and the focus of the research. So there can be efficiency increases. However, we know historically that investments in research and development have been an engine for the economic growth of the Nation and of other nations in the world. Roughly 50 percent of the new jobs created will be in STEM fields.

We are also on the cusp of the convergence of a lot of technologies that have been behind the curtain in basic research for a number of years and that are finally coming together and finally reaching the point where they can make a huge impact. Advanced materials, advanced manufacturing, these can be turned into economic engines for the nation and discriminators for our competitiveness.

Chairman BROOKS. Thank you.

And Dr. Hickman, before I get to your remarks, I see my time has expired. But inasmuch as I am the Chair, I get to waive those kind of things. But I want to assure my colleagues that if they have a pending question they would like all the panelists to answer that I will similarly waive the 5-minute rule so that they can get an answer from each of our panelists.

Dr. HICKMAN. Well, I agree with the comments that the previous speakers made. I don't need to reiterate their comments regarding the payback overall of research activities and the needs for improvements and efficiencies.

I also would like to tie a major role that research universities have in developing the future workforce, which will tie back to future entitlements. It may be a much longer-term perspective than the current entitlement issues, but there is that relationship, including the factor of making sure that we are trained in various

STEM-related fields and that applies across the broad reaches of the population of the United States.

Chairman BROOKS. Thank you, Dr. Hickman.

Dr. Graziano?

Dr. GRAZIANO. Yeah. One thing I want to bring up in this regard because I think what matters is not just getting more money out there, which is of course important, but how we focus that money. And we talk a lot about universities doing basic research and then industry then just turning it into products. And I think the area to focus is really in that transition period. There is still a lot of risk coming from fundamental research on the products. There is a lot of development and a lot of knowledge that needs to be done there.

I think something like the proposals that have come out of the Advanced Manufacturing Program report tried to address that much the way the DARPA model tries to bridge that gap, you know, the valley of death sort of thing.

So I think it is a matter of focusing there not only because of helping to bridge that gap but it brings other organizations like the community colleges and it gets to bringing that research there, training a workforce not just at the high-level research areas but the technology areas and the medium-range areas. I think it is an area where we can really have impact if we could address the focus a little more, not just throw more money at it.

Chairman BROOKS. Ms. Garton, again, with respect to the competition between research universities and a myriad of other programs and the entitlement programs that are ballooning, where do you stand? What would you recommend that we in Congress do?

Ms. GARTON. Well, I agree with the other panelists that it is—that basic research that drives the transformational new ideas into entirely new industries. I also agree with them that undertaking more efficiencies, developing more streamlined processes, working together with the Federal Government to make our indirect cost recoveries cover all of our infrastructure needs. Those are very important components of becoming more efficient with the funds that we have. But it is that link between research and education that is going to reduce the need for entitlement programs in the future as we have a workforce that is expanding and new opportunities are being created from our research and using our own graduates as the workforce that drives that new economy.

Chairman BROOKS. Thank you, Ms. Garton, for your insight.

At this point, the Chair recognizes Mr. Clark—yeah, there is—from the great State of Michigan. You are up for your five minutes plus as needed.

Mr. CLARKE. Thank you, Mr. Chair. I appreciate it.

And as I mentioned to some of the panelists, I represent metropolitan Detroit, an area that has been very hard hit economically over the past few decades but yet has a very powerful national brand, and I would argue that brand is—goes far beyond the—its reputation the manufacturing sector. Once Detroit is perceived as coming back, that means our U.S. economy has come back with much strength in our global economy.

Once concern I heard throughout your various testimonies is difficulties relating to negotiating intellectual property agreements between business and industry. How can this Subcommittee actu-

ally make it easier to negotiate those agreements? Let me give you some examples. How can we better clarify who owns the property? Mr. Johnson, you indicated—Dr. Johnson, you indicated sometimes universities don't want to give up those rights. How can we make it easier to license technologies produced as a result of university research possibly by reducing some of the costs or some of the bureaucratic hurdles that have been mentioned?

Also, Dr. Hickman, you indicated that the time to negotiate these master research agreements is sometimes too lengthy. Are there any thoughts on what we could do to reduce those times? I know these are kind of specific questions but perhaps we can create a better way of negotiating these agreements that could ultimately spur—make it easier to create more jobs. That is my first question and I do have others. And this is posed to anyone.

Dr. JOHNSON. Okay. Thank you. I think the IP agreement support is best achieved through a partnership and a collaboration. I don't really easily see the Federal Government's role in the activity. What I do see is that when researchers at the university and when researchers in industry understand the other's needs that the agreements can be reached better. Historically, I think industry would come to a university and say we will pay for this research and all we would like is the intellectual property. That is really not in the university's best interest and they don't like that and they don't want to do that when in fact industry really only wanted used rights of that intellectual property, not ownership of the property. And I think reaching agreements and coming to better understanding of what each party needs will yield faster agreements and better agreements in the long run. Maybe there is a role for the Federal Government but I don't see it within that process.

Ms. GARTON. If I could add the National Science Foundation and National Institutes of Health have participated with the University-Industry Demonstration Partnership that Mr. Hickman described and that is an organization that has done a lot to improve the climate for contracting and licensing and really has developed some new agreement mechanisms and some supports for negotiators and training for people who negotiate agreements and has done a lot to make that process much easier.

Mr. CLARKE. Thank you very much.

Mr. Green, you powerfully mentioned that the return on research-ready investment could be 1,000X, which is extraordinary. In your testimony you indicated that businesses should better incentivize early-stage research partnerships with universities. If you or any of the other panelists have some thoughts on how we can best do that, best incentivize businesses to work at early stage with universities on research.

Mr. GREEN. Yeah, I think the first thing is, you know, getting the success stories known because there are some great stories out there and very self-interest where universities and businesses teamed up to do extraordinary things. But I think, as was mentioned in the opening remarks, you know, our lack of big industrial research capabilities that we used to have a la Bell Labs and Xerox Park and so forth, we have to replace that with something and we have to move from, you know, the science project if you will to industrialization of the innovation and invention. And I think that is

something that could be facilitated through, you know, convening and collaborating, you know, by this panel or others in government as well.

Mr. CLARKE. Yes, Dr. Hickman?

Dr. HICKMAN. Yes, another factor that is very important is just engaging universities. We have our employees engaging at universities on curriculum reviews and on advisory councils. When you start maintaining these relationships, such opportunities come to the forefront. And when the university learns your company and what your needs are, the company learns the university and what their capabilities are—it is that matchmaking process that becomes so important. That takes some work and takes some engagement on behalf of both parties—and opportunities do come to the forefront when that happens.

Dr. GRAZIANO. The—also just to add to that—and I agree. I don't think it is something the Federal Government can really dictate that engagement. It is something we have to drive. But ways to incentivize, some of the smaller programs, things like NSF Goalies, which, you know, bring fundamental research together with industrial partners. You know, those kind of programs that bring people together like that help create those points of engagement. We are engaging in a lot of places, we have a lot of good resources, but there is a lot of medium-sized companies that—and I was one with Rohm and Haas that, you know, it is harder to put those resources there. So that kind of incentive to get connected I think on programs together can be useful.

Mr. CLARKE. My goal representing southeastern Michigan is to encourage industry to partner with our great research universities. We have University of Michigan, Michigan State University, and then right in the heart of the center of Detroit is Wayne State University and how that type of partnership could create more jobs and economic development, especially for the central part of the City of Detroit where we have a lot of cheap, vacant property that has infrastructure. We have the roads, we have the sewers right there. We also have very hardworking and creative people who are out of work who are ready and willing to work. So we have all the assets that you need right there.

Many of you have mentioned the importance of making permanent and enhancing the R&D tax credit. You have other thoughts on how we could—on how that proposal could be further enhanced to spur job creation in blighted areas or high unemployment areas such as Detroit? But Detroit is really unique. It has gone through tough times but yet it has all of the assets and it has that international brand, though, that could be leveraged to create jobs throughout the country.

Dr. GRAZIANO. Well, one program I would point out—and I think one of the goals of the Advanced Manufacturing Program around these manufacturing innovation institutes and the manufacturing demonstration facilities, I think they provide a means to bring a lot of small and medium enterprises together. They are meant to be sort of pilot-shared areas so maybe they could start to make use of the infrastructure and facilities that are vacant in places like Detroit and start to bring in—and they are also meant to bring a

level of training so it might be a way to retrain employees, you know, toward some of these manufacturing areas.

So I think some of the concepts around there might be worth looking at that are ways that could help revitalize some of these areas that have infrastructure and some resources, how do we take better advantage of it. And that is where maybe I think the Federal Government might be able to help that with steering in that direction.

