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.

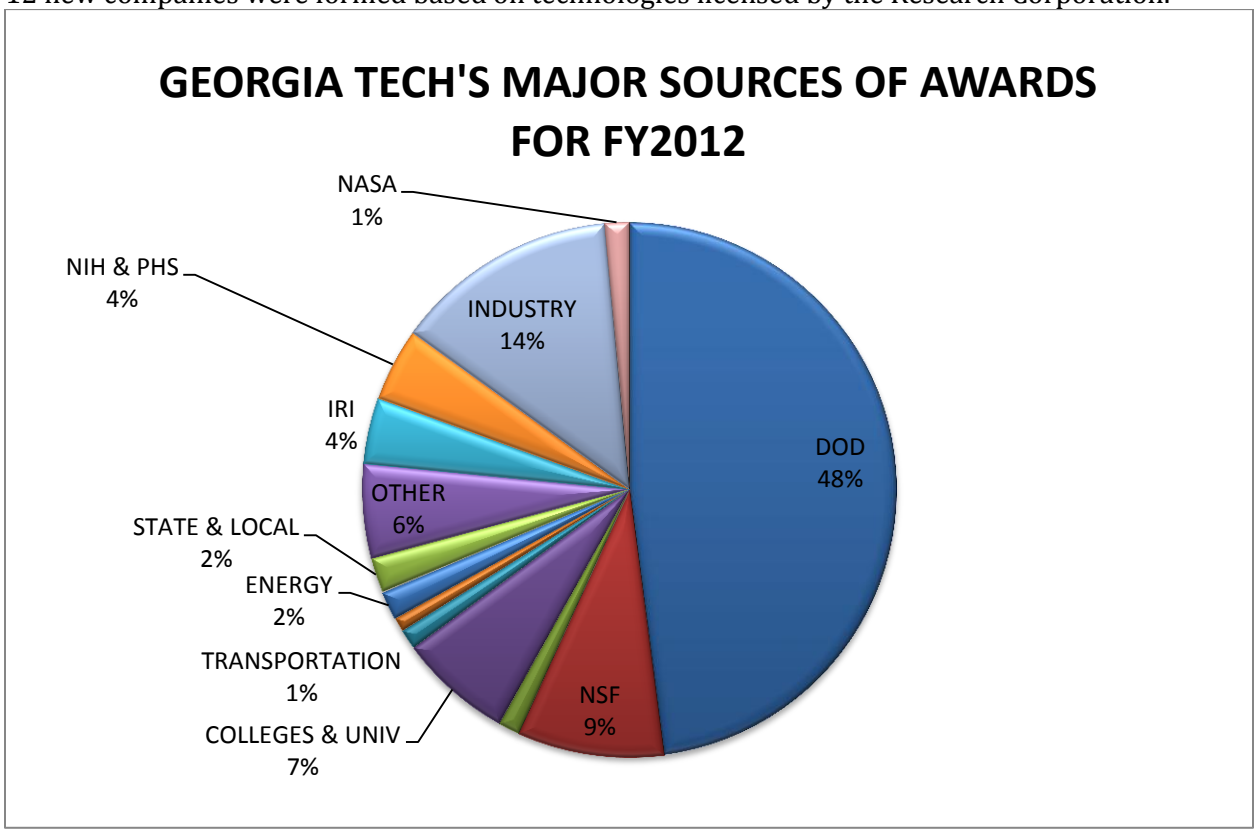

Figure 1

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

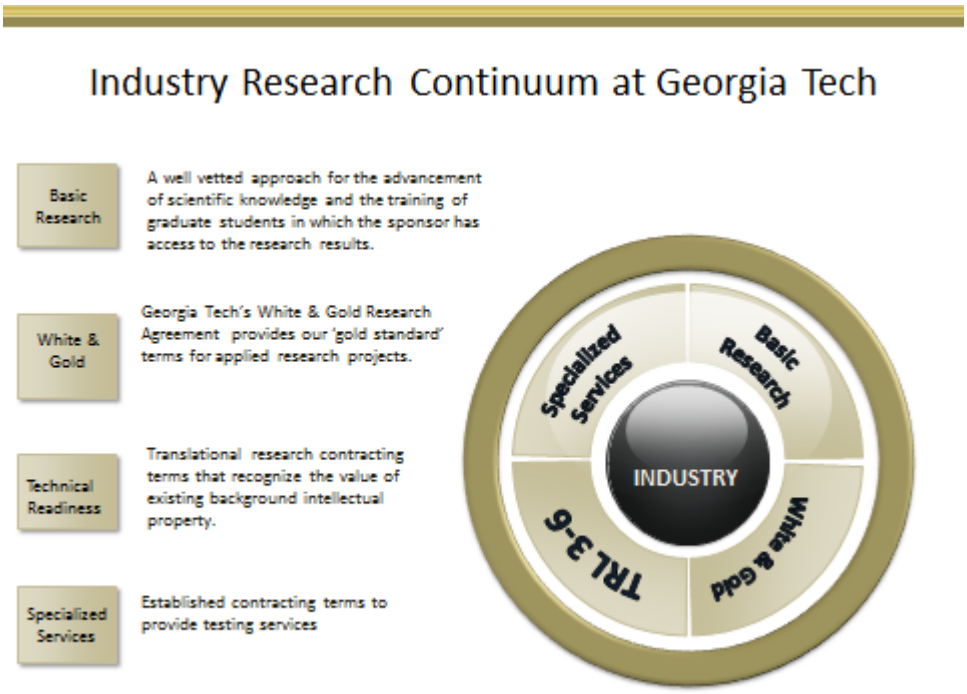

