Testimony of

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From the Lab Bench to the Marketplace:
Improving Technology Transfer

Chairman Lipinski, Ranking Member Ehlers, and distinguished members of the Subcommittee, I am Tom Peterson, Assistant Director for the Engineering Directorate (ENG) at the National Science Foundation (NSF). Thank you for the opportunity to testify on NSF's perspective of the process by which knowledge and technology are transferred from academic institutions to the private sector and on the best practices and policies to facilitate the commercialization of federally funded research.

The National Science Foundation is the Nation's premier mission agency for promoting fundamental research and education in science and engineering across the board. Additionally, however, programs within the National Science Foundation help to foster and encourage the translation of new knowledge generated through basic research into processes, products and methodologies with significant economic or societal impact. Programs with an innovation component are supported across the Foundation, which plans to invest more than $400 million in center and partnership programs in fiscal year (FY) 2011. Within NSF, the Directorate for Engineering is the natural focus of innovation-related efforts. Engineering research in general focuses on discovering how basic scientific and engineering principles work as well as how they can be harnessed for practical ends.

The term "innovation" can often be subject to innovative definitions, but for our purposes we define innovation as the conversion of fundamental discoveries into new commercial products and processes. It has long been recognized that there is a gap between "discovery" (produced by fundamental and applied research in universities) and the design/development work in industry that yields new products. This gap is often referred to as "the Valley of Death". If there is a long research pathway needed to translate academic discoveries into industrial products, and if industry is not willing to invest in that pathway, the academic discoveries sit on the shelf and the opportunity for new products and new industries is lost. While other countries have not had the United States' capacity to produce new discovery through fundamental research, many are better at translating and implementing those discoveries (whether their own or "imported") into commercial products. This "translational" phase of research is where the U.S. has an opportunity to improve.

1. ***Describe how the National Science Foundation fosters the transfer of knowledge and technology from U.S. universities to the private sector.***

The NSF has developed a strategy utilizing a combination of the Foundation's experience, existing programs and new initiatives to speed the generation of useful discoveries and their effective penetration into industry. By so doing, these discoveries can yield high-value products and processes, new businesses and even new industries, greatly expanded employment opportunities, and a more technologically advanced workforce widely distributed across the U.S.

Successful innovation demands research that is most often characterized by several distinct features:

- It is technology- and often engineered-systems motivated
- It requires the integration of multiple disciplines
- It is developed in collaboration with industry or other practitioners.

Several large, ENG-funded programs existing within the NSF embody these features and are already successfully producing translational research that results in innovation in industry.

Existing ENG Resources

Engineering Research Centers (ERCs)—Engineering Education & Centers (EEC) Division: Established in 1985, this is the flagship engineering centers program at NSF, with more than $67 million planned for FY 2011. The 54 ERCs formed to date have literally changed the culture of academic engineering by supporting cross-disciplinary teams, strategically focused on joining discovery with research that advances enabling and engineered systems technology, in partnership with industry. Currently, 15 ERCs are within the 10-year window of NSF support, and the majority of ERCs who have 'graduated' are still in operation. Their education programs start with pre-college students and teachers and continue through practicing engineers.

A primary driver for the establishment of the ERCs program by the NSF was to facilitate the transfer of knowledge and technology developed out of the ERCs' research on next-generation engineered systems to U.S. industry. This focus on innovation was and still is at the heart of the ERC–industry partnership. That partnership has yielded rich dividends.

The third generation of ERCs (Gen-3), funded since 2008, are even more directly focused on bridging the innovation gap through partnerships with small firms and groups dedicated to entrepreneurship. The very structure of the Gen-3 ERCs establishes a culture of discovery and innovation by requiring from each ERC:

- **Guiding strategic vision** for transforming engineered systems and the development of an innovative, globally competitive and diverse engineering workforce
- **Strategic plans** for research, education, and diversity to realize the vision
- **Cross-cultural, global research/education experiences** through partnerships with foreign universities