Mr. GREEN. I might also just add, you know, I think this is a place where our community colleges, which are also the overlooked and underappreciated resource in this country—Jim Jacobs who leads Macomb Community College just up there is one of the best people in the country. You know, the 45,000 people they used to train them for the auto industry and now they train them for healthcare and now they do other things. I mean it is a profound success. And I think—you know, I have always encouraged our national universities to adopt our community college system, one, as a source of terrific raw talent, underappreciated and overlooked. But secondly, it is the place where small and medium business can collaborate on a micro-scale and tackle some of these issues of the community.

And I think the important thing it isn't about degrees; it is about capabilities and it is about training for people—training people for three blocks away, not 3,000 miles away. And I think, you know, Detroit has made good progress in that but that is an important thing we have an obligation to pursue across the country.

Mr. CLARKE. Well, thank you so much.

Oh, yes, Dr. Johnson?

Dr. JOHNSON. Just wanted to mention that in the fall we will be taking a research team to the University of Michigan to have a 2-day collaboration. I think it happens to also be the days before the university plays the Air Force so I am hoping to stay and watch that game.

Commenting on the comments that were made to answer your question from the other panel members, I think there is this wonderful blend of—take the University of Michigan as an example of a really good research university. The—so you have business models that aren't closing. People want to do things and they want to—you know, there are activities that the business model won't close on and they require subsidies in order to work. Fortunately, there are many technology advances that are enabling the business models to close, mostly through cheaper manufacturing, cheaper products being able to do things in a more efficient and more affordable way. The research universities play a major role in making that happen so I can envision a partnership between the research universities, advanced manufacturing that is benefitting from the research university research making these cheaper because what you are doing really is fighting cheap labor. Right? What you are doing is taking away the cheap labor advantage through advanced manufacturing.

And then finally, I completely agree with community colleges. That was a question that we had earlier that the community colleges aren't just a place to prepare people for four-year colleges. All right. It used to be the community college prepared people to work

in skilled labor fields. I think this renaissance in manufacturing coupled with the research universities and the community college as a source of talent can be a wonderful consortium that could in fact help Detroit.

Mr. CLARKE. Thank you so much. I really appreciate your time and I would like to follow up with each one of you and your staffs on these issues. Thank you again.

Chairman BROOKS. Thank you, Mr. Clarke.

The Chair at this point recognizes Mr. Hultgren from the great State of Illinois.

And you weren't here but I am being a little bit liberal with respect to the 5-minute time limit. That doesn't often happen.

Mr. HULTGREN. I know. I have never known you to be liberal so that is good. No, thank you. Just kidding.

It is so good to be with you. I apologize. It is one of those mornings where we have got—I have got three Subcommittee hearings going on at the same time so I am kind of jumping around but very important subject. I just want to thank you so much, each one of you, for being here, for the work that you are doing. It is very important work. I do want to just give a special thank you to Mr. Green. I have the privilege to have the Q Center, which is an unbelievable education center in St. Charles in my district. Thousands and thousands and thousands of people are trained there and just an amazing place. I had the privilege of being out there a couple of months ago I think and was very, very impressed. So I appreciate the great work that Accenture is doing. It is fantastic.

But my hope is I am passionate about science, science education, basic scientific research, figuring out how we can push that forward and this is a really important discussion to have. I think during challenge times when budgets are tight, it opens up an opportunity for us and that opportunity is to communicate like we have never communicated before and realize that we are all in this together. And I think that is what is so important about this panel today is recognizing that interaction between business, corporate innovation, and our research universities and hopefully even taking it on the next step to our research laboratories.

I am passionate about our research laboratories and I think all three of those need to fit together all taking the responsibility that we are in this together. If it is going to work well, we have all got to take responsibility for telling the story of what makes America great, and a big part of what makes it great is wonderful research institutions, wonderful national laboratories, and wonderful corporate partners that are willing to come alongside to help us in this effort but also to ultimately bring benefit to the American people and to the world. I mean that is really what is going on. So thank you so much for being here.

Couple questions I have, Mr. Green, I would like to start with you if that is all right. But I know the National Academy Study Committee found that while industry has dismantled its large corporate research laboratories, they do—have not yet fully partnered with research universities to fill that gap. Why do you think this gap still persists and what can we do to push through that gap?

Mr. GREEN. Yeah, well, I think, you know, we heard today on the panel a lot of really excellent relationships and partnerships, but

I think the size of the problem is so big we have to institutionalize it and industrialize it. The last major wave in renaissance of invention was when our research universities and the U.S. Government teamed up after the war. The thing that is going to be the next renaissance, just adding business to that——

Mr. HULTGREN. Yes.

Mr. GREEN. —and having the incentives, the framework, and the industrialization to make it easy, to make it focused, and to take some of these issues that today, you know, we think are complex—they aren't—and wrestle those things to the ground in order to jumpstart, you know, sort of the renaissance of the innovation economy, which is, you know, what we need. And I think the report does a good job of articulating that. The Graduate Pathways Support does as well. It frankly suffers from a lack of leadership. How do you get all the people on the same page to pursue the same outcome?

Mr. HULTGREN. Well, I would open it up to some of the others of you as well on the panel if you would have any thoughts of how can we utilize this partnership? How can we take that next step? Many have and I am so grateful again we have got a panel full where we have seen that benefit, but how do we take it to the next level to other corporations who haven't accessed this and maybe even more smaller and medium-sized companies that potentially could grow into large companies and could benefit from that. Any thoughts on what is holding us back, what we can do as Members of Congress to push this forward?

Dr. GRAZIANO. Well, it is a tough thing to say how to actually do these things, right? And so I get back again to, okay, it is not just a matter of throwing more money at it. I mean more money is certainly useful but really focusing it in areas that, like you say, how do we bring small-, medium-sized enterprises together? How do we bring community colleges into the picture? So taking programs that will benefit—that we see will benefit our Nation and achieve our goals of growth in areas and zeroing in on what those area is is a challenge as well, too, and trying to bring opportunities for all those partners to share that don't necessarily have the resources at their disposal through co-funded programs with Federal Government, with private industry, with local government. I think those are the opportunities to bring a lot of different entities together that don't necessarily have the resources to do some of the kind of larger investments that some of the larger companies can do and it helps bring partners together and not just get universities and business to know each other but gets us knowing the small companies that we may not know about as well.

Dr. HICKMAN. I think there is an important role to research parks, the research incubators and that universities play. We were not the first ones on the University of Illinois campus, but we saw what the other companies were doing there. We went, too. You find a whole environment that supports innovation with the students and the type of energy students have, it opens up resources. The faculty get to know you. And so any activities at universities also should allow faculty some freedom to start up some of these small companies, to be able to get them started in a place that can be later turned over to industry is a very important role. These foster

a whole environment of innovation that will be important for years to come.

Mr. HULTGREN. Well, again, thank you so much for being here and I really do appreciate the testimony and want to continue this discussion as well.

One challenge I would make to each one of you and to others that I make a challenge to many of my constituents who are physicists at Fermilab doing great work there and I would love for them just to be able to focus on their physics research but, you know what, they have to be good at telling the story of how important the work is that they are doing and how we have to, as a Nation, be a part of this, how this has to be a priority. So what we have pushed on, really, is even with collaboration there reaching out to universities who are also engaged for them to connect with their Members of Congress. And that is something I would just encourage you as well all the people involved in this partnership to be telling the story back to Members of Congress of how valuable this is, how valuable this collaboration is and how important our research universities are to be a part of that for us to be that innovative nation that we all want going forward.

So thanks for being here. Thank you for your time. Thanks for your work and hopefully we work together in the time to come here.

So I yield back. Thanks, Mr. Chairman.

Chairman BROOKS. Thank you, Mr. Hultgren.

At this point, the Chair recognizes one of our newer Members—and I am a freshman; she is newer than me—from the great State of Oregon, Ms. Bonamici.

Ms. BONAMICI. Thank you so much, Mr. Chairman.

And thank you, Chairman, and also Ranking Member Lipinski, for holding this hearing today and for all of you for your testimony on this critical issue.

The district I represent in Oregon is home to a thriving technology industry, and we have industry giants like Intel and numerous smaller technology companies. We also have in Oregon a signature research center ONAMI, which is the Oregon Nanoscience and Microtechnologies Institute that is a collaboration among all of our Oregon research universities and industry and our investment community, very successful work on not only the research but the commercialization going on there.

We all know and we have had the discussion here today that the economic success of our country is going to depend on having the workforce that these companies and all the numerous startup companies need to continue innovating and growing. And I look forward to working with all of you and all of us on the Subcommittee in promoting STEM education.

And although I know our focus today is on the university level, I am actually pleased to see that, Dr. Graziano, you mentioned in your testimony the importance of preschool—or pre-K through postsecondary education. And I am especially appreciative, too, of the comments, and Mr. Green, you mentioned the need for creativity and innovation. And given those needs, we should also be concerned about the trend in education about cuts to non-STEM disciplines that lead to creative, innovative thinkers. If you know the

connection between music and math, you will appreciate that. We all know we need those creative, innovative thinkers and a well rounded education, including of course focus on STEM will lead to that.