Figure 2

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.

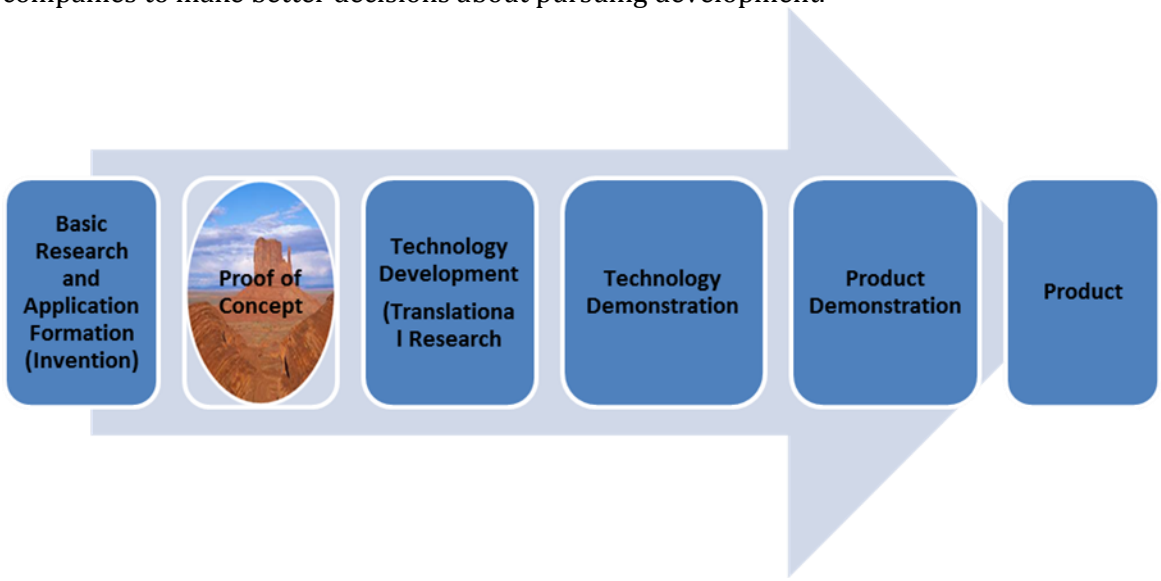

Figure 4

[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.