Technology Leadership and Strategy Initiative

# 2010

# Energize & Examine

Compete.

Council on Competitiveness

Technology Leadership and Strategy Initiative

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# Energize & Examine

**TLSI Dialogue Series 2010: Energize & Examine**
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# Energize.

**Dialogue 3:**
**Energizing Commercialization and Building the 21st century Public-Private Collaboratory to Drive Strategic Technologies**

**June 24, 2010**
**Washington, D.C.**

# Letter from the President

On behalf of the Council on Competitiveness, it is my pleasure to release the third report of the Technology Leadership and Strategy Initiative (TLSI). The TLSI engages technology leaders from America's premier companies, universities and laboratories to chart a course for more effective research collaboration and greater commercialization of technologies.

The initiative is led by Ray Johnson, senior vice president and chief technology officer of the Lockheed Martin Corporation, and Mark Little, senior vice president and director of GE Global Research for the General Electric Company. The Council welcomes a third co-chair to the TLSI leadership team by introducing Klaus Hoehn, vice president, advanced technology and engineering for Deere & Company.

There is a growing interest in the TLSI from America's top technologists and policymakers, as evidenced by the number and quality of participants and observers at the third dialogue. As we continue examining the state of American innovation and discuss the critical issues, our challenge will be to harness our momentum into priority recommendations and commit to the hard work of implementing them.

This report has two sections. Part 1 sets the stage for the dialogue. It outlines TLSI working groups that will dig deeper into subject areas raised in the first two dialogues. Part 1 also presents data on how America conducts research and development, breaking down the roles of different actors, reviewing general stages of innovation and explaining commercialization models. Angel and venture interests are explained, as is the relationship between the TLSI and the Council's U.S. Manufacturing Competitiveness Initiative. Finally, Part 1 poses questions about how the U.S. should promote key technologies.

Part 2 reviews the third dialogue held June 24, 2010, in Washington, highlighting the ideas put forward. We continued our discussion on improving public-private collaboration, reviewed the working groups and examined how intellectual property policies could encourage higher commercialization rates. Attendees also discussed commercialization models and strategies for mobilizing capital for innovation.

I would like to thank our featured speakers: Zach Lemnios, Director, Defense Research and Engineering; Brett Lambert, Deputy Assistant Secretary of Defense for Industrial Policy; David Kappos, Under Secretary of Commerce for Intellectual Property and Director of the United States Patent and Trademark Office; Arun Majumdar, Director of the Advanced Research Projects Agency—Energy; Vint Cerf, vice president and chief Internet evangelist, Google; and Chris Scolese, the Associate Administrator of the National Aeronautics and Space Administration.

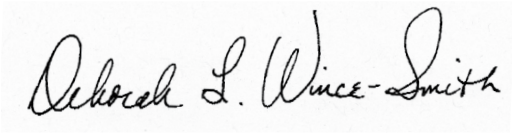
The Council expresses its sincere thanks to the U.S. Department of Defense for its support. The Council is committed to help the Department bring more technologies into practice faster and more efficiently—thereby strengthening our national and

economic security. The TLSI dialogues are designed to be an open exchange of ideas. The opinions and positions presented in this report are those of the Council or the individual who offered them. The opinions and positions in the report do not reflect official positions of the U.S. Department of Defense or other government agencies.

America faces many challenges, but the Council is animated by our nation's strengths and resilience. We should take heed of advice given by Thomas Edison, perhaps America's greatest innovator. Edison said, "Be courageous. I have seen many depressions in business. Always America has emerged from these stronger and more prosperous. Be brave as your fathers before you. Have faith! Go forward!"

Indeed, we will go forward and forge the next generation of American prosperity.

Deborah L. Wince-Smith



President & CEO

# Executive Summary

The third dialogue of the Technology Leadership and Strategy Initiative aims to advance the ideas put forward in the first two dialogues by organizing them into working groups that will develop actionable recommendations for various innovation stakeholders. The Council on Competitiveness also seeks in this dialogue to augment and refine those ideas by taking a closer look at commercialization models, the role of manufacturing in an advanced 21st century economy, and the role of government in promoting strategic technology investments to support national security and drive economic competitiveness.

# Part 1:
# Setting the Stage for TLSI Dialogue 3

PART 1: SETTING THE STAGE FOR TLSI DIALOGUE 3

# Introduction

The U.S. Navy had a problem—how to keep algae from coating the hulls of submarines and ships. Such "fouling" reduces vessel speed and increases fuel consumption. That translates into extra fuel costs and maintenance for the Navy to keep its ships free of barnacles, oysters, algae and other debris. Toxic antifouling paints were typically used for this purpose, but organotin and copper compounds used in these paints harm sea life and ecosystems as toxins leach from the paint. The U.S. Office of Naval Research solicited research to find new antifouling strategies to reduce use of toxic paints and to trim costs.

Dr. Anthony Brennan, a materials science and engineering professor at the University of Florida, visited the Pearl Harbor naval base in 2002 as part of this antifouling research. He and several colleagues watched an algae-coated nuclear submarine return to port. Brennan remarked that the submarine looked like a whale lumbering into the harbor. He asked which slow moving marine animals do not foul. The only one? The shark.[1]

Brennan was inspired to examine shark skin, or more specifically, its dermal denticles. Shark skin denticles are arranged in a distinct diamond pattern with tiny riblets. Using electron microscopy, Brennan confirmed his theory that the topography of shark skin discourages microorganisms from settling.

Based on this insight, Brennan founded Sharklet Technologies and developed an innovative surface technology that imitates the properties of a shark. The shape and pattern disrupt algae and bacterial growth without toxicity or the leaching of any chemicals. The first test yielded impressive results, reducing green algae settlement by 85 percent compared to smooth surfaces.

Brennan and Sharklet Technologies understood that their innovation had other potential applications. People typically kill microorganisms to control them. Yet, overuse of antibiotics, disinfectants and other kill strategies helped create superbugs such as methicillin-resistant Staphylococcus aureus (MRSA), commonly found in hospitals. The Sharklet pattern has been manufactured onto adhesive-backed skins that can be applied to high-touch areas to reduce the transfer of bacteria among people. The company also promotes the skins as ideal for public restrooms, childcare facilities and other bacteria-prone places where it is desirable to inhibit the survival, transfer and migration of bacteria.

Supported by the National Institutes of Health, Sharklet Technologies also is developing medical devices, including a Sharklet Urinary Catheter to help reduce hospital-acquired infections. Each year, urinary catheters are used in more than five million

1 Sharklet Technologies. http://www.sharklet.com.

patients in hospitals and extended care facilities. For patients requiring a catheter for longer than seven days, 25 percent will develop a catheter-associated urinary tract infection (CAUTI). CAUTIs are the leading cause of hospital-acquired infections, accounting for more than 40 percent.[2]

The story of Sharklet Technology illustrates the potential of innovation. By pushing the boundaries of knowledge to solve one problem, innovators frequently find new ways to apply that knowledge to other challenges. The government, through support from the Office of Naval Research and the National Institutes of Health, helped grow a company out of academia that has the promise to aid public health, reduce navy maintenance costs, and improve the environment. Private firms, led by Austin-based Limestone Ventures, supplied $1.5 million in 2009 to develop Sharklet products.

The TLSI seeks to enable more effective collaboration between government, academia and private firms so that more good ideas make the transition from lab to real life. With smart public policies, more productive innovation strategies, and targeted investments, the Council on Competitiveness believes that Americans can accelerate the creation of new technologies and firms that will lead the way to a more prosperous economy and society.