What I want to ask about today is one of the recommendations provided in the National Academies report and that is that the businesses and universities work together to develop new graduate programs that address strategic workforce gaps for science-based employees. I have spoken with some of the constituent businesses in Oregon that have open positions because of these gaps, the workforce gaps. My question is for both of those in the private sector and on the university side, if you could talk about how you respond to those gaps, how you identify that the gaps exist, and then match up the companies with the universities to help create the students with the full set of skills they need to succeed in the workplace. And I know, Dr. Graziano, you in your testimony point to one of the main principles of using key partnerships to create the workforce of the future. So I would like to hear a little bit about how you are identifying the gaps and then working to fill them. Thank you.

Dr. GRAZIANO. Well, a lot of where I have worked has been in the graduate level so I probably don't have all the details down at the workforce level at the midrange. But I think one of the big issues there—and I think it also applies to what Mr. Hultgren had brought up—is communication. We are losing so many people at a young age away from the sciences and it gets to how do we communicate better that there is exciting things to be done in science and engineering and education? The thing that excited me and got me in chemistry—which I hated in high school by the way—was—in the '60s and '70s was the environmental movement. It was just all over there. And I see a resurgence in people's interest in the technical challenges now with energy, with water, with food, all those things, and we got to do a better job exciting people about these areas so that we don't lose them at a very young age.

Ms. BONAMICI. Thank you.

Yes, go ahead.

Mr. GREEN. I think there is a lot of good information out there. I mean sometimes in this education space we, you know, tend to reinvent the wheel and do the study again to come up with the same thing that was in the study before, but I think in the area—what Change the Equation group has done, Business-Higher Education Forum, which is very well known, very straightforward. We do have to not just education; we have to energize and inspire. And that I think is the challenge of, you know, today's generation. Right, the education is very vertical. We have to teach in a horizontal way that shows the outcome and that focuses on inspiration, right, things that one can do with this.

And so I think there are two things. First of all, there is time-to-job, right, filling the jobs we have and I think community colleges have proven to be incredibly focused at that, incredibly good at it. The second thing is companies need to go upstream. We can't say to the education infrastructure we know what we like when we see it. Right? We have go to in there and on the Commission on the Pathways through Graduate Schools and into Careers Report

talks about that. We have to go shape what we want as outcome and I think that is incumbent upon all of us to do that in all of our important recruiting schools. And we have to think about jobs not in terms of the jobs of today but the jobs we haven't invented yet because 40 or 50 percent of the jobs five years from now don't even exist today and we need to put more business cycles into helping the education infrastructure figure that out.

Ms. BONAMICI. Thank you.

And I know, Dr. Johnson, you——

Dr. JOHNSON. Yeah, thank you.

Both of your questions, the second one first, take an area of great interest to us today in the corporation and I think nationally cybersecurity. We recognized a few years ago that the number of graduating cybersecurity experts if you will, people educated specifically in cybersecurity, was not going to meet the needs of our corporation, much less the Nation. And so we worked with major universities, with our partner universities to develop programs in that area. So this is an example of how we develop programs that feed a particular need today at the graduate—at the undergraduate and graduate level.

Your other question really was talking about the pipeline and we are really proud to be able to comment on our sponsorship for the USA Science and Engineering Festival that was held in—the first one was held in October of 2010 on the National Mall where we were able to get over a million people to visit over 1,500 hands-on exhibits where you translate from the theoretical to the practical to do that inspiration, to get kids excited about science. And then we held the second festival in April of this year at the Washington Convention Center, again, diverse set of families from all over the metro area who got a chance to see this time over 3,000 hands-on exhibits.

So we are concerned about the pipeline decisions to go into science and engineering generally is to be made at a young age so they get algebra at an eighth grade so they can continue on that math and science track. So we are strong supporters of developing that pipeline.

Ms. BONAMICI. Thank you very much.

Ms. GARTON. Ms. Bonamici, I would just—I would like to add that I think that one of the most important things that we can do in universities to bring a little bit of understanding about future workforce needs to our curriculum is to really engage our students from the very beginning of their undergraduate careers in problem-based learning. And that is one of the things we have done at Georgia Tech I think pretty successfully is bringing industry into the university to help inspire some of the problems, to help identify some of the challenges that they are facing and offer them to our students as problem-based learning challenges even as freshman and then working all the way through the senior design courses. Often companies give us access to company data sets or to company facilities so our students can work on these problems, and we have had a lot of inventions come out of those undergraduate problem-based learning courses and through some of the grand challenge contests that companies have sponsored at universities where they

identify a problem and ask students to work on the grand challenge to get a prize.

And so you develop that creativity, you spark that inventiveness, you engage them in the research, you teach them the skills to solve the problem, and that is part of the way we find where the work force needs are going to be and what we need to bring into the curriculum. And we spur those students on to engage in research and to be creative and to solve problems.

Ms. BONAMICI. Thank you very much. My time has expired but thank you for your very inspirational ideas. Thank you.

Chairman BROOKS. Thank you, Ms. Bonamici, for your insightful questions and the Committee's witnesses' responses.

I would like to thank the witnesses for their valuable testimony and the Members for their questions. The Members of the Subcommittee may have additional questions for the witnesses and we will ask you to respond to those in writing. In that vein, I have one.

We had a hearing not too long ago on the regulatory impact on university research. And the witnesses at that hearing indicated that they had some specific regulations that they thought were counterproductive, excessive, overly burdensome, what have you. This may apply strictly to Ms. Garton, but still, if anyone else wishes to supplement with a written response, I would very much appreciate it. If you are familiar with any Federal Government regulations which you believe have the net effect of inhibiting the universities' abilities to properly conduct basic research of the kind that we have been discussing today, please share that with me and our committee staff so that we will be in a better position to address some of those regulations going forward.

With that request having been made on the record, the record will remain open for two weeks for additional comments from Members.

The witnesses are excused and this hearing is adjourned.

[Whereupon, at 11:39 a.m., the Subcommittee was adjourned.]

Appendix I

Answers to Post-Hearing Questions

ANSWERS TO POST-HEARING QUESTIONS

Responses by Mr. William D. Green

BILL GREEN, Executive Chairman, Accenture
Responses to Questions for the Record

HOUSE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON RESEARCH AND SCIENCE EDUCATION

The Relationship Between Business and Research Universities: Collaborations Fueling American Innovation and Job Creation

August 1, 2012

The Honorable Mo Brooks

1. The National Academies report included several recommendations that include increased federal and state financial support. I am concerned that these recommendations illustrate a potential lack of realistic perspective about the outlook for federal and state funding over the next several years. We in Congress are working hard to ensure every federal dollar is intelligently invested in programs that will support job creation and American innovation. How have today's economic realities affected your industry-university collaborations?

Mr. Chairman, in today's economic climate, austerity requires all of us – businesses, universities and governments – to be more innovative than ever, to remain competitive and to optimize the productivity that will determine our economic future. Like others, Accenture has learned to work more efficiently to achieve the goals of our partnerships. We know that individuals with graduate degrees will drive the R&D that fuels innovation and job creation, so we must continue our efforts to encourage students to earn advanced degrees. We and other growth-oriented companies understand this warrants continued investment even in a challenging economy.

The funding increases will ensure that critical basic research programs are supported, and achieve a balanced research portfolio capable of driving the innovation we need for economic prosperity. Together with cost-efficient regulation, this stable funding will enable universities to make comparable investments in research facilities and graduate programs. And because research and education are intertwined in universities, this funding will also ensure that we continue to produce the scientists, engineers and other knowledge professionals the nation needs.

2. The National Academies report recommends taking steps to grant residency for non-U.S. citizens who earn doctorates in areas of national need. There are some who may want to ensure caveats that help to guarantee the Nation's safety. Likewise, it is equally important that American students receiving these doctorates receive priority for potential jobs. What are your thoughts on this recommendation?

For a number of reasons, this recommendation makes great sense for the American economy and for our country. We have a burning need for highly-trained scientists and engineers in multiple industries, and non-U.S. doctoral researchers have already chosen to study at our world-class institutions. In an increasingly competitive global marketplace for people, ideas and commerce, we need to attract and retain as many top minds as we can. Over the past 50 years, highly-trained immigrants have been job creators as innovators and entrepreneurs. We should take reasonable steps to increase their presence.

I will underscore, as does the report, that homeland security considerations must be paramount. The Department of Homeland Security should be involved in determining areas of national need and which universities are accredited for study, in addition to their traditional role in immigration.

In addition, given the great shortage of U.S. doctoral candidates, I do not believe the need for priority treatment will be an issue.

3. In your testimony you mentioned your work on the Pathways Through Graduate School and Into Careers report. You noted that report recommends "increasing collaboration between higher education and business/industry." That report is yet another source citing the importance of the types of collaborations we discussed at the hearing. Based on the testimony at the hearing, it would seem that a number of U.S. industries are working on partnerships and collaborations with institutions of higher education. Can these existing partnerships serve as a guide to other businesses who wish to take a similar step towards collaboration? Why has this become such an essential step in continued innovation and job creation in the U.S.?