- Strategic, discovery & systems motivated cross-disciplinary research program, including **small firms engaged in translational research**
- Education program **strategically designed to produce creative, innovative engineers** by engaging students in all phases of the innovation process
- **Long-term, focused pre-college partnerships** to bring engineering concepts to classroom & increase enrollment in engineering
- **Innovation partnerships** with member firms and organizations dedicated to stimulating entrepreneurship and speeding technological innovation
- **Cohesive and diverse** cross-disciplinary leaders and team, management systems
- Multi-university configuration, cross-institutional commitment to facilitate and foster the cross-disciplinary culture, diversity, and **mentoring**

Funded jointly by NSF, universities, and industry, collectively these large centers have resulted in commercialized products and processes whose value is estimated to significantly exceed ten billion dollars; and they have produced more than 10,000 graduates at all levels who are in great demand by industry.

The story of ERC innovations is updated periodically and posted at http://showcase.erc-assoc.org.

Industry/University Cooperative Research Centers (I/UCRCs)—Industrial Innovation & Partnerships (IIP) Division: Formed in 1972, the I/UCRC program is the oldest centers program at NSF. It has survived because it is a model that works: small interdisciplinary groups of faculty and students focusing on industry-relevant and mutually agreed-upon research. Industry and other agencies provide the majority of the support —7 to 8 times the NSF investment, which is planned at $10 million for FY 2011. Currently there are 43 I/UCRCs. They can be funded by NSF for three five-year periods, with a reduced level in the second and third periods. I/UCRCs also have a long history of producing technological advances with billions of dollars of economic value and some 4000 MS and PhD graduates who are highly sought by industry because of their industry-relevant experiences.

Emerging Frontiers in Research and Innovation (EFRI)—The EFRI Office was established in 2006 to provide ENG with a rapid-response capability for focusing on important emerging areas of research. Each year, interdisciplinary initiatives are funded in areas that represent transformative opportunities, potentially leading to new research areas for NSF, ENG, and other agencies; new industries or capabilities that result in a leadership position for the Nation; and/or significant progress on a recognized national need or grand challenge. EFRI awards support small teams of interdisciplinary investigators for four years. Focus areas for FY 2009 are BioSensing & BioActuation: Interface of Living and Engineering Systems; and Hydrocarbons from Biomass. The topics for FY 2010 are Science in Energy and Environmental Design: Engineering Sustainable Buildings; and Renewable Energy Storage. EFRI plans to invest $31 million in FY 2011 research areas.

Partnerships for Innovation (PFI)—IIP Division: Begun in 2000, the PFI program promotes innovation by forming partnerships between academe, the private sector, and local, regional, or federal government. The program activities include generation of new ideas through research; transformation of new ideas into new goods, businesses, or services to society; building infrastructure to enable innovation; and education/training of people to enable/promote innovation. More than a thousand partnerships have been formed since the beginning of the PFI program. To date, 157 PFI grants have been awarded; currently there are 51 PFI projects. These are funded for 2 to 3 years, after which they are sustained by the partners or other stakeholders. Their outputs include innovation in all its forms: knowledge and technology transfer, product commercialization, start-up formation, workforce development, and education in the innovation enterprise in academia at all levels and in industry. NSF has requested $7 million for PFI in FY 2011.

Various NSF-wide programs, in which ENG participates, also explicitly and effectively foster this kind of industry-collaborative research. They include:

- **Grant Opportunities for Academic Liaison with Industry (GOALI)**—this proposed $4-million FY11 investment promotes university-industry collaboration by supporting academic fellowships/traineeships in industry, industrial practitioners on campus, and industry-university team research.
- **Small Business Innovation Research (SBIR)/Small Business Technology Transfer (STTR)**—this proposed $143-million FY11 investment stimulates technological innovation by strengthening the role of small business in meeting Federal R&D needs, increasing the commercial application of federally supported research results, and fostering participation by socially and economically disadvantaged and women-owned small businesses.
- **National Nanotechnology Initiative (NNI)**—a government-wide program established in 2001 to coordinate Federal nanotechnology R&D; the NSF investment in NNI for FY 2011 is planned at $399 million. One of its goals is to foster the transfer of new nanotechnologies into products for commercial and public benefit through academic researcher collaboration with industry. The ENG Senior Advisor for Nanotechnology is one of the key architects and leaders of NNI.