The TLSI seeks to enable more effective collaboration between government, academia and private firms so that more good ideas make the transition from lab to real life.

2 Sharklet Technologies. http://www.sharklet.com.

PART 1: SETTING THE STAGE FOR TLSI DIALOGUE 3

# Getting Down to Business—TLSI Working Groups

Over the course of the first two TLSI dialogues, participants suggested forming working groups around key issues so that a core group of leaders could exchange ideas outside of the dialogues, organize them into findings and recommendations, and present them to the TLSI at large for consideration in future dialogues. Four working groups were initially proposed: accelerating innovation, innovation outreach, regulation and talent.

## Accelerating Innovation

The aim of the Accelerating Innovation Working Group is to improve the speed and number of inventions/insights that move from laboratory to market, including government markets. To accomplish this aim, the working group will consider best practices in government, university and industry labs and recommend to the larger TLSI changes to administrative, regulatory, budget or legal practices.

The first two TLSI Dialogues put forward many potential topics for the working group.

- **Government Actions:** Participants suggested improving the tech transfer functions of the national and defense labs, engaging those functions at the onset of research planning and ensuring that they have adequate resources. Participants also urged a shift in culture to promote commercialization through clearly defined missions and incentives. It was suggested that model master agreements be made more flexible to address industry differences and to extend such agreements to tech transfer.

  Governments also can improve their ability to generate and deploy new technologies for public sector missions. Participants discussed agencies moving from acquisition to commercialization strategies, where agencies play a more active role in technology development and they communicate more effectively to the private sector their operational requirements and the market potential of the technology.
- **University Actions:** Universities, too, would benefit from adequately funded tech transfer functions that engage researchers at the onset of projects. Participants also urged a shift away from strict licensing models to ones that encourage greater partnership with industry. And some participants have encouraged universities to pool their IP portfolios with other universities, including globally, to enable faster bundling and so firms can locate relevant IP through fewer portals.

  Universities also promote commercialization by achieving their core mission to prepare students for success. TLSI participants have noted the importance of multidisciplinary education, study outside of the United States and instruction in the process of commercialization.

- **Industry Actions:** Participants have emphasized the need for industry to engage with government and universities through forums like the University-Industry Demonstration Project of the National Academies. Industry was urged to leverage various forms of open innovation and to support steps designed to limit defensive patenting. The private sector also can help bridge the gap between the output of most research institutions and the needs of capital markets and businesses in order to invest.

TLSI participants identified policy regimes (e.g. Bayh-Dole, ITAR) that impact government-industry-university partnerships. Although the Accelerating Innovation Working Group is not restricted from commenting on those regimes, a Regulatory Reform Working Group will focus primarily on those issues.

## Innovation Outreach

The Innovation Outreach Working Group aims to develop and execute strategies to "tell the innovation story" more effectively to key audiences—particularly policymakers, students and the American public. For America to build the world's most robust 21st century innovation economy, it needs an engaged and informed citizenry that understands the value of innovation, that is inspired to pursue careers in scientific disciplines and that supports policies that enable new ideas to become practical realities.

Key audiences to be reached include:

- **Policymakers:** The entire innovation process, from idea creation to commercialization, is influenced heavily by public policy. TLSI participants are examining federal policies as wide ranging as research, education, intellectual property, export controls, immigration, litigation and risk capital.

  American political leaders should change their perception of innovation from a minor issue centered on science and technology to a major economic and societal issue centered on creating the jobs of the future and solving our toughest challenges. This will only happen if a critical mass of leaders appreciate the economic benefits of innovation and grasp the need for a coherent, integrated strategy to expand and accelerate the movement of ideas to market. The working group will consider strategies to build this critical mass of support.
- **Students:** TLSI participants noted that U.S. students have many career choices to pursue, and that too few are choosing the path of science, technology, engineering or mathematics. Part of the solution is to inspire more students to realize what they can accomplish through these disciplines. The working group will examine current practices to reach students and suggest ways to expand, change or prioritize those efforts.

- **The American Public:** If political leaders and students are to support innovation through policies and career choices, it will not occur in a vacuum. Voters and parents who possess a higher level of science and innovation literacy are more likely to encourage their government representatives and family members to act in ways that build a 21st century innovation economy. The working group will suggest additional ways to grow public awareness of the value of innovation and public support for strengthening the American innovation enterprise.

## Regulation/Policy

The Regulation/Policy Working Group aims to lower the barriers to commercialization by reforming federal laws and regulations to make commercialization less expensive, faster, better incentivized and more coherent. The TLSI believes that an improved legal and regulatory environment for innovation would increase the return substantially on federal and private sector research investment, creating more jobs, economic growth, solutions for government, and new products and services.

TLSI participants have identified many legal and regulatory regimes that, if reformed, could facilitate innovation and commercialization. Participants also noted that the federal government should establish mechanisms to coordinate public policy for innovation across agencies.

- **Legal / Regulatory Regimes:** Recommendations have been suggested regarding:
  - Tax—including the R&D credit and incentives for risk capital and infrastructure investment
  - Tort—including product liability and patent litigation
  - ITAR—including restrictions on foreign-born talent and export controls
  - Intellectual Property—including patent reform and tech transfer rules
  - SME Formation—including the SBIR/STTR programs and Sarbanes-Oxley rules
- **Coordinated Public Policy for Innovation:** TLSI participants noted that innovation policy remains fragmented in a number of ways, and that mechanisms should be established to coordinate and implement change. Innovation policy should assume a more central role in economic policy making, and national leaders should consider the patchwork of requirements on each actor in the innovation pipeline and how to make compliance easier, less expensive, coordinated and clear.

## Talent

The Talent Working Group seeks to ensure that the United States develops, attracts and retains world-class scientific and technical talent to fuel innovation needed by business and government. The working group also aims to integrate knowledge into the future innovation workforce beyond traditional science, technology, engineering and mathematics (STEM) disciplines. Business skills, foreign languages, and social sciences, for example, are essential to 21st century commercialization.

The first two TLSI Dialogues put forward many potential topics for the working group.

- **Develop STEM Talent:** Participants made clear that improvements are required from kindergarten through graduate school to grow the domestic pipeline of world-class talent. Elementary school students in many states would benefit from more qualified science teachers, stronger standards of learning and/or accountability measures, and programs that do more to fire students' imagination about science and technology. Secondary students, said participants, are hindered by many of the same issues and fail to enroll in college due to cost, complexity, and preparation issues.

  At the collegiate and graduate levels, participants advocated increased support for STEM students through scholarships, fellowships and traineeships. The TLSI dialogues endorsed efforts underway to boost federal research funding that supports students indirectly. Participants also discussed (1) more multidisciplinary curriculums and research funding, (2) exposing students to entrepreneurs through professors of the practice, and (3) engaging in global research partnerships.

- **Attract and Retain Talent:** America has always been a nation of immigrants and relied on their talents to spur innovation. Today, more than 40 percent of the U.S. science and engineering workforce with a Ph.D. is foreign-born. Immigrants founded more than half of the startups in Silicon Valley between 1995 and 2005, and almost 45 percent in New York. And yet, America's immigration, visa and export control regimes restrict the number of highly-skilled foreign-born workers who could create jobs in the United States. The regimes also limit the type of research on which these individuals can engage.

  The TLSI acknowledges the importance of adequate security safeguards for classified research and the necessity of dealing with illegal immigration. Participants agree unanimously, however, that U.S. policy should shift from restricting high-skill legal immigrants in STEM fields to encouraging them to stay.