Yes, Mr. Chairman, existing partnerships with higher education described by Accenture and others at the hearing can be useful guides to other businesses seeking similar collaboration, and we encourage all companies to extend and build on what is being done today. It is in their best interests and those of our country.

As the National Academies and Pathways reports made clear, these partnerships have become an imperative for industry, which has always been an important source of research and innovation. However, as industry has largely dismantled the large corporate laboratories that drove American industrial leadership in the 20th century – Bell Labs is probably the best known example – new partnerships with America's research universities need to be formed to fill the gap. Likewise, partnership in the development of advanced graduates, particularly those with science, technology, engineering and mathematics (STEM) degrees, is critical if America is to develop the talent needed to fill many jobs today and a vast number of positions that will be created in the future.

CEOs told us they are most concerned about remaining competitive in an increasingly global marketplace, and that they worry about how they will find and mold the talent that drives research. Partnerships with our fine research universities provide a multiple win – for corporations in terms of accelerated innovation and internal talent development, and for

universities in terms of increased funding for research that will develop new talent to fill the jobs of tomorrow, jobs that innovation will spawn.

The Honorable Dana Rohrabacher

1. The National Academies report, *Research Universities and the Future of America,* from June of this year, states, "the cumbersome export controls ... fail to recognize the fundamental difference between the physical export of very sensitive technologies to a foreign country and the legitimate sharing of information at U.S. universities..." At the other end of the spectrum, a retired University of Tennessee Professor was convicted in 2009 of violations of export control laws when he illegally exported advanced plasma technology data from a military contract to China. What is the appropriate balance for regulation of industrial and university research and development in the context of national security? What factors should Congress consider when assessing the burden of regulations established for national and homeland security reasons?

We, at Accenture, certainly recognize the critical responsibility of the U.S. Government to enforce U.S. export control laws in order to protect America's national security interests. And we believe that private sector companies and academic leaders share in the responsibility of ensuring that U.S. export control laws are both respected and followed.

Your question suggests the various considerations that should be taken into account while enforcing export control laws related to academia. Clearly, we need export controls to protect America's national security interests, and this, of course, is job number one for Congress when assessing regulation requirements for industrial and university research and development. At the end of the day, the objective should be to articulate a set of clear and implementable rules and procedures that safeguard our national security interests while also permitting a sensible and legitimate exchange of information within academia.

The Honorable Dan Benishek

1. I'd like to follow up on the question I asked at the hearing regarding collaborations with community colleges and smaller universities. Gogebic Community College in my district performs research. Beyond partnering with bigger universities, what advice would you provide to them on how best to reach out and explore collaborations with local industry for specific research collaborations? Would you recommend this same advice or a different strategy to other smaller schools and community colleges who may want to cultivate industry collaborations for workforce development programs and curricula specific to local industry needs? Please elaborate.

Thank you for your question, Representative Benishek. I am an outspoken advocate for America's community colleges and two-year institutions of learning. They have been a valuable resource for decades, providing education and job training for both traditional college students, newly graduated from high school, and for mature learners seeking to upgrade skills or retrain for new jobs as our economy changes. I am also a proud graduate of a two-year college.

Community colleges have shown a great ability to develop deep knowledge of and roots in their communities, particularly local business communities. This has helped them develop curricula

to address the talent development needs of local companies, including everything from working with robotics in a manufacturing environment to nursing skills for the healthcare industry.

And this is my recommendation for any community college or small college: To research and reach out to local businesses to find out what they are doing, where they are going, and what they need to fill today's jobs—and, particularly, the jobs that will be created by innovation and growth. They should also assess their own research strengths to understand how they align with local needs. Working collaboratively with local businesses can be the first step toward expanding a program or developing new programs, based on local needs.

The process of reaching out is straightforward. Survey the field, network or reach out directly, set up meetings and discuss opportunities to collaborate. I wish your constituents at Gogebic Community College all the best with this endeavor.

Responses by Dr. Ray O. Johnson

Questions Submitted for the Record to Dr. Ray O. Johnson

Senior Vice President and Chief Technology Officer
Lockheed Martin Corporation

Hearing Date: August 1, 2012

House Subcommittee on Research and Science Education

"The Relationship Between Business and Research Universities: Collaborations Fueling American Innovation and Job Creation"

Questions from Chairman Mo Brooks

Q1: The National Academies report included several recommendations that include increased federal and state financial support. I am concerned that these recommendations illustrate a potential lack of realistic perspective about the outlook for federal and state funding over the next several years. We in Congress are working hard to ensure every federal dollar is intelligently invested in programs that will support job creation and American innovation. How have today's economic realities affected your industry-university collaborations?

Today's economic realities are impacting our university collaboration efforts. Our research budgets must aggressively compete with other business priorities that offer more near-term benefits. In addition, we are increasingly concentrating our efforts in fewer, larger partnerships with universities. This shift is a combination of intensified efforts in certain strategic areas, such as cyber security and nanotechnology, as well as the overall economic downturn.

Q2: The National Academies Report recommends taking steps to grant residency for non-U.S. citizens who earn doctorates in areas of national need. There are some who may want to ensure caveats that help guarantee the Nation's safety. Likewise, it is equally important that American students receiving these doctorates receive priority for potential jobs. What are your thoughts on this recommendation?

As a federal contractor, Lockheed Martin is required to treat all applicants equally and consider those that meet the basic qualifications of the job. In order to ensure compliance as an Equal Opportunity Employer, priority preference for American citizens could be considered discriminatory. This practice is consistent with the Code of Federal Regulations – Title 41, Part 60-250.5. Many of our positions, however, require security clearances and citizenship is an important component of obtaining security clearances.

Q3: Your testimony stated that Lockheed Martin is looking for "game-changing inventions, not evolutional improvements," why is that? What is the key distinction for Lockheed Martin between these scientific processes? Why is one valued more highly than the other?

Our customers face extremely challenging issues, from the diverse needs of today's Warfighters to our country's pursuit for greater energy efficiency. These issues cannot be overcome on acceptable timelines solely with incremental improvements of existing technologies, equipment, and services. We want to offer game-changing solutions that can quickly make profound contributions to our customers and to the greater community. The rigor and review processes used for potentially profound inventions and innovations are the same as those used for evolutionary improvements. This pursuit is inherent in Lockheed Martin's culture. Our founders were among the first to attempt flight.

Questions from Congressman Dana Rohrabacher

Q1: Some countries offer companies tax incentives to undertake collaborative research with universities. For example, France and Italy offer credits of 60 percent and 40 percent, respectively, while America's R&D tax credit expired at the end of 2011. Has your company taken advantage of such incentives? If so, do these incentives encourage your company to preferentially conduct collaborative research with universities in those countries?

Lockheed Martin does claim the U.S. R&D tax credit when available under U.S. law. An immaterial amount of the company's qualifying research expenditures for U.S. R&D tax credit purposes is attributable to collaborative research with U.S. universities. We are not aware of any collaborative research between Lockheed Martin and universities in France and Italy which allow us to take advantage of special tax incentives in those countries. Additionally, we are unaware of any collaborative research between Lockheed Martin and universities in any foreign country that allows us to take advantage of special tax incentives in foreign countries.

Q2: The National Academies report, *Research Universities and the Future of America*, from June of this year states, "the cumbersome export controls . . . fail to recognize the fundamental difference between the physical export of very sensitive technologies to a foreign country and the legitimate sharing of information at U. S. universities . . ." At the other end of the spectrum, a retired University of Tennessee Professor was convicted in 2009 of violations of export control laws when he illegally exported advanced plasma technology data from a military contract to China. What is the appropriate balance for regulation of industrial and university research and development in the context of national security? What factors should Congress consider when assessing the burden of regulations established for national and homeland security reasons?

In May 2010 guidance, the U.S. Department of Defense indicated that it "fully supports free scientific exchanges and dissemination of research results to the maximum extent possible" and, while there may be compelling reasons to control some university research, "such occasions should be rare."

One of our strongest assets as a nation is the commitment and dedication to technological innovation. Ensuring that we can attract the brightest foreign students to study and work in the United States and facilitating an efficient global supply chain and marketplace are both critical to our future success in developing advanced military and "dual-use" technologies (technologies that have both civilian and military applications). In this context, Lockheed Martin has been a strong supporter of ongoing efforts to modernize U.S. export controls. Where the U.S. export control system can be made less onerous, more effective, and focused on the most sensitive technologies, we have encouraged reform. But such reforms should and do not undermine U.S. national and homeland security; national security considerations must remain the predominant consideration for how the United States implements its export control system.