These illustrate the extent of participation by ENG in university industry partnerships. There are a few other such programs distributed at other parts of NSF that are referenced in the next section.

2. ***How is NSF planning to implement the new "innovation ecosystem" component of the Partnerships for Innovation (PFI) program proposed for the FY2011 budget?***

The ENG directorate at NSF is fortunate to have, in its FY 2011 budget, proposed increases in support for partnership programs contributing to innovation. These proposed increases are most welcomed. In developing plans that demonstrate good stewardship of these anticipated additional funds, and mindful that the total requested increase in FY 2011is $12 million, we have studied means by which we can build on the existing strengths of NSF support, rather than trying to 'start from scratch' with new programs. This is *not* meant to represent a 'business as usual' approach, and as can be seen from our proposed plans, new and unique initiatives are proposed. Rather, we are trying support concepts that will provide the most rapid evidence of success, and that means building on programs in the community that have already demonstrated propensity and talent towards market innovation. That is, we intend to support those members of the community who have shown an interest and an ability to take the fruits of basic research and translate those fruits into societal benefit. Our investment is designed to engage more faculty and students in innovation, to increase the commercial impact of innovative technologies, and to build regional connections for the innovation ecosystem.

New and Emerging Initiatives

Focused additional effort for the innovation ecosystem is being directed by the ENG directorate using both reallocated dollars from our base budget as well as the proposed additional support in FY 2011 budget for partnerships for innovation.

At a recent workshop held to elicit input from experienced PFI grantees and other members of the community, NSF was encouraged to consider investments in:

- Undergraduates as inventors and innovators
- Open participation in innovation and entrepreneurship from community colleges through the 4-year universities and on into Graduate institutions
- Leveraging of existing small business strengths over and above the spin-off model
- Supporting innovation process models that create small groups of collaborators across diverse sectors
- Incentivizing universities to support an innovation culture and its role on societal impact

In response to the clear need to improve American innovation and speed the translation of discovery into industrial products, a number of new initiatives are already being developed or planned that will integrate the efforts of the EEC Division, the IIP Division, and/or the EFRI Office.

Innovation Fellows: Planned by the EEC Division for FY 2011, this program will support cohorts of engineering undergraduates to pursue an innovation-focused Ph.D. graduate program that includes summer internships in industry.
Industry Postdoctoral Fellows: In partnership with The American Society for Engineering Education, the EEC Division plans to expand the Innovation Fellows program to include 40 grants per year to postdoctoral students for innovation-focused work in industry, the costs of which are shared between industry and NSF. EEC piloted this activity in FY 2010.
Industry-defined Fundamental Research: This pilot initiative, begun in FY 2010, is being developed within the IIP Division in response to a proposal from The Industrial Research Institute (IRI). IRI will invite its members, other professional society members, and university partners to examine possible research thrusts that are fundamental and that could have a transformative economic impact on an industry or sector. These research areas will then feed into the research programs of the other divisions of ENG.
University-Industry Collaboration to Advance Discovery: This initiative, under study by the EFRI Office, will accelerate innovation based on the transformational research already funded by EFRI by providing incentives to industry researchers to partner with EFRI grantees. It is envisioned as a GOALI-like exchange between the academic researchers and potential industrial adopters and refiners of the technologies developed. As a first attempt to implement this idea, the FY 2010 EFRI Solicitation allows industry researchers to serve as co-PIs on a research project defined as a GOALI project.
SBIR/STTR and ERC Supplement Opportunity for Collaborations (SECO): This collaboration opportunity, piloted in FY 2010, seeks to form partnerships between small businesses and ERCs that will leverage NSF's investments in SBIR/STTRs and ERCs to speed innovation. The SBIR/STTR program stimulates entrepreneurship in this country through government support for research in small business. These small firms often need additional research to commercialize their products. The agility of small companies to respond to market conditions and opportunities has the potential of providing substantial commercialization advantages. The Engineering Research Centers program creates a culture in engineering research and education that links discovery to technological innovation through transformational fundamental and engineered systems research in order to advance technology and produce engineering graduates who will be creative U.S. innovators in a globally competitive economy.