PART 1: SETTING THE STAGE FOR TLSI DIALOGUE 3

# Review of Public-Private Partnerships for Commercialization

## Perspective and Overview

The Council recognizes ongoing efforts and a continuing need for more robust micro-level measurement of innovation that could yield better innovation management practices. As people strive to improve metrics at the organizational, regional, national and global levels, this section offers TLSI participants a macro overview of basic information available now about the United States. This information may be helpful in reaching out to policymakers unfamiliar with innovation issues and should help inform the TLSI dialogues moving forward.

Dialogue participants suggested that there would be value in presenting an overview of the innovation process, including how ideas are brought into practice by different commercialization models. Each component of the innovation process can be pursued through open or closed strategies. As noted in the first two TLSI dialogues, organizations are increasingly embracing forms of open innovation that brings outside entities (e.g. customers, suppliers, partners, social networks) into the mix of ideas.

Despite the existence of many innovation pathways and strategies, there are fundamental pieces to the process that are measured to help understand at a macro-level how innovation is carried out in the United States. Discussed in this section are the components of research and development (R&D), the main actors who perform and fund that R&D and some common commercialization models.

## Components of R&D

R&D is typically broken into three buckets: basic research, applied research and development. Basic research is fundamental investigation to advance scientific knowledge, with practical application not being an immediate objective. It is also commonly referred to as pure, discovery or frontier research. In 2008 (latest data available), America invested 17 percent of its total R&D in basic research[3] (figure 1). This represents both public and private investment.

Applied research seeks to solve practical problems. Applied research investigates whether and how basic research findings might be used to develop new goods, technologies, services or processes. America invests 22 percent of its R&D (public and private) in applied research.[4]

Development directs applied research knowledge toward the production of goods, technologies, services or processes. Activities include design, prototyping and testing to meet specific requirements, such as safety, health or environmental standards. America invests 60 percent of its R&D (public and private) in development.[5]

3 Science and Engineering Indicators 2010. National Science Board of the National Science Foundation. Jan. 2010.

4 Ibid.

5 Ibid.

Using this lens, a highly simplified understanding of the innovation process is that basic research yields understandings that can lead to applied research to tackle specific challenges or opportunities. Development builds on applied research to construct and test a product, service or process that firms commercialize or governments deploy.

## Main Actors

Business, academia and government are the major players. Business performs (73 percent) and funds (67 percent) the majority of American R&D by a wide margin (figure 2). Because companies have obligations to shareholders and thrive by commercializing innovation, their focus is more on development and applied research than on basic research that tends to be longer-term and have a higher risk of a return. Business is the top investor in applied research and development.

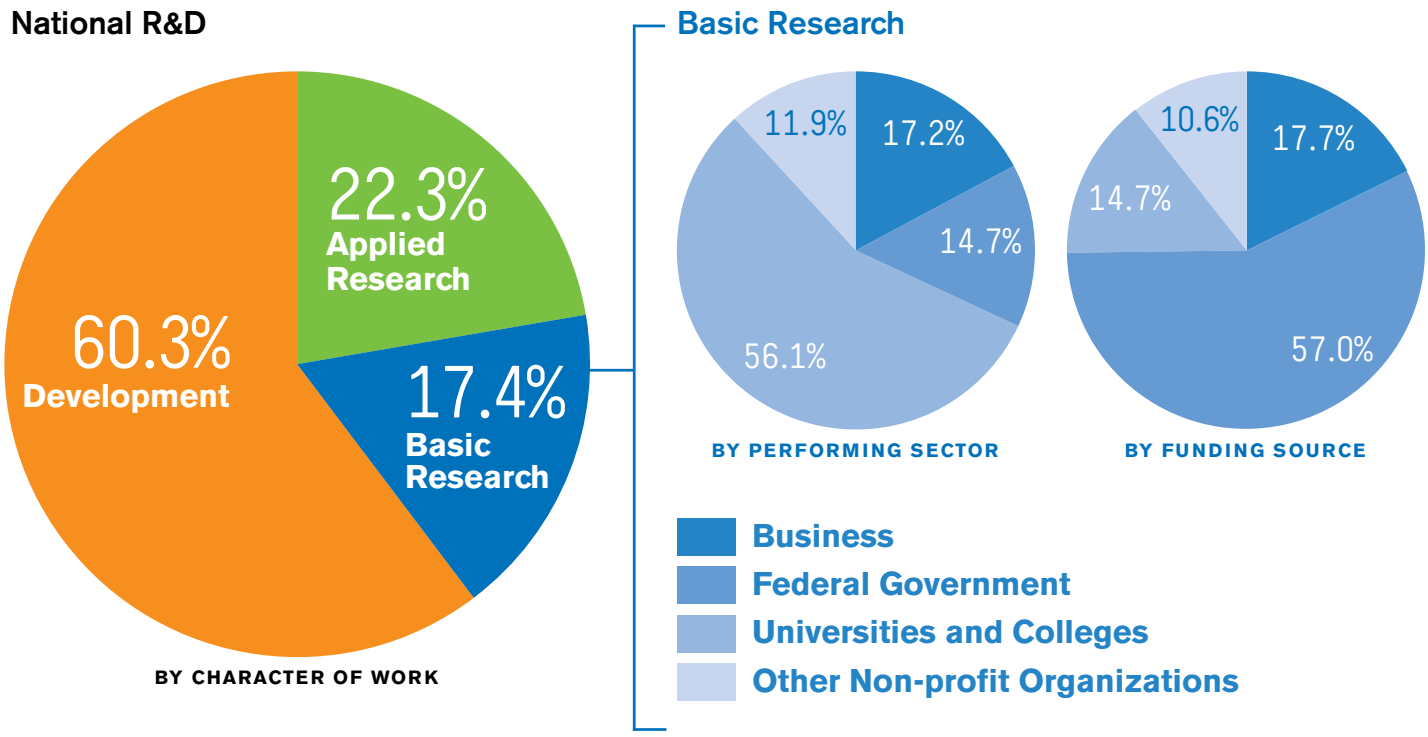
Universities and colleges are America's primary performers of basic research, conducting 56 percent of the workload (figure 1). Without the pressure to produce quarterly earnings, academia prepares the next generation of innovators by engaging them in fundamental, potentially disruptive research. Such efforts expand human knowledge not only for its own sake, but potentially lay the long-term foundations for major societal or commercial shifts.

The federal government is a major funding source of R&D, and through its labs is a significant performer. The federal government is the primary funding source of basic research in the United States, contributing 52 percent of the total amount (figure 1). The Department of Defense, however, invests heavily to meet development needs (figure 3) and is the largest government investor in R&D. The agencies that support the next largest share of research are the Department of Health and Human Services, mainly through the National Institutes of Health; the Department of Energy; the National Aeronautics and Space Administration; and the National Science Foundation.

A focal point of the TLSI is improving public-private-university partnerships, so it is worth noting the technology transfer activities of federal agencies, particularly their number of collaborative engagements (see figure 4). The Department of Defense by a wide margin has the most collaborative engagements, but other noteworthy collaborators are the Department of Agriculture and the Department of Commerce through the National Institute of Standards and Technology and the National Oceanic and Atmospheric Administration. Data for the Department of Homeland Security is expected to be available in the 2011 *Science and Engineering Indicators* report.

**Figure 1. National R&D, by Character of Work, and Basic Research, by Funding and Performing Sectors, 2008**

Source: National Science Foundation, Division of Science Resources Statistics, National Patterns of R&D Resources (annual series). Appendix tables 4-3, 4-4, 4-5, 4-6 and 4-8.