It has been Lockheed Martin's experience that U.S. research institutions, corporations, and universities alike are strongly committed to protecting U.S. national security. Accordingly, Congress should continue its close collaboration with the U.S. private sector and academia to ensure that export controls continue to protect our sensitive technological advancements, while taking into consideration the strong U.S. commitment to and benefit from fostering innovation and facilitating the exchange and sharing of fundamental research.

Question from Congressman Dan Benishek

Q1: I'd like to follow up on the question I asked at the hearing regarding collaborations with community colleges and smaller universities. Gogebic Community College in my district performs research. Beyond partnering with bigger universities, what advice would you provide to them on how best to reach out and explore collaborations with local industry for specific research collaborations? Would you recommend this same advice or different strategy to smaller schools and community colleges who may want to cultivate industry collaborations for workforce development programs and curricula specific to local industry needs? Please elaborate.

Community colleges play an important role in research processes. My recommendations for ways that colleges can engage with industry are the same for two-year and four-year schools.

Some of the most successful collaborations are summer internships. In recent years, one of Lockheed Martin's business areas required internal research and development principal investigators to use at least one summer intern per project, depending on funding level. Through this work, the students, colleges, and Lockheed Martin formed productive relationships. I recommend that community colleges continually look for internship opportunities for their students.

Another recommendation is to create visiting faculty programs. I know many experts who would enjoy the opportunity to take a sabbatical for a semester or more and teach. This type of program gives students exposure to real-world experts with real-world experiences, and it can be enormously fulfilling to practicing engineers and scientists. Sabbaticals also have the potential to influence or even define curricula that are based on industry best practices.

A third recommendation is for community colleges to consider collaborative and/or sponsored capstone or research projects. Some schools require students to perform a research project as a condition to graduate. Lockheed Martin actively supports capstones and helps to shape, steer, and mentor the students throughout the projects. Well architected capstones are mutually beneficial situations. They help the students and schools solve real problems rather than hypothetical ones, and they help establish relationships with industry.

Responses by Dr. John S. Hickman

QUESTIONS FOR DR. HICKMAN:

1. The National Academies report included several recommendations that include increased federal and state financial support. I am concerned that these recommendations illustrate a potential lack of realistic perspective about the outlook for federal and state funding over the next several years. We in Congress are working hard to ensure every federal dollar is intelligently invested in programs that will support job creation and American innovation. How have today's economic realities affected your industry-university collaborations?

Deere's research and development efforts are aimed at creating the high-quality equipment solutions which customers can rely on to run their businesses – allowing them to be more productive and more profitable. The pace of growth and the breadth of application of technology advancements make it clear that no one company has the resources to develop, maintain, and support all of the hardware and software applications being demanded in even one industry. Our R&D collaborations with research universities play an important role in delivering such innovation and are part of our overall R&D budget.

Business results impact all aspect of corporate investment including capital investments, R&D expenditures, etc. Deere has continued to increase its absolute R&D expenditures every year over the last ten years. Total R&D spend has more than doubled over the last ten years.

2. The National Academies report recommends taking steps to grant residency for non-U.S. citizens who earn doctorates in areas of national need. There are some who may want to ensure caveats that help to guarantee the Nation's safety. Likewise, it is equally important that American students receiving these doctorates receive priority for potential jobs. What are your thoughts on this recommendation?

Deere supports policies that enable U.S. employers to seek and retain high-skilled workers, including those trained at U.S. research universities. Legislation to remove the per country cap in our legal immigration employment-based (EB) green card system is important to Deere because it would improve our ability to utilize the talents and skills of many highly-qualified EB applicants from large countries. Instead of creating new jobs and products here, the per country cap encourages highly-skilled workers to take their talents to foreign competitors abroad. In short, removing this cap will help keep U.S. manufacturers competitive in a global marketplace.

1. Some countries offer companies tax incentives to undertake collaborative research with universities. For example, France and Italy offer credits of 60 percent and 40 percent, respectively, while America's R&D tax credit expired at the end of 2011. Has your company taken advantage of any such incentives? If so, do these incentives encourage your company to preferentially conduct collaborative research with universities in those countries?

The R&D tax credit is one of many factors that impact decisions of where to locate R&D centers and collaborations with research universities. The R&D tax credit allows U.S. manufacturers like Deere to establish research centers in the U.S. as well as research collaborations with universities. These create high quality engineering positions for U.S. employees. These positions also create additional positions related to the support of the

engineering centers. The R&D tax credit helps create a level playing field with foreign competition allowing for competitive pricing of our products. Deere supports the extension of the R&D tax credit in the U.S. because we believe it helps companies to remain globally competitive.

As a global company, we have research and development activities in many different locations around the world. There is clearly strong global competition to attract R&D jobs and centers.

2. The National Academies report, Research Universities and the Future of America, from June of this year, states, "the cumbersome export controls ... fail to recognize the fundamental difference between the physical export of very sensitive technologies to a foreign country and the legitimate sharing of information at U. S. universities ... '; At the other end of the spectrum, a retired University of Tennessee Professor was convicted in 2009 of violations of export control laws when he illegally exported advanced plasma technology data from a military contract to China. What is the appropriate balance for regulation of industrial and university research and development in the context of national security? What factors should Congress consider when assessing the burden of regulations established for national and homeland security reasons?

National, regional and local governments around the world have enacted legislation to regulate business conduct in many areas such as employment, finance, taxation, safety, environmental protection, export control, competition and fair trade. Deere accepts these compliance responsibilities, sometimes referred to as corporate governance, as a normal business requirement. Related to export control, the company has designed and implemented policies and procedures to comply fully with the laws and regulations of the United States government that impose limitations on exports and U.S. foreign trade, known collectively as U.S. Export and Foreign Trade Controls. Such procedures extend to our participation in sponsored research including that at universities.

1. I'd like to follow up on the question I asked at the hearing regarding collaborations with community colleges and smaller universities. Gogebic Community College in my district performs research. Beyond partnering with bigger universities, what advice would you provide to them on how best to reach out and explore collaborations with local industry for specific research collaborations? Would you recommend this same advice or a different strategy to other smaller schools and community colleges who may want to cultivate industry collaborations for workforce development programs and curricula specific to local industry needs? Please elaborate.

By their very nature, community colleges often have their most impactful sphere of influence at the community or local level. Community colleges provide many recognized benefits to industry including being a source of talent in skilled trades and other skills as well as development of existing employees. Those community colleges with research programs should leverage their existing industry talent and employee development relationships as initial steps to highlight their research competencies and explore new collaborations.

Responses by Dr. Lou Graziano

Responses to Questions for the Record
Louis, Graziano, Ph.D.
The Dow Chemical Company

HOUSE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON RESEARCH AND SCIENCE EDUCATION
The Relationship between Business and Research Universities: Collaborations Fueling American Innovation and Job Creation
Wednesday, August 1, 2012
10:00 a.m.

Questions from The Honorable Chairman Brooks

1. The National Academies report included several recommendations that include increased federal and state financial support. I am concerned that these recommendations illustrate a potential lack of realistic perspective about the outlook for federal and state funding over the next several years: We in Congress are working hard to ensure every federal dollar is intelligently invested in programs that will support job creation and American innovation.

How have today's economic realities affected your industry-university collaborations?

Starting new collaborations is difficult to justify in today's economy. Meeting our shareholders' expectations in light of the uncertainties around global economic growth make investment in university research, which typically has a more strategic long-term return, a challenge. We have been more selective about our academic partnerships to ensure a good return on investment. Nevertheless we have made a number of strategic investments with our university partners because we realize the importance of these collaborations to maintaining sustained business leadership, which relies so heavily on a competitive science and technology platform.

I appreciate the financial burdens that come with the National Academies report recommendations. We struggle with maintaining an appropriate investment during times of economic uncertainty. Despite these concerns, we feel it is in the best interest of our shareholders and to the health of our company to continue to make select investments in the areas of science and technology that will sustain Dow as a leader in the world of business sand science. We see firsthand the investments that other governments are making to ensure a vibrant competitive technology base in their regions and strongly encourage Congress to make decisions which will ensure that our nation continues to be the global leader in science, technology and manufacturing.

2. The National Academies report recommends taking steps to grant residency for non-U.S. citizens who earn doctorates in areas of national need. There are some who may want to ensure caveats that help to guarantee the Nation's safety. Likewise, it is equally important that American students receiving these doctorates receive priority for potential jobs. What are your thoughts on this recommendation?

Dow strongly supports such action. We recognize the need to produce job opportunities for our citizens. At the same time we must make all allowances for the best and the brightest to continue to contribute to our nation after we have educated them. The benefits gained by embracing the greatest minds in areas of national need will help to present employment opportunities for many others. This will maximize the return on our investment in education. Only by taking a strategic approach to this issue, one which ensures that the United States effectively competes for the greatest potential contributors, can we ensure a sustained leadership position in the world.

Questions from the Honorable Mr. Rohrabacher

1. Some countries offer companies tax incentives to undertake collaborative research with universities. For example, France and Italy offer credits of 60 percent and 40 percent, respectively, while America's R&D tax credit expired at the end of2011. Has your company taken advantage of any such incentives? If so, do these incentives encourage your company to preferentially conduct collaborative research with universities in those countries?

A consistent and predictable R&D tax credit allows Dow and other companies to make investments in R&D that deliver medium to long term gains and help us stay out in the forefront of bringing new solutions to the challenges our nation faces. We do indeed take advantage of such credits, but not knowing from one year to the next if those credits will still be there makes it difficult to make the kind of multi-year commitments necessary to tackle many of the more challenging technological problems. Dow does make investments in our academic partners abroad. One of the bigger impacts on choosing a foreign partner over a national one is our ability to conduct research agreements under favorable intellectual property terms.

2. The National Academies report, *Research Universities and the Future of America,* from June of this year, states, "the cumbersome export controls ... fail to recognize the fundamental difference between the physical export of very sensitive technologies to a foreign country and the legitimate sharing of information at U. S. universities ... " At the other end of the spectrum, a retired University of Tennessee Professor was convicted in 2009 of violations of export control laws when he illegally exported advanced plasma technology data from a military contract to China. What is the appropriate balance for regulation of industrial and university research and development in the context of national security? What factors should Congress consider when assessing the burden of regulations established for national and homeland security reasons?

Dow fully supports the Administration's efforts to simplify and reform export control laws - to make sure that our regime reflects today's commercial reality, and works through a streamlined, simplified, easily enforceable process. We would welcome as liberalized a regime as possible. The focus of a reformed export control regime should be on restricting real security threats, and not restricting competitive advantage for American technologies, including Dow innovations.

3. With respect to the U.S. science, technology, engineering, and mathematics (STEM) workforce and its role in competitiveness, we frequently hear concerns about the supply of STEM talent from the U.S. business community. According the American Chemical Society,

in some fields, such as chemistry, unemployment is at a record high.

How can research universities and industry work together to send the right labor market signals to U.S. students so that they can graduate to jobs?

Addressing this issue is a partnership between the school districts, counselors, educators and parents. Universities need to partner with industry, key associations and non profits that reach students as early as 3rd grade to instill excitement and engagement in STEM. This requires consistent engagement through middle school in order for the students to have the core work ethic; skill set and core competencies for complex problem solving and interest in science going into high school. Novel approaches need to be pursued to engage parents and counselors early about the workforce needs and opportunities. Waiting until high school is too late.

How are universities striving to ensure that the domestic STEM labor supply includes the types of workers businesses need to remain globally competitive?

Universities are partnering with non profits like NACME, FIRST, Project Lead The Way, Girls Inc, Women In Technology, SWE, NSBE, NSTA, Teacher for America, UTeach etc and industry to do the following: 1) professional development of teachers in STEM disciplines, 2) develop curriculum that supports higher level and hands-on learning for students in the early formative development all the way to Advanced Placement curriculum and 3) provide broader access to students regarding STEM. But the problem is that everyone is trying a lot of different approaches versus a common and cohesive approach. More collaboration is needed among the universities, industry and non profits to reduce duplication and enable more targeted and focused impact.

What mechanisms exist to communicate business workforce needs to academic institutions?

We are not aware of any real mechanisms that exist other than the relationships that companies have with their strategic or core universities. What we have seen to date is the companies sharing with universities core competency needs and expectations of new hires on a one on one basis. Given the severity of these issues industry really could use a medium in which to proactively provide real-time input to all universities and community colleges the core skills needed from incoming STEM professionals.

What federal policies might facilitate or support this type of information exchange?
It is important to note that the federal role in education is limited due to the Tenth Amendment. This amendment states the Constitution's principle of federalism by providing that powers not granted to the federal government nor prohibited to the States by the Constitution are reserved to the States or the people. Therefore most education policy is decided at the state and local level. As you review each of the briefs below, you will note that each call for implementation to be enacted at the state or local level.

Also important in answering this question is the historical context. I found the background information below on the Organization for Economic Co-operation and Development (OECD) website.

Four times over the last two decades, national reports have helped redefine how the United States sees education in general and the transition from schooling to productive employment in particular. These reports were titled: *A Nation at Risk*; *Workforce 2000; The Forgotten Half: Non College Youth in America;* and *America's Choice: High Skills or Low Wages!* Each report reflected a sense that the U.S. economy was losing its competitive edge. In addition, the reports drastically changed the debate and discussion on educational perspectives. The reports signaled that the United States appeared ready to consider a set of initiatives designed to make more systematic programs of workforce development as part of a general strategy for reviving the American economy. In the end, the notion of building a new school-to-work system lost out to the realities of American politics, however, an important corner had been turned. The transition from initial education to working life—in the United States often reduced to the school-to-work transition or transitions—became a subject of both public policy and public investment.

The four policies listed below show the result of the shift in education reform debate. These policies call for specific actions that ensure industry and education work together to reform the current education system.

School to Work Opportunity Act of 1994 – President Clinton signed the School-to-Work Opportunities Act on May 4, 1994. The Act authorized $300 million for fiscal year 1995 and "such sums as may be necessary for each of the fiscal years 1996 through 1999." In 1994, eight states were awarded five-year implementation grants: Kentucky, Maine, Massachusetts, Michigan, New Jersey, New York, Oregon, and Wisconsin. All states received funds to plan and develop their programs in late 1993 and early 1994. In addition, 15 local partnerships were funded. The School-To-Work (STW) program--or school-to-careers program as it is often called--is one response to more than a decade of renewed interest in improving American education. Since the early 1980s, researchers, educators, employers, and policymakers have sought ways to make education relevant to students' future careers, adapt instruction to the ways in which students learn best, and ensure that students learn the habits and skills that employers value. By adding meaningful context from the world of work, educators hope to engage the interest and intellect of students and help them learn more effectively. Whether learning by doing and in context is accomplished at school, in a work setting, or both, STW seeks to improve career prospects and academic achievement in high school, and thereby boost enrollment in postsecondary education and increase the likelihood of high-skill, high-wage employment. The Act ensures a coordination of work- and school-based learning components by involving employers, improving secondary-postsecondary linkages, and providing technical assistance.

Workforce Investment Act of 1998 – On August 7, 1998, President Clinton signed the Workforce Investment Act of 1998 (WIA)-comprehensive reform legislation that superseded the Job Training Partnership Act (JTPA) and amended the Wagner-Peyser Act. The WIA reformed Federal job training programs and created a new, comprehensive workforce investment system. The reformed system was intended to be customer-focused, to help Americans access the tools they need to manage their careers through information and high quality services, and to help U.S.

companies find skilled workers. The WIA created a strong role for local Workforce Investment Boards and the private sector through a coordinated effort, business-led boards act as "boards of directors," focusing on strategic planning, policy development, and oversight of the local workforce investment system.

As part of the **American Recovery and Reinvestment Act of 2009**, Congress made substantial, badly-needed new investments in WIA. As Congress looks to reauthorize WIA in 2012 it will be an opportunity to help ensure our nation's workers receive the services and support they need to go back to work and begin rebuilding our economy. Ensuring that every U.S. worker has at least an industry certification, vocational degree or two years of college should be a national priority.

Goals 2000: Educate America Act – Signed into law on March 31, 1994, the Act provides resources to states and communities to ensure that all students reach their full potential. It is based on the premise that students will reach higher levels of achievement when more is expected of them. Congress has appropriated $105 million for Goals 2000 for fiscal year 1994. First-year funds became available to states July 1, 1994. In the first year, individual states will submit applications describing the process by which the state will develop a school improvement plan, make sub-grants to local schools, as well as grant awards for pre-service and professional development. Goals 2000 establishes a framework in which to identify world-class academic standards, to measure student progress, and to provide the support that students may need to meet the standards. The Act codified in law the six original education goals concerning school readiness, school completion, student academic achievement, leadership in math and science, adult literacy, and safe and drug-free schools.

Goals 2000 also creates a **National Skill Standards Board** to facilitate development of rigorous occupational standards. The Board will identify broad occupational clusters and create a system of standards, assessment, and certification for each cluster. The skills certificate will give students the portable, industry-recognized credentials described in the School-to-Work Opportunities Act of 1994 that indicate mastery of skills in specific occupational areas. Just as school-to-work transition is an umbrella concept for initiatives such as tech prep, youth apprenticeship, career academies, and the like, the Goals 2000: Educate America Act is an even larger umbrella that encompasses school-to-work transition and other school reform efforts. In short, Goals 2000 will fund systemic reform at the state and local levels and will provide a framework within which to organize all state and federally funded education programs.

The National Skills Standards Act of 1994 – A key part of the **Goals 2000: Educate America Act -- Title V** -- establishes the National Skill Standards Board (the Board). This Board will be responsible for creating a national system of voluntary skill standards to be available for use by employers, workers, unions, educators, and government. The structure of this Board follows a long American tradition of creating public and private sector partnerships to solve collective problems which are beyond the scope of either sector. Assuring that our nation has the strongest, technically competent workforce and facilitating its transition to high performance work organizations, represents such a joint challenge.

Questions from The Honorable Mr. Benishek

1. I'd like to follow up on the question I asked at the hearing regarding collaborations with community colleges and smaller universities. Gogebic Community College in my district performs research. Beyond partnering with bigger universities, what advice would you provide to them on how best to reach out and explore collaborations with local industry for specific research collaborations? Would you recommend this same advice or a different strategy to other smaller schools and community colleges who may want to cultivate industry collaborations for workforce development programs and curricula specific to local industry needs? Please elaborate.

I reviewed GCC's website and have provided some thoughts to consider below. Aside from partnering with larger universities I suggest:

1. Targeting research and trade shows that deal in the products and technologies with which GCC's research thrusts are aligned and seeing if poster presentations at those events are appropriate.

2. Reaching out to GCC alumni who are now members of the business communities that make and use products that might incorporate the technologies and products that GCC studies (I noticed from the GCC website that they have programs in Automotive Technology, Graphic Communications, Computer Aided Design and Building Trades & Construction. These may be appropriate areas to target, especially if you can find some regional companies that might need to learn more about what the GCC students have to offer). As you make these contacts, use them to determine what their needs are in the workforce and if appropriate, gear GCC curricula to assure ability to produce competitive students that meet their needs.

3. Consider whether mining information from small business research areas (e.g., SBIR funding) might lead to some contacts. Many small businesses are resource limited and if GCC has some special testing capability it may be a way to engage your students in some business opportunities.

4. Look for opportunities where the federal or state governments are supporting training centers. Have GCC consider whether the Utility Training program is keeping up with the anticipated needs of utilities in light of the potential shift to new energy sources.

Responses by Ms. Jilda Diehl Garton

Questions from Mr. Brooks

1. **The National Academies report included several recommendations that include increased federal and state financial support. I am concerned that these recommendations illustrate a potential lack of realistic perspective about the outlook for federal and state funding over the next several years. We in Congress are working hard to ensure every dollar is intelligently invested in programs that will support job creation and American innovation. How have today's economic realities affected your industry-university collaborations?**

While federal research support is vitally important for the novel work Georgia Tech researchers are doing, we also have a long history of working with industry to develop new technologies. While faculty members are innovative in the laboratory, the Institute has been innovative in its approach to working with industry. Whether directly attributable to the recent economic environment or not, Georgia Tech's strategic vision has spurred the Institute to focus on projects and engagements with industry that allow our scientists and engineers to collaborate on the development of technologies more broadly and through later stages of technical development. Objectives in the Institute's Strategic Plan for Research - creating transformative opportunities, strengthening collaborative partnerships, and maximizing societal impact - renewed our commitment to work with industry to transfer research results for public benefit.

We view research engagement as a continuum from basic research which leads to transformative discoveries, to translational research to develop new technologies, and then finally to work with industry to facilitate development of new products and services. New master agreement forms are useful for projects that seek to develop and test prototypes and for engagement with industry to integrate innovations into new systems. We now approach research with industry across progressive levels of technical development with agreements designed more specifically for different points along the continuum. Through these new models we intend to reduce barriers to development of innovations from basic research into new products and services by facilitating the engagement of our scientists and engineers in translational research and development supported by industry.

Georgia Tech is also helping create new environments for engagement with industry. Facilities such as the Center for Carbon Neutral Energy Solutions (CNES), which addresses energy self-sufficiency, offer the opportunity for Georgia Tech to work with industry on pilot scale projects to deploy new technologies. Construction of the CNES building is supported by the U.S. Department of Commerce. Other living laboratories provide venues for reducing risks for industry in adopting new technologies. For example, Georgia Tech HomeLab provides an independent evaluation capability for companies where Georgia Tech researchers can measure the long-term effectiveness and suitability of home health and wellness products in real-life through a network of 250 homes in Georgia.

Georgia Tech's efforts to engage with industry extend to the educational process. Faculty bring industry problems into the classroom through problem-based learning and capstone projects. In addition, industry challenges, entrepreneurship education, and prizes such as the Inventure Prize add opportunities for students to become inventors and entrepreneurs as they earn their degrees. This helps industry and American competitiveness in two ways: graduates leave the Institute with practical

experience in innovation that they take to their employers and students learn to be entrepreneurs and may create new businesses to commercialize new inventions themselves.

I share the concern that every dollar be invested wisely whether in basic science and engineering research where the breakthroughs that create new industries are likely to occur or in expanding collaborations that make it more likely that innovations will achieve practical application and enhance the American economy. That is one of the reasons we have worked diligently with the Industry-University Demonstration Partnership (UIDP) which was formed to improve the climate for contracting and technology transfer. UIDP helps companies and universities efficiently reach agreements that support the missions of both. To ensure maximum benefit from the federal investment in research, it is also important that available funds be used both for direct costs of research and for the maintenance of infrastructure through Facilities and Administrative Costs. As described in my written testimony, redundant regulations and reporting requirements should be minimized while regulatory frameworks that ensure safety and integrity in research should be efficient and consistent across federal grant-making agencies.

2. **The National Academies report recommends taking steps to grant residency for non-U.S. citizens who earn doctorates in areas of national need. There are some who may want to ensure caveats that help to guarantee the Nation's safety. Likewise, it is equally important that American students receiving these doctorates receive priority for potential jobs. What are your thoughts on this recommendation?**

I generally support the proposal to create a pathway to expedite granting permanent residence to individuals who come to the United States and earn doctoral degrees science, technology, engineering and math (STEM) fields at American universities. Our Nation's safety is everyone's concern and, as a person who deals with export control issues on my campus, I believe that it would be most useful to address security concerns posed by prospective students to the maximum extent possible prior to granting student visas and admitting the students to the U.S. The Student Exchange and Visitor Information System is (and should be) used to ensure that foreign nationals granted student visas are following through with their educational plans and making expected progress toward graduation. I also believe that it is beneficial to have these talented individuals become American citizens and contribute to our economy through the innovations they bring to industry and through the companies they create to bring innovations to the marketplace.

We should all be concerned that American students have the educational background to be successful in their undergraduate programs and that they go on to graduate programs. We also need incentives and role models who encourage students to pursue degrees in STEM fields. Diverse perspectives bring innovative thinking to problems of national and global proportion - a philosophy that is reflected in Georgia Tech's undergraduate programs. Bringing research opportunities to a diverse population of students helps provide the nation with a more skilled workforce. Georgia Tech produces more engineering graduates than any other university in the nation and ranks second in the nation in doctoral degrees in engineering awarded to African American and Hispanic students. Georgia Tech is proud of its record in graduating women and minority engineers at all levels and at the success of its graduates in finding employment. Georgia Tech is also a globally engaged institution and we believe that, to be successful, our students will need to compete in the global economy. To meet the demand for graduates in disciplines that require STEM preparation, the United States needs to draw broadly from all its students and from around the world and prepare them to compete in a global economy.

3. Can you please provide additional information about the Enterprise Innovation Institute at Georgia Tech? How did this begin? How does it identify and support key innovations that may impact local, state, and national economies?

Georgia Tech recognizes that entrepreneurs play a vital role in creating new jobs and new investment for Georgia. The Enterprise Innovation Institute (EI^2) was created more than a decade ago to support these entrepreneurs through a comprehensive set of initiatives. In establishing EI^2, Georgia Tech brought together existing programs such as the Advanced Technology Development Center (ATDC) and added focused efforts on new initiatives to identify emerging technologies with commercial potential. Today, EI^2 includes a number of initiatives that directly support innovators both within Georgia Tech and throughout Georgia. EI^2 has many programs that are described at http://innovate.gatech.edu/about-us/ including:

- **ATDC** - ATDC is a startup accelerator that helps Georgia technology entrepreneurs launch and build successful companies and is the oldest such incubator embedded in an academic institution. ATDC was launched by the State of Georgia and located at Georgia Tech in the 1980s. Companies affiliated with the ATDC program reported revenues totaling more than $1.3 billion in 2011, and more than 5,500 jobs.
- **Georgia Tech VentureLab** - VentureLab began operations in 2001 and supports Georgia Tech researchers, graduate students and others as they develop startup companies based on research innovations. It is a comprehensive center for technology commercialization that assists potential entrepreneurs in developing engaging business models, connecting with experienced entrepreneurs, locating sources of early-stage financing, and preparing their new companies for global markets. It is open to all faculty, research staff, and students who want to form startup companies based upon their research.
- **Flashpoint** - Flashpoint is a startup engineering program that accelerates the startup work of extraordinary entrepreneurs. Flashpoint teams access experienced mentors, technical, marketing and design experts, investors and entrepreneurial stars, and work in an exciting, immersive, shared-learning, open workspace.
- **GaMEP** - The Georgia Manufacturing Extension Partnership (GaMEP) assists small and mid-size manufacturers in areas such as lean innovation, quality, energy, and sustainability, to increase top line growth and reduce bottom line cost.
- **Technology Innovation Practices** - The Technology Innovations Practices program helps communities determine if business incubation should be part of their economic development strategy and, if so, how to successfully implement, operate, and stimulate a successful incubation program
- **SBIR Assistance Program** - Through the Georgia SBIR Assistance Program, companies receive help winning Small Business Innovation Research (SBIR) grants from federal agencies.
- **Minority Business Development Assistance** - The MBDA Business Center helps emerging and existing minority businesses experience growth and sustainability and to have long-term economic impact through the creation of jobs and revenue.

4. Does Georgia Tech, either through the Georgia Tech Research Corporation or elsewhere, have programs in place to help researchers identify what research may be viable for commercialization and to assist them in moving their research from the lab to the marketplace, including the pre-commercialization or proof-of-concept stage? I understand the University is now involved in I-Corps, were these programs in place prior to the connection to I-Corp and if so, were they working and creating successes?

Georgia Tech has a number of programs in place to help entrepreneurs identify and commercialize technologies but is working hard to find better ways and to generalize what we learn to have a greater impact. Georgia Tech's mission is to encourage innovation, advance knowledge, and serve the public interest. It engaged in more than $655 million dollars in research in 2012 which led to more than 400 invention disclosures the majority of which are the result of federally-funded research. Working with inventors to license technologies is a key part of our mission.

The Georgia Tech Research Corporation (GTRC), which is responsible for intellectual property management and licensing created the Georgia Tech Integrated Program for Start-ups (GT:IPS™) to assist faculty and students who would like to commercialize inventions. GT:IPS™ provides the training and support prospective entrepreneurs need to launch companies based on Georgia Tech intellectual property. The curriculum covers diverse topics ranging from intellectual property management and basic legal documents to finding funding for the new company and making an "elevator pitch."

In order to "graduate" from the program, the inventor presents a vetted business plan, details about the new company's management team, conflict of interest declarations, and a list of potential funding sources. After graduation, the company can enter into an express licensing agreement known as the "GT:IPS™ License" that requires no negotiation. This facilitated license reduces the time it takes to finalize a deal and launch a new venture while the educational program better positions the entrepreneurs for success.

GTRC is part of a larger ecosystem that identifies commercial opportunities and fosters the creation of new ventures at the Institute. GT:IPS™ is one of the programs available to faculty and student entrepreneurs to facilitate licensing while Flashpoint at Georgia Tech is a startup accelerator that enables rapid evolution of the company to an investable venture through start-up engineering. Flashpoint is open to new companies and new non-profit organizations that form at Georgia Tech whether or not they are based on technology licensed by GTRC. Flashpoint teams access experienced mentors, technical, marketing and design experts, investors and entrepreneurial stars. They work in an immersive, shared-learning, open workspace that enables rapid development of the commercial opportunity.

The Enterprise Innovation Institute (EI^2) is a comprehensive program focused on business and economic development assistance. EI^2 brings together new and established Georgia Tech programs to help industry, entrepreneurs, economic developers, and communities become more competitive through the application of science, technology and innovation. The VentureLab serves as a technology scout and

helps identify new technologies with commercial potential. In fiscal year 2011, VentureLab evaluated more than 200 Georgia Tech inventions. Working closely with GTRC, EI² identifies and supports key innovations with the potential to significantly impact local, state, and national economies.

Also a part of EI², the Advanced Technology Development Center (ATDC) — is helping Georgia technology entrepreneurs launch and sustain successful companies.

The National Science Foundation selected Georgia Tech as a National Innovation Node to help lead its Innovations Corps (I-Corps) program. Georgia Tech, along with the University of Michigan and Stanford University, will leverage initiatives at each campus and use a common approach to equip academic inventors to develop discoveries from their research programs to commercial products. I-Corps connects NSF-funded scientific research with the technological, entrepreneurial and business communities – the innovation ecosystem –to move technologies from the laboratory to the marketplace. Georgia Tech is teaching the I-Corps curriculum to teams from around the nation that have been identified by NSF. The three I-Corp universities will, as a major goal of the three-year project, analyze and leverage data from the I-Corps program to develop an understanding of how academic institutions can improve support for innovation ecosystems. In addition to building new companies directly through the I-Corps Program, this research will help identify successful approaches that can be adopted around the United States to enhance innovation ecosystems. Finding the most effective mechanisms to promote innovation ecosystems while developing and demonstrating the most efficient ways to accelerate movement of innovations to the marketplace is a key element of American competitive success. More must be done to find successful models of start-up company formation that can be replicated around the country; through its regional node, Georgia Tech will work to build the ecosystem.

Question from Mr. Rohrabacher

1. The National Academies report, *Research Universities and the Future of America*, from June of this year, states, "the cumbersome export controls...fail to recognize the fundamental difference between the physical export of very sensitive technologies to a foreign country and the legitimate sharing of information at U.S. universities..." At the other end of the spectrum, a retired University of Tennessee Professor was convicted in 2009 of violations of export control laws when he illegally exported advanced plasma technology data from a military contract to China. What is the appropriate balance for regulation of industrial and university research and development in the context of national security? What factors should Congress consider when assessing the burden of regulations established for national and homeland security reasons?

The Association of American Universities (AAU), Council on Governmental Relations (COGR), American Association for the Advancement of Science (AAAS), and Association of Public and Land-grant Universities (APLU) offered a framework for considering reform of export controls as they apply to U.S. universities in a letter to date February 7, 2011 to Charles B. Shotwell, Director, Office of Defense Trade Controls Policy and Timothy Mooney, Bureau of Industry and Security.[1] The letter provided comments regarding the State Department's Advance Notice of Proposed Rulemaking (ANPR) to revise the United States Munitions List to a "positive list" of controlled defense articles[2] and on the Commerce Department's ANPR[3] to similarly revise the Commerce Department's Commerce Control List.

Adopting a structure of controls based on the objective performance or capability criteria of controlled items and tailoring levels of control to security significance embodies one of the main criteria to consider in considering export controls *e.g.* tiering regulation to levels of risk. Eliminating or reducing the jurisdictional ambiguity between the Department of State and the Department of Commerce and harmonizing the U.S. Munitions List and the Commerce Control List to give them a common structure would make compliance easier, less burdensome and less costly.

Our export control regimes must have a mechanism for regular review of controlled technology so that control levels remain relevant and ensure security. Universities must deal with rapidly changing technologies across every discipline imaginable. An efficient mechanism to assess controls for emerging technologies and to update and the lists with input from the U.S. science and technology community should be developed.

Finally, U.S. universities' ability to involve gifted foreign national students and faculty in research activities in diverse fields such as engineering, energy, space technology, computer and software design, and bioengineering has been a key to U.S. success over the decades. The conduct of open, publishable, non-proprietary fundamental research at U.S. universities is not and should not be limited by export controls. In cases such as the one cited in the question, where there are contractual restrictions on publication involving proprietary research, export controls may well apply but, as noted in the AAU,

[1] http://www.aau.edu/policy/export_controls.aspx?id=7314
[2] Federal Register, December 10, 2010 (22 CFR Part 121, RIN1400-AC78)
[3] Federal Register, December 9, 2010 (15 CFR Part 774; Docket No. 101112562-0577-01)

COGR, APLU and AAAS comments, the technology in question should be subject to tiered controls based on its security significance.

Question from Mr. Benishek

1. I'd like to follow up on the question I asked at the hearing regarding collaborations with community colleges and smaller universities. Gogebic Community College in my district performs research. Beyond partnering with bigger universities, what advice would you provide to them on how best to reach out and explore collaborations with local industry for specific research collaborations? Would you recommend this same advice or a different strategy to other smaller schools and community colleges who may want to cultivate industry collaborations for workforce development programs and curricula specific to local industry needs? Please elaborate.

One of the greatest strengths of any college or university regardless of size is its student body while the greatest responsibility of an academic institution is the education of its students. Engagement of students in problem based learning that teaches them to apply what they learn to innovation in their disciplines is increasingly important for their future success and for the competitiveness of their future employers. Industry tells us that they seek graduates with practical experiences in research when they recruit new employees. Inviting local industry to work with faculty to bring real-world problems to the college for student projects is a great way to reach out and initiate discussions about both workforce development and future research collaborations. Faculty-led research projects funded by industry often involve undergraduate researchers and many graduate students have their first research experiences working on funded projects at their undergraduate institutions. Primarily undergraduate institutions are a vital link in preparing U.S. undergraduates for post-graduate studies and inspiring them to pursue doctoral degrees in science, technology, engineering and math.

Undergraduate research experiences are different from internships which are also an important component of the undergraduate experience. Smaller schools and community colleges often encourage or even require internship experiences. Those institutions with research-active faculty and facilities for research may well consider both kinds of learning opportunities and promote undergraduate participation in research led by faculty.