These partnerships are expected to lead to one or both of the following outcomes:

- ERC generated research will be more quickly translated into the marketplace through collaboration with an SBIR/STTR awardee or small R&D firm.

- The capability of an SBIR/STTR awardee or small R&D firm to achieve its product goals will be strengthened through the research capacity of an ERC.

Assembling an "Innovation Ecosystem" in NSF

These current and prospective programs constitute a portfolio of innovation-oriented programs within ENG that, together, address: (1) large research universities as well as smaller teaching-oriented institutions serving diverse populations; (2) large groups and small groups of faculty as well as individual researchers, at one or multiple institutions; (3) multidisciplinary research foci from fundamental through proof-of-concept; and (4) education of engineering students in an industry-oriented, systems-research-focused environment.

The elements of this portfolio thus comprise a collective ecosystem for generating innovation in U.S. industry through NSF support. Other programs within ENG and throughout NSF also comprise natural elements of this "innovation ecosystem" and bring resources explicitly to bear in the effort to complete the building of this ecosystem. Among the largest of these programs are:

- **Science and Technology Centers** (Office of Integrative Activities)
- **Materials Research Science and Engineering Centers** (Division of Materials Research)
- **Nanoscale Science and Engineering Centers** (Foundation-wide)
- **Expeditions in Computing** (Directorate for Computer & Information Science & Engineering).

The key characteristics of the ecosystem and each of its component elements must be:

1. The university research is explicitly driven by industrial needs (not near-term but clearly defined mid- to longer-term needs), ranging across the full spectrum of industrial sectors and company sizes from start-ups to Fortune 500 companies.
2. Faculty are involved along a continuum from fundamental discovery-oriented research to beyond the proof-of-concept phase, working with industry at all stages, and with faculty at all points along the continuum aware of how their work contributes to the whole. (System-wide communications and annual grantee conferences will be needed.)
3. Through a concerted focus on NSF-funded translational research in collaboration with industry, the handoff of technology to industry moving into industrial development will be smoother—the "Valley of Death" is bridged—resulting in rapid, efficient innovation.

Numerous options are still under consideration for support in order to better translate basic research discoveries into marketable products and processes. The 2011 Budget Request provides $12 million for two proposed "innovation partnerships". One will focus on supporting the individual entrepreneur, through a "Technology Translation" plan. The other will focus on supporting entrepreneurial—and typically interdisciplinary—teams and building regional innovation communities through a "Center Connection" plan. While details of each plan continue to be addressed, Table I below provides a comparative summary of both approaches.

	Technology Translation Plan	**Center Connection Plan**
Technology Source	Technology derived from Individual PIs with current or prior NSF research support.	Technology derived from currently active Centers, such as ERCs, I/UCRCs, STCs, MRSECs, NSECs.

Goal	Rapid conversion of research discoveries into new commercial products or processes.	Translate Center-developed research and/or technology into new start-up business (es) or existing firms. Develop a network of connections between university researchers and local/regional business community.
Expected Accomplishments	A Final Technology Translation Plan (FTTP), suitable for review by potential third-party funders. IP protection obtained in preparation for disclosure of the FTTP to potential third-party funders	Development of a network of connections between university researchers and local/regional business community. Faster translation of research into existing firms and/or new start-up firms. Evidence of developing local and/or regional innovation ecosystem and creation of jobs. Preparation of students with entrepreneurial experience.

Table I. Proposed New Innovation Ecosystem Models: FY11 Partnership for Innovation Support

3. How is NSF supporting knowledge transfer through its education and training programs?

Since the mid-1980s, when concerns about U.S. industrial competitiveness were widespread, it has been widely believed that baccalaureate programs in the Nation's engineering schools have tended to produce engineers who, while well prepared in engineering science, need more experience with technological advancement and interdisciplinary teamwork; who need more training before they can meet the basic needs of industry. Many large corporations find that they must provide significant training beyond on-the-job experience. Traditional engineering students obtain little practical experience in their educations. Furthermore, although industrial employers place high value on teamwork, most graduating engineers traditionally have had limited experience in working in teams. ERCs are designed to produce graduates who excel in these areas, where traditional graduates fall short. The centers try to bring to engineering education a new culture based on goal-oriented values, complementing the theoretical science-based education long predominant in academic engineering. Those involved in the ERCs have come to recognize that education may actually be the centers' most important means of contributing to the Nation's global competitiveness. ERCs devote much energy and resources to "spreading the culture" through education, and to creating an environment conducive to this new kind of education. ERC education programs are a primary means of achieving the overall goal of culture change in engineering education, and in academic engineering generally. They encourage that change by articulating the ERC ideals, making opportunities available to implement the ideals, and facilitating the use of those opportunities.

This is particularly important in engineering, where discoveries made at universities have the potential for a more direct realization in the form of commercially useful products and processes. One of the three “guiding goals” of the Engineering Research Centers, for example, is “to educate a globally competitive and diverse engineering workforce from K-12 on.” This goal is pursued in several ways: by making education a core part of the center’s strategic plan; by integrating fundamental research with engineering practice and incorporating it in the curriculum; by involving industry directly in the education process; by including students at all levels, from undergraduate through postdoctoral, on research teams; and by encouraging innovation and entrepreneurship.

Engineering Research Centers have proven their capacity to produce graduates who are more effective in industry as innovators and leaders of cross-disciplinary teams. The Gen-3 ERCs have an additional challenge: to develop education programs in which students learn how to be even more creative and innovative through explicit training in product design, entrepreneurship, and working in collaboration with start-up firms carrying out translational research. The ERC pre-college programs engage both teachers and students in engineering research projects carried out in an innovation ecosystem (an ERC) in partnership with industry. Overall, it represents an effort on the part of the ERC program to establish a comprehensive system of engineering education that produces a large and diverse cadre of engineers primed for global leadership in innovation.

The PFI program has spawned several innovation-enabling education and training models.   Precollege programs at tribal colleges attract and train high school students in hands-on engineering problem solving skills.   The program offers a combined engineering and business bachelor’s degree tailored to industry needs, providing mentorships to budding entrepreneurs and helping assess market potential. It also serves to cross-fertilize collaboration across engineering, business, medicine, law and other colleges, thereby fostering a true innovation culture.

4. ***Beyond NSF’s traditional role of supporting basic research, what is the unique role of the agency relative to universities and to the private sector in promoting regional innovation and strengthening U.S. economic competitiveness?***

In a study conducted by the Pennsylvania State University under NSF support[3], leaders from government, industry, and universities convened to consider issues and develop alternatives for action aimed at more effectively leveraging university research for United States industrial competitiveness and economic growth.   More than 120 leaders from government, industry, and universities explored problems and proposed solutions from the perspective of five key industry sectors. As might be imagined the five focus groups discussed a wide range of issues and identified a multitude of problems and potential solutions. At the same time, a limited number of common issue areas were identified across the groups. Specifically, four major issue areas were consistently identified representing fundamental barriers to more effective leveraging of university research for industrial competitiveness and growth:

- Insufficient industry engagement in university research
- Restrictive intellectual property management policies
- Inadequate resources for technology commercialization
- Low flow of talent across industry-university boundaries

Many potential solutions to these and other issues were suggested and strenuously debated in the focus groups. A number of the solutions suggested to address the above four core issue areas stand out, either because of the consistency with which they were advocated or because they represent especially unique and creative approaches. These stand-out solutions for each of the above core issues are highlighted below.

Issue Area	Proposed Solutions
Insufficient Industry engagement in university research	Increase federal support for industry-university research partnerships Expand support for sector-focused industry-university research consortia
University Intellectual Property Management Policies	Create an industry-university panel to develop amendments to Bayh-Dole 1980. Incentivize university tech transfer offices to support industrial competitiveness and economic growth objectives.
Inadequate resources for technology development	Strengthen SBIR and broaden and refocus STTR Create new program for development of commercially promising university discoveries
Talent Flow across university-industry boundaries	Better prepare scientists and engineers for careers in industry Expand interaction between university faculty and industrial counterparts

Table II. Mechanisms for Leveraging University Research for Industrial Competitiveness and Growth

NSF involvement in support of innovation and industry-university partnerships goes beyond programs exclusive to the NSF. We have partnered with many governmental agencies in a number of activities focused specifically on the support of innovation.

For example, the NSF has been an active participant in the inter-agency working groups focusing on the development of regional innovation clusters (RICs). It is one of the partnering agencies participating in the "Energy Efficient Building Systems Regional Innovation Cluster" initiative, also called an Energy-RIC or E-RIC, an effort involving the Departments of Energy, Commerce and Labor, NIST, EDA and SBA as well as NSF in an interagency working group focusing on the stimulation of Regional Innovation Clusters. NSF has had representation on this working group since its inception.

Additionally, in March of 2010, the Office of Science and Technology Policy (OSTP) and the National Economic Council (NEC) issued a Request for Information (RFI) about ideas and best practices for Proof of Concept Centers (POCCs). POCCs have seen some success in supporting early stage technologies by providing seed funding and expert assistance in the path toward commercialization. This RFI resulted in well over one hundred responses from entrepreneurs, industry and universities. Important issues about how to measure success and lessons learned are now being assembled and reviewed. These “voices from the field” will serve as the basis for a set of recommendations for how the federal government can help spur a culture of innovation among the various stakeholders.

And, NSF along with NIH is partnering with EDA/DOC in the “i6 Challenge”, which is designed to encourage and reward innovative ideas that will accelerate technology commercialization in a regional innovation ecosystem. Through supplemental funding NSF SBIR/STTR grantees will participate in this innovation ecosystem.

The requested FY 2011 budget for NSF will enable the innovation ecosystem to leverage the strengths of American universities through connections with industry, and these connections may then foster regional "engines of innovation" in any arena of advanced technology—whether it be new approaches to energy generation and use, advanced information technologies, cyber security, or bioengineering. By encouraging and accelerating knowledge transfer from universities to industrial partners, NSF programs (such as the Engineering Research Center program) can help bring the technology to the marketplace. The ultimate goal is to extend America's historical reputation for "Yankee ingenuity" to a new recognition as "a nation of innovators." The economic benefits of this enhanced innovation will be distributed more evenly across companies of all sizes, types, and geographic locations in the U.S. as well as a broader spectrum of Americans. And it will produce graduates who are capable of continuing the "Innovation for Prosperity" envisioned here out into the future to sustain our Nation's technological leadership and economic vitality for generations to come.

5. ***How does the NSF assess the long-term economic impact of both its knowledge and technology transfer programs and of its basic research programs?***

Perhaps the most challenging aspect of supporting the translation of basic research ideas and concepts into the market place is assessing, specifically, how relevant and productive our investments have been. The reasons for this are manifold and include:

- Often the 'lead-time' between the basic research discovery and the marketable product or process is significant. Commercialization rarely takes place in the early stages of support for basic research, and hence a 'cause and effect' between support for basic research and the subsequent development of a commercial product cannot be established by simply taking a 'snapshot' assessment of an individual grant or contract. The *Science of Science and Innovation Policy (SciSIP)* program in the NSF Directorate for Social, Behavioral and Economic Sciences attempts to study this very complex question.
- The development of new product areas (for example, cell phones, or iPods) result not from one single research discovery but from an entire portfolio of research projects. Hence, the relationship is less a relationship between a product and one individual project and much more a relationship between a product and support for a research portfolio, distributed over both time and university principal investigator.

All that being said, however, our partnership portfolio (which includes the Engineering Research Centers (ERC), the Industry/University Cooperative Research Centers (I//UCRC), the Partnerships for Innovation (PFI) program, the Grant Opportunities for Academic Liaison with Industry (GOALI) program, and the small business (SBIR/STTR) program) is the most heavily assessed portfolio in the ENG directorate and, with the possible exception of education programs in the EHR directorate, the most heavily assessed portfolio in the entire NSF. Those assessment instruments include examining the breadth and depth, and specificity, of industry partnerships, the numbers of start-ups and small businesses spun out, the numbers of invention disclosures, patents generated and jobs created by NSF supported work. While those analyses are not necessarily conducted annually, they are conducted with regularity, often involving outside contractors. Even the National Academies have been involved, for example, in the evaluation of our SBIR program. Example statistics from those analyses include:

- From 1985 through 2009, ERCs have produced 1,701 invention disclosures, had 624 patents awarded, granted 2,097 patent and software licenses, spun off 142 firms, and have produced more than 10,500 graduates at all levels.
- The highly leveraged I/UCRC program has established over one thousand industry connections to about 150 universities. In addition to millions of dollars in direct investment by these industries to support university research, they have invested significantly to move translational research into the market place. One of the most effective means of technology transfer has been through undergraduate, graduate and postgraduate students who are then hired by industry from these centers. Industry finds these students to be 'industry ready' to make early contribution and in fact many of them come back to become the industry sponsors at these centers.
- Over one thousand high tech small businesses have been supported by the NSF SBIR/STTR program since the congressional legislation in 1982. In-depth analysis has shown that these firms create jobs at the rate of approximately 8 percent and impact the economy with revenue growth at approximately 18 percent. About 40 percent of firms have strong collaboration with universities with half of their technologies coming directly from universities.
- Since the inception of the GOALI program in early 1980s, about one hundred university-industry collaborations are established each year. The PFI program started in 2000 and has contributed thousands of public and private innovation partnerships for universities ranging from Foundations, K-12 school systems, technical professional organizations, small businesses and Fortune 500 industries.

Summary

The Engineering directorate takes very seriously its responsibility to show leadership within the NSF in translational research, bridging the important step from basic research discovery to market commercialization. Our research portfolio is a balance of support for basic research as well as these translational research areas, which contribute vitally to innovation. And, importantly, in maintaining a healthy connection with the business and industry community through translational research activities, we further enhance our *basic* research portfolio with new ideas generated by our industry partners. In short, it is a benefit to both our academic researchers and to the marketplace that we continue to foster these strong ties between ENG and the real world.

Mr. Chairman, this concludes my remarks. I would be happy to answer any questions.

<u>References</u>

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Short Biography
Thomas W. Peterson, Ph.D

Dr. Thomas W. Peterson is assistant director for Engineering at the National Science Foundation (NSF). Prior to joining NSF, he was dean of the College of Engineering at the University of Arizona. He received his Bachelor of Science from Tufts University, his Master of Science from the University of Arizona and his doctorate from the California Institute of Technology, all in Chemical Engineering. He has served on the faculty of the University of Arizona since 1977, as head of the chemical and environmental engineering department from 1990 to 1998, and as dean from 1998 until January 2009.

During his service as dean, Peterson was a member of the Executive Board for the Engineering Deans' Council of ASEE and was vice-chair of EDC from 2007 to 2008. He has served on the board of directors of the Council for Chemical Research and on the Engineering Accreditation Commission (EAC) of the Accreditation Board for Engineering and Technology (ABET). He was one of the founding members of the Global Engineering Deans' Council, and at Arizona made global education experiences a high priority for his engineering students. He is a fellow of the American Institute of Chemical Engineers and a recipient of the Kenneth T. Whitby Award from the American Association for Aerosol Research.

The ENG Directorate at NSF provides critical support for the nation's engineering research and education activities, and is a driving force behind the education and development of the nation's engineering workforce. With a budget of approximately $640 million, the directorate supports fundamental and transformative research, the creation of cutting-edge facilities and tools, broad interdisciplinary collaborations, and through its Centers and Small Business Innovation Research programs, enhances the competitiveness of U.S. companies.