Notes: Data for 2008 are preliminary. National R&D expenditures estimated at $398 billion in 2008. Federal performers include federal agencies and federally funded research and development centers. State and local government support to industry included in industry support for industry performance. State and local government support to universities and colleges included in universities and colleges support of universities and college performance. Detail may not add to total because of rounding.

**Figure 2. Shares of National R&D Expenditures, by Performing and Funding Sectors, 2008**
Source: National Science Foundation, Division of Science Resources Statistics, National Patterns of R&D Resources (annual series). Appendix tables 4-3 and 4-7.

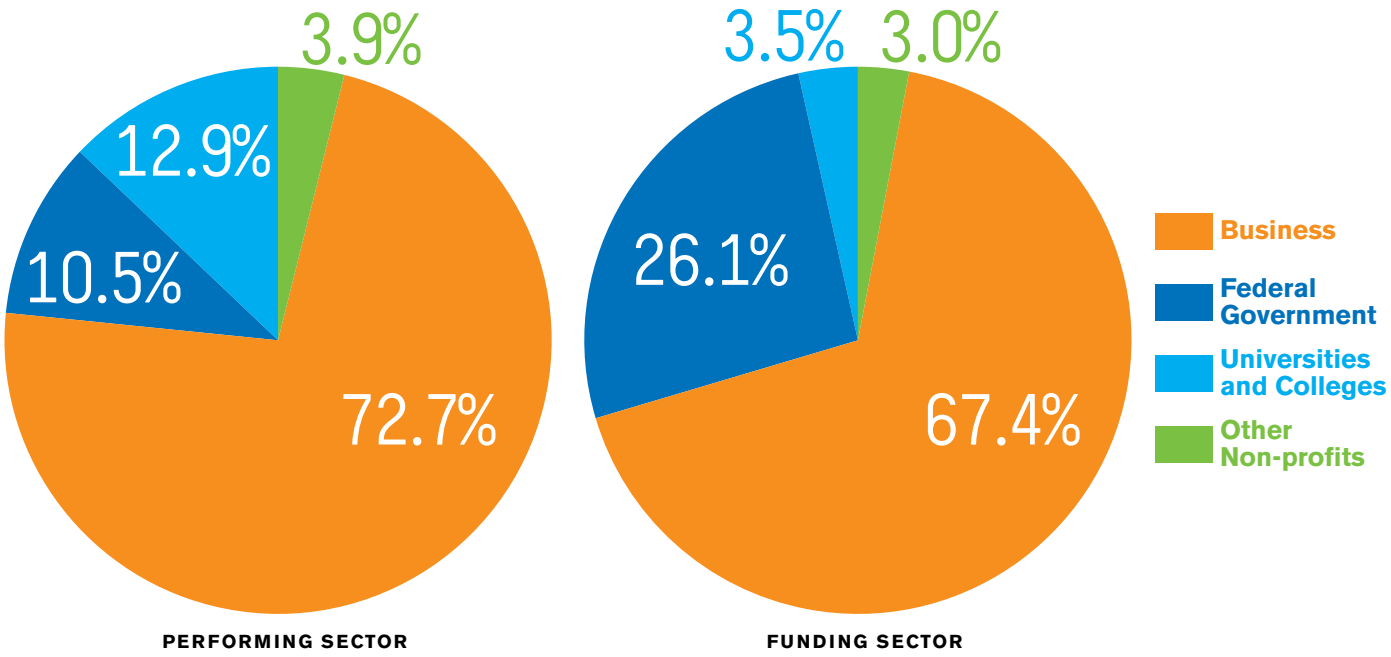



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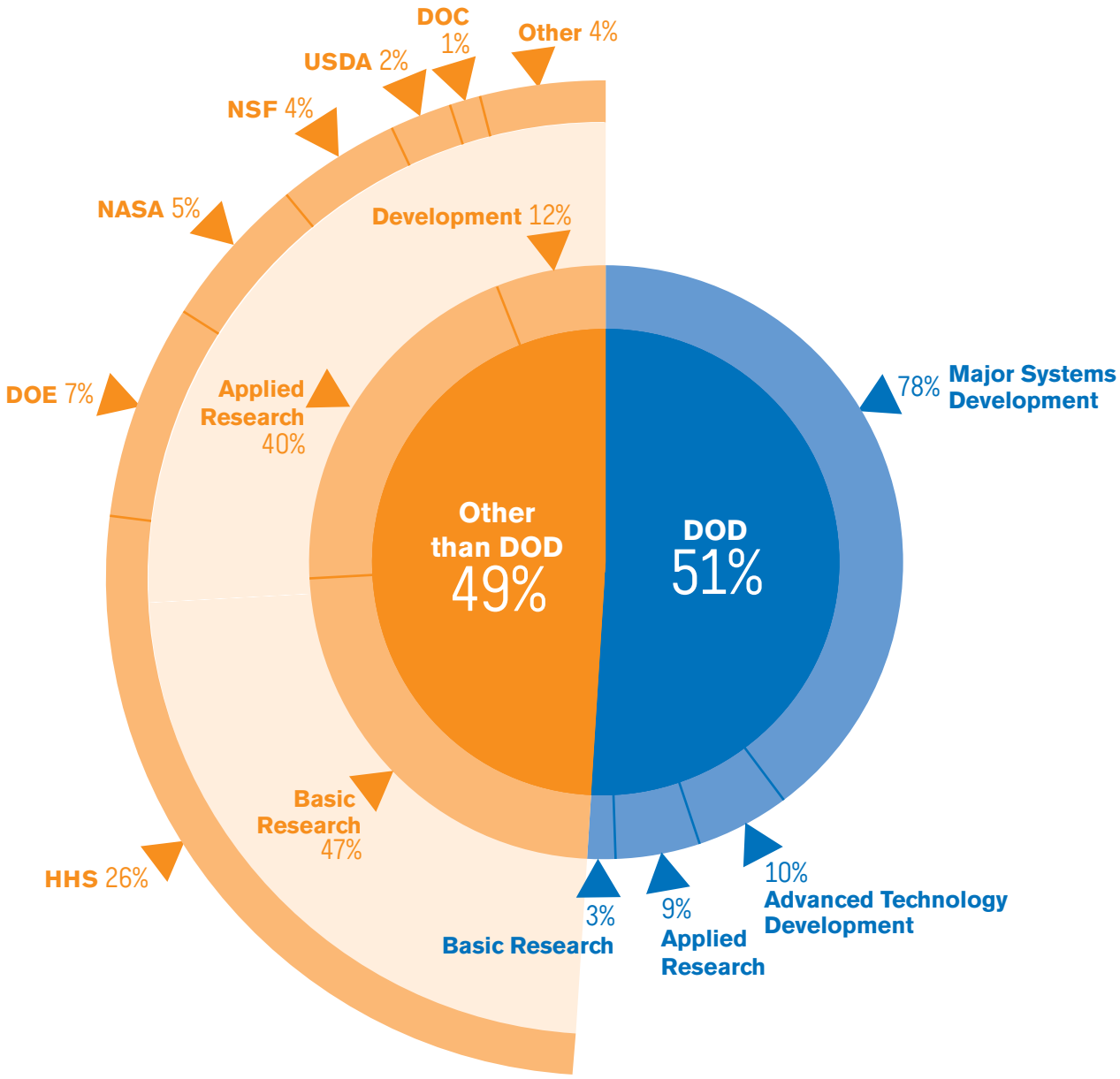
**Figure 3. Projected Federal Obligations for R&D, by Agency and Character of Work, 2008**

Source: National Science Foundation, Division of Science Resources Statistics, Federal Funds for Research and Development: Fiscal Years 2007-09. Appendix table 4-30.




DOC = Department of Commerce; DOD = Department of Defense; DOE = Department of Energy; HHS = Department of Health and Human Services; NASA = National Aeronautics and Space Administration; NSF = National Science Foundation; USDA = Department of Agriculture

Note: Detail may not add to total because of rounding.

**Figure 4. Federal Laboratory Technology Transfer Activity, by Selected U.S. Agency: FY 2007**
Source: Science and Engineering Indicators 2010, based on National Institute of Standards and Technology data

| Technology Transfer Activity Indicator | Total | DOD | HHS | DOE | NASA | USDA | DOC |
|---|---|---|---|---|---|---|---|
| Invention Disclosures and Patenting | | | | | | | |
| Inventions disclosed | 4,486 | 838 | 447 | 1,575 | 1,268 | 126 | 32 |
| Patent applications filed | 1,824 | 597 | 261 | 693 | 105 | 114 | 7 |
| Patents issued | 1,406 | 425 | 379 | 441 | 93 | 37 | 4 |
| Licensing | | | | | | | |
| All licenses, total active | 10,347 | 460 | 1,418 | 5,842 | 1,883 | 339 | 217 |
| Invention licenses | 3,935 | 460 | 915 | 1,354 | 461 | 339 | 217 |
| Other intellectual property licenses | 6,405 | 0 | 460 | 4,488 | 1,422 | 0 | 0 |
| Collaborative Relationships for R&D | | | | | | | |
| CRADAs, total active | 7,327 | 2,971 | 285 | 697 | 1 | 230 | 2,778 |
| Traditional CRADAs | 3,117 | 2,383 | 206 | 697 | 1 | 184 | 154 |
| Other collaborative R&D relationships | 9,445 | 0 | 0 | 0 | 2,666 | 4,084 | 2,695 |

CRADA = Cooperative Research and Development Agreement; DOC = Department of Commerce; DOD = Department of Defense; DOE = Department of Energy; HHS = Department of Health and Human Services; NASA = National Aeronautics and Space Administration; USDA = U.S. Department of Agriculture

NOTES: Other federal agencies not listed but included in total: Department of the Interior, Department of Transportation, Department of Veterans Affairs, and Environmental Protection Agency. Department of Homeland Security expected to provide technology transfer statistics starting in FY 2008. Invention licenses refers to inventions that are/could be patented. Other intellectual property refers to intellectual property protected through mechanisms other than a patent, e.g., copyright. Total active CRADAs refer to agreements executed under CRADA authority. Traditional CRADAs are collaborative R&D partnerships between a federal laboratory and one or more nonfederal organizations. Federal agencies have varying authorities for other kinds of collaborative R&D relationships.

## Commercialization Models

Many strategies are employed to take an idea to market. The path can vary greatly depending on the entity bringing the innovation into practice, the type of technology, incentives or hurdles created by the regulatory environment, the availability of risk capital or talent, and many other factors. The aim of this section is to review briefly some of the main commercialization models,[6] recognizing that significant variation exists within each model and that hybrid models are often employed.

1. **Licensing:** Under licensing models, an owner of intellectual property (IP) charges a fee to another party to use that IP to commercialize a product or service. Universities, companies and federal laboratories employ licensing strategies to earn revenue from their IP that they might not be best equipped to bring to market or that others may be infringing. In many cases, the IP to be licensed is a necessary or desired component to an innovation that draws on IP from multiple parties. In cross-licensing agreements, parties exchange permission for each to utilize the IP of the other party so that both can innovate either jointly or separately.
2. **Internal Business Unit:** Under this commercialization model, firms take a product or service to market through one of their business units. The innovation may have been researched and developed through an open or closed innovation strategy, but the path to market is internal to the firm. Often, this model of commercialization is used for incremental innovations to existing offerings in the core business or an acquisition that compliments existing offerings.

### Licensing: University of Minnesota and Miromatrix

Source: University of Minnesota, http://www1.umn.edu/news/features/2010/UR_CONTENT_179497.html

In 2008, University of Minnesota Professor Doris Taylor garnered worldwide attention when her team created a beating animal heart in the laboratory.

In 2010, the University signed an exclusive global agreement with Miromatrix Medical Inc. to license the technology, which may enable the replacement of human organs with organs that are currently non-transplantable. The new organs would be created by harvesting from either human or non-human donors, stripping them of their cells, and regenerating them with cells from the recipient or a compatible donor.

The University believes that Taylor's research holds the potential to launch an entirely new industry on the scale of the medical device industry. Miromatrix CEO Robert Cohen says the company intends to commercialize a series of products based on this work.

6 The models presented are drawn primarily from TLSI conversations with Andrew Garman and Tom Uhlman of New Venture Partners and Thomas Cellucci of the Department of Homeland Security.


### Entrepreneurial Spin-Out: InnoCentive

Sources: Chesbrough, Henry and Garman, Andrew. *How Open Innovation Can Help You Cope in Lean Times*. Harvard Business Review. December 2009.

http://www.innocentive.com/about-us-open-innovation.php

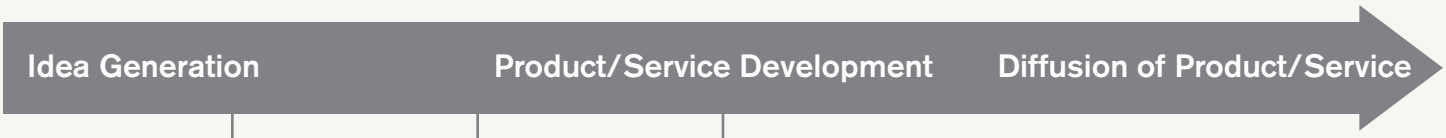
Ely Lily turned an internal project that aimed to create a superior process to source new ideas for drug development into an independent venture that eventually became InnoCentive.

InnoCentive built the first online Open Innovation Marketplace and offers prize-based open innovation sourcing. Scientists, engineers and entrepreneurs (solvers) can collaborate in a global community to deliver solutions for R&D-driven organizations (seekers). InnoCentive's seekers include organizations such as Eli Lilly, SAP, NASA and the Rockefeller Foundation.

Seekers submit complex problems to a highly skilled community of more than 200,000 solvers in more than 175 countries. Solvers who deliver the most innovative solutions receive financial awards ranging up to $1 million (U.S.).

3. **Joint Venture:** Under this model, at least two firms agree to commercialize together and share the proceeds. Joint ventures capitalize on different strengths of the partnering entities. Joint ventures are often the commercialization model of choice for overseas engagements where the host country's knowledge, talent, technology or networks are desired or required.
4. **Entrepreneurial Spin Out:** Under this model, a new commercial entity is spun out of an existing business, a university or a national laboratory. Angel investors and venture firms typically play a crucial role to support development, build a credible management team and bring the innovation to market. In some cases, the entity from which the new venture is spun will take an equity stake in the new firm or become a customer or partner with the new firm.
5. **Government Acquisition:** The defining characteristics of this form of commercialization is that the government finances applied research and/or development to meet a specified public sector need and that in many cases, such as Department of Defense or NASA acquisitions, the government represents the initial or possibly sole market for the innovation.
6. **Government Commercialization:** This model differs from traditional acquisition in that the government takes on a more collaborative role and relies on the private sector to finance the development of what will often be a more widely-distributed commercial product for public and private customers. In the case of the Department of Homeland Security, the government provides price points, specifications and an estimate of market potential. It also offers a validation of the product after testing and evaluation, and may help market the product to public sector channels. A variation on this commercialization model is the use of government-sponsored competitions.

## Figure 5. General Innovation Process, Main Actors and Commercialization Modes




### BASIC RESEARCH

Investigation to advance scientific knowledge, with practical application not an immediate objective

**U.S. Basic Research Performed by:**

Universities 56%

Business 17%

Fed. Gov. 15%

**Funded by:**

Fed. Gov. 57%

Business 18%

Universities 15%

### APPLIED RESEARCH

Investigation of basic research findings to develop new goods, technology, services or processes

**U.S. Applied Research Performed by:**

Business 69%

Fed. Gov. 13%

Universities 12%

**Funded by:**

Business 61%

Fed. Gov. 32%

Universities 4%

### DEVELOPMENT

Directs applied research toward production. Includes design, prototyping and regulatory approval

**U.S. Development Performed by:**

Business 90%

Fed. Gov. 8%

Universities 1%

**Funded by:**

Business 84%

Fed. Gov. 15%

Universities 0.3%

### COMMERCIALIZATION MODELS

Simplified models of how innovations are brought to market. Many hybrids and variations of these models are utilized in practice, depending upon the innovation, market realities and the choices made by individuals and institutions.

**1. Licensing:** Under this model, an intellectual property (IP) owner charges a fee for another to use that IP to commercialize. In a cross-license agreement, parties permit each other to use IP owned by both sides.

**2. Internal Business Unit:** Under this model, a firm takes a product to market through it own business unit(s). Typically, this model is used for incremental innovations to existing products in the core business.

**3. Joint Venture:** Under this model, at least two firms commercialize together and share the proceeds. Often this is the model of choice for overseas ventures where host country expertise and knowledge is desired or required.

**4. Entrepreneurial Spin Out:** Under this model, a new free standing entity is spun out of a firm, university or government lab. Generally requires angel investors and/or venture firms to provide funding and credible management team.

**5. Government Acquisition:** Under this model, a government agency funds applied research and development (usually private) to meet a public need. Government then deploys the end product.

**6. Government Commercialization:** Under this model, government takes a collaborative role. The agency issues price points, specifications and market potential, but relies on private development funding and private distribution.

## Perspective for TLSI

The TLSI is striving to improve the policy environment for innovation, identify strategic technologies and generate more productive public-private-university partnerships. If Americans are to increase their return (economic and societal) from public and private R&D investment, it is helpful to keep the big picture in mind.

Business is the principle engine of commercialization and primary source of R&D funding in the United States. Lowering regulatory costs (particularly for startups), strengthening investment incentives and ensuring world-class talent are consistent themes raised in the TLSI dialogues to generate more U.S.-based innovations.

The federal government and universities are the primary engines that fund and conduct basic research, which history shows can create disruptive technologies that have advanced economic growth and quality of life, often dramatically. The TLSI has noted, however, that precious few good ideas make the transition from university or federal labs to real life application, often for reasons other than the merit or market viability of the idea.

It is unsurprising, of course, that a smaller share of research from universities and federal labs will be commercialized than from companies because universities and federal labs conduct a higher share of basic research than companies. Basic research, after all, is conducted to expand knowledge without a specific commercial application in mind.

That being said, TLSI participants are unanimous in their belief that the potential for partnership and commercialization is much higher at universities and labs than present performance. Often due to intellectual property or other concerns, businesses partner with universities and labs on only a small percentage of their research engagements. Looking over the past 20 years, for example, the share of business-funded R&D performed by universities has declined steadily from a high in 1994 of 1.5 percent to a present day low of 1.1 percent.[7]

Many universities and labs suffer from a culture that under invests in technology transfer or lacks incentives and management practices that favor commercialization. Other good ideas die on the vine for a lack of risk capital or entrepreneurial management expertise. Attention to reversing these problems through public policy and/or better management practices holds great promise for American innovation.

Americans also should be concerned about the success and efficiency of innovation to meet societal needs, which often translates to innovation through government acquisition or commercialization models. The last TLSI report noted mega projects in security, health and energy. These grand challenges cannot be fully addressed without stronger, more productive partnerships between government, businesses and universities.

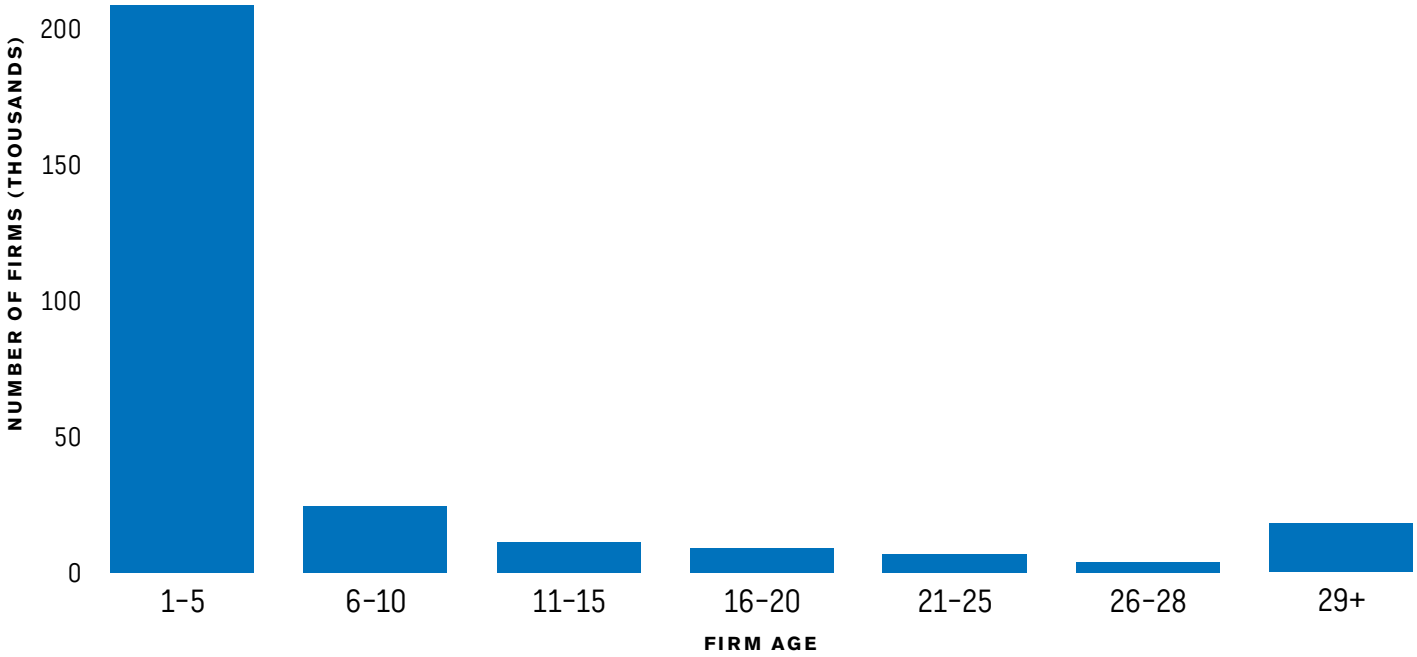
## Entrepreneurial Spin Outs, Job Creation and Risk Capital

Whether trying to spur commercialization from business, government labs or universities, special attention should be placed on the dynamics of spinning out new, high-growth companies. This form of commercialization is the primary source of young, high-growth enterprises that create a disproportionate share of new American jobs. Fast growing young firms comprise less than 1 percent of all U.S. companies but generate more than 10 percent of new jobs in any given year.[8]

7 National Science Foundation. *Science and Engineering Indicators 2008*. Appendix Table 4-5.

8 Stangler, Dane. High-Growth Firms and the Future of the U.S. Economy. Kauffman Foundation. March 2010

**Figure 6. Number of Firms in the Top 5 Percent of Growing Companies, by Age in Years**
Source: Dane Stangler, High-Growth Firms and the Future of the U.S. Economy. Kauffman Foundation. March 2010




The overwhelming share of high-growth companies are young, between 1 and 5 years old (figure 6).[9] The creation of these firms often relies on angel investors and venture firms. The Angel Capital Association (ACA) recently testified before Congress "that angel investors may be responsible for up to 90 percent of the outside equity raised by startups after the capital resources of their founders, friends and family are exhausted. These [startups] rarely have the collateral to receive bank loans, and they are generally too small and too young to receive venture capital.

"The best angels provide more than capital to small businesses. These "mentor capitalists" give back to the entrepreneurial economy by making high-risk investments directly in early-stage companies in their communities and using their entrepreneurial

### Policy Priorities of Angel Investors

Source: Angel Capital Association

1. Preserve low capital gains taxes on investment in truly early-stage firms and offer tax credits for such investment
2. Offer grants for foundations to educate angel investors, potential angels, university leaders, and support organizations for entrepreneurs
3. Maintain the regulatory net worth thresholds for accredited angel investors
4. Leverage angel investment with funds from or incentivized by government, as various states have done

9 Stangler, Dane. High-Growth Firms and the Future of the U.S. Economy. Kauffman Foundation. March 2010

experience to mentor the companies as they grow. "Many top angels got into this type of investment as a way to "give back" to their communities—by investing in local companies and providing them with mentoring and connections, they can help create jobs in their towns."[10]

In addition to urging that government preserve the connection between entrepreneurs and angels as a private sector activity, the ACA states that tax policy is crucial to preserve and grow angel investment and credits lower capital gains rates for the recent growth. ACA also cites Wisconsin policies, including an angel tax credit, as responsible for growing angel investment by 57 percent between 2006 and 2007.[11]

Angel and venture investors play complimentary but different roles. Angel investors as a whole commit smaller amounts of individuals' resources to more entrepreneurial firms at earlier stages and with more risk. Venture firms invest larger amounts of institutional dollars to fewer firms at later stages (figure 7).

**Figure 7. Average Investment of Angel and Venture Capital Per Business: 2002–08**

Sources: Jeffrey Sohl, Analysis Reports, Center for Venture Research, University of New Hampshire, http://wsbe.unh.edu/analysis-reports-0; and National Venture Capital Association and Price Waterhouse Coopers, Money Tree Report, https://www.pwcmoneytree.com/MTPublic/ns/index.jsp, accessed 15 March 2009

| Year | Angel Capital | | | Venture Capital | | |
|---|---|---|---|---|---|---|
| | Businesses (n) | Total Investment ($billions) | Average Investment/ Business ($thousands) | Businesses (n) | Total Investment ($billions) | Average Investment/ Business ($thousands) |
| 2002 | 36,000 | 15.7 | 436 | 2,634 | 21.3 | 8,087 |
| 2003 | 42,000 | 18.1 | 431 | 2,461 | 19.3 | 7,842 |
| 2004 | 48,000 | 22.5 | 469 | 2,625 | 22.1 | 8,419 |
| 2005 | 49,500 | 23.1 | 467 | 2,708 | 22.9 | 8,456 |
| 2006 | 51,000 | 25.6 | 502 | 3,089 | 26.3 | 8,514 |
| 2007 | 57,120 | 26.0 | 455 | 3,301 | 30.6 | 9,270 |
| 2008 | 55,480 | 19.2 | 346 | 3,262 | 28.1 | 8,614 |

NOTE: Business includes anything from an entrepreneur with an idea to a legally established operating company.

Science and Engineering Indicators 2010

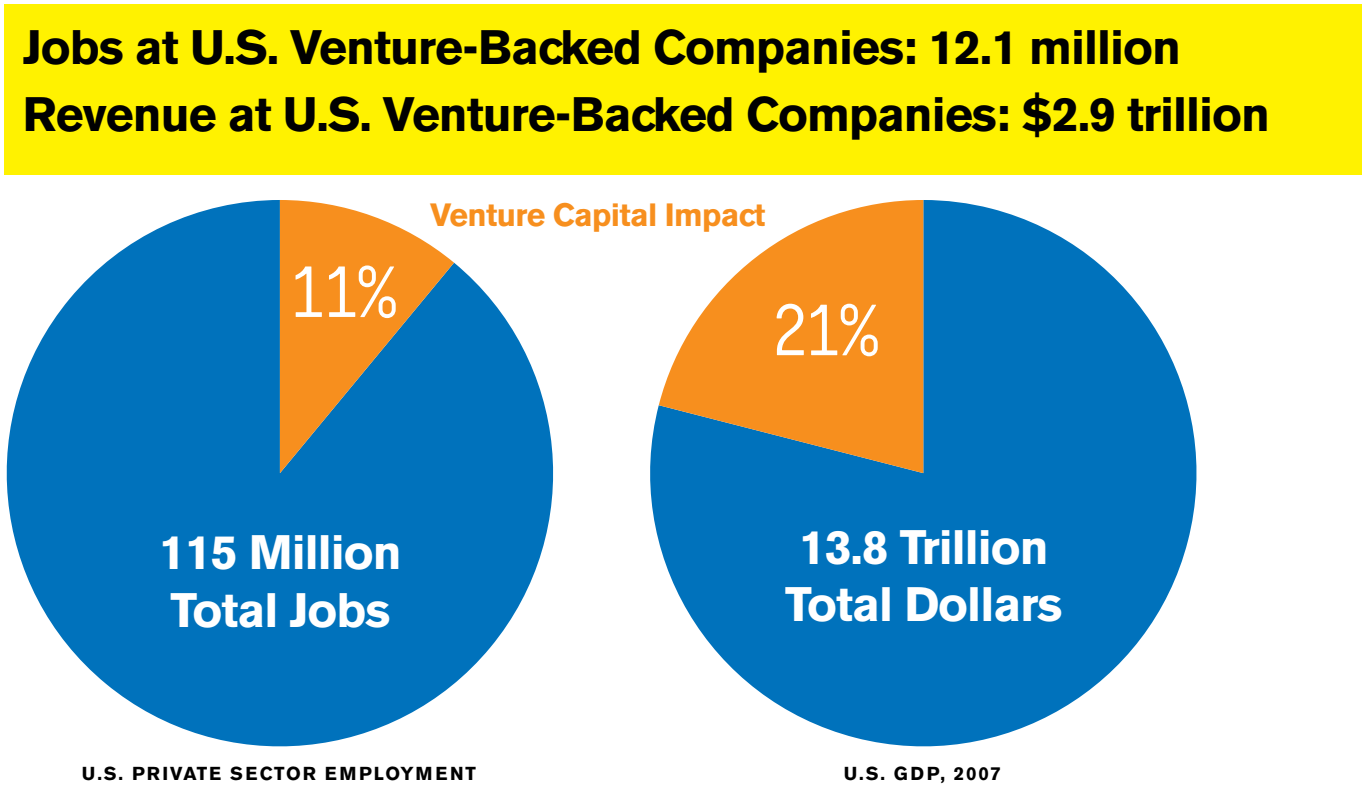
10 May, John for the Angel Capital Association. Testimony before the Investigations and Oversight Subcommittee of the House Small Business Committee. March 26, 2009.

11 Ibid.

The report issued prior to the second TLSI dialogue emphasized how important venture firms are to some of America's most dynamic sectors. Venture-backed firms account for 81 percent of the jobs in the software industry and 74 percent of the employment in telecommunications and semiconductors. Venture-backed firms also account for 67 percent of the revenue generated by electronics companies, 55 percent in semiconductors, and 51 percent in telecommunications.[12]

In 2008, venture-backed companies created 12.1 million jobs, accounting for 11 percent of all U.S. private sector employment. Venture-backed firms also generated $2.9 trillion in revenue, accounting for 21 percent of U.S. gross domestic product (figure 8).[13] In March 2010, Paul Holland of Foundation Capital testified before the House Technology and Innovation Subcommittee on behalf of the National Venture Capital Association. He suggested how government can grow jobs and growth across the United States by supporting entrepreneurial startups, and how standing pat risks losing America's innovation edge as other nations move aggressively to improve their capabilities.

**Figure 8. The Economic Impact of Venture Capital at a Glance**




12 IHS Global Insight. *Venture Impact–The Economic Importance of Venture Capital-Backed Firms to the U.S. Economy*. Prepared for the National Venture Capital Association. 2009.

13 Ibid.

Holland asserted that, "Government and civic support…starts with favorable tax policies, common-sense regulatory structures and encouragement of basic research. State and local initiatives that reward emerging growth companies also make a significant difference. A program like Ben Franklin Technology Partners in Pennsylvania that supports startup companies in their earliest stages helps create a pipeline from which venture capitalists can draw. Also, state pension funds that invest in local venture capital firms also drive success."[14] Holland noted that states such as California, Pennsylvania and Wisconsin have supported local venture firms strongly in recent years, resulting in increased investment by indigenous firms in their states' startups.

Holland also testified about the importance of federal policies to invest in basic research, improve math and science education, retain talented foreign nationals, maintain low capital gains rates on entrepreneurs and venture investors, lower regulatory barriers to initial public offerings, and improve patent quality and predictability.

"Historically," claimed Holland, "our government has helped pave that path with policies that encourage innovation on many levels. Yet, the environment has changed significantly in the last decade and the United States is no longer guaranteed a monopoly on entrepreneurship and innovation." He noted the significant rise of venture capital and entrepreneurial activity in regions outside the United States. "We face a new competitive environment in which innovation can be developed anywhere.

**Federal Policy Priorities of Venture Firms**

Source: March 2010 Testimony on behalf of the National Venture Capital Association

1. Reauthorize the America COMPETES Act to support basic research and STEM education
2. Enact the Start Up Visa Act to retain job-creating foreign nationals in the U.S. who have obtained venture funding from a qualified investor
3. Maintain low capital gains tax rates and continue applying that rate to carried interest to preserve the flow of venture capital
4. Enable more small cap Initial Public Offerings through Sarbanes-Oxley and other regulatory reforms
5. Enact reforms to improve patent quality and enhance the predictability of how patents will be awarded and protected

Foreign governments are being extremely aggressive in promoting favorable tax policies, improving their legal, accounting and intellectual property structures, and boosting their R&D spending to foster more innovation in their countries. The U.S. needs not only to maintain our current commitment to an innovation agenda, but rise up to meet the challenge set by our foreign competitors or risk losing our technological edge."

14 Holland, Paul for Foundation Capital and the National Venture Capital Association. Testimony before the House Technology and Innovation Subcommittee. March 24, 2010.

PART 1: SETTING THE STAGE FOR TLSI DIALOGUE 3

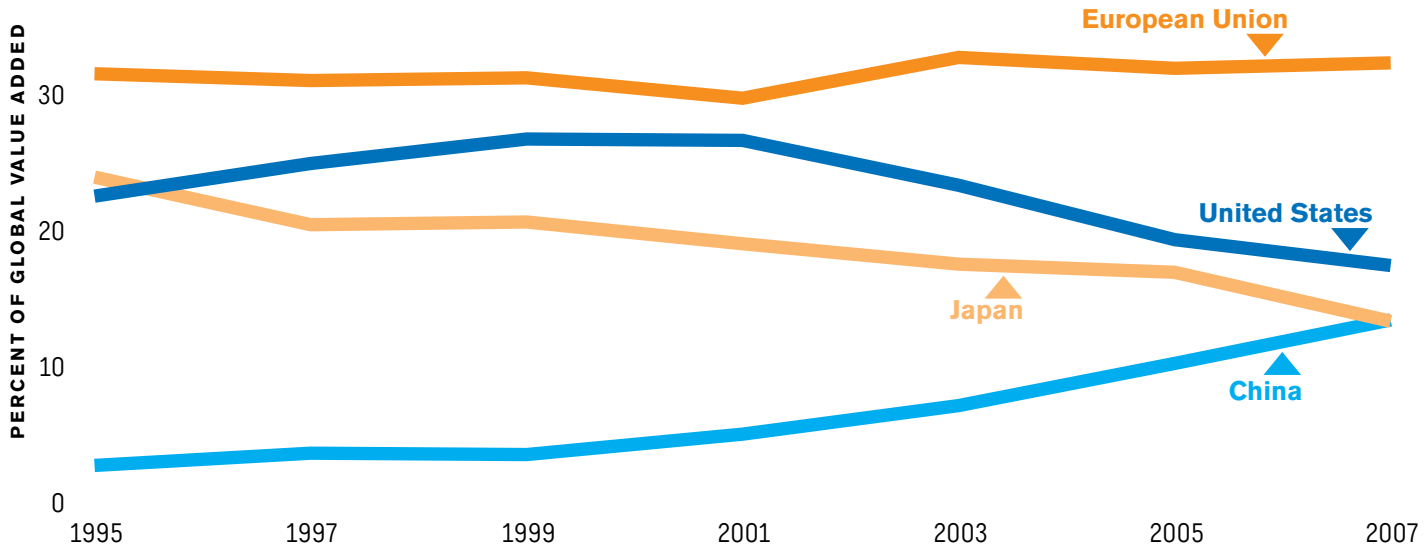
# U.S. Manufacturing Competitiveness Initiative

## Overview

On June 23, 2010, the Council on Competitiveness will launch the U.S. Manufacturing Competitiveness Initiative (USMCI). America's national and economic security—and ability to create wealth and new jobs—depends upon a robust and adaptive manufacturing ecosystem. To maximize the economic benefit of its innovations, the Council believes that the United States must create a more competitive environment capable of capturing a higher share of jobs and revenue related to production.

Manufacturing accounts for the majority of U.S. R&D, drives productivity growth and contributes a significant share to gross domestic product. According to the National Association of Manufacturers, America's share of the global value added in manufacturing has remained relatively steady at about 22 percent since 1980.[15] The U.S. share of global value added in medium to high technology, however, has declined steadily since 1999 (figure 9).

**Figure 9. Share of Global Value Added for Manufacturing in Medium to High Technology**
Source: Science and Engineering Indicators 2010




15 Manufacturing Institute. *The Facts About Modern Manufacturing*. 8th edition. 2010.

As manufacturing efficiency has risen through automation, much has been written about a shift to service economies in both developed and developing economies. The USMCI recognizes the importance of the service sector, but will explore the linkages and interdependencies between services, manufacturing and R&D activities. Without a strong manufacturing base, the United States risks losing R&D activities for key sectors over time and risks underperforming in service employment.

America needs a vision and goals for manufacturing. Vibrant regional innovation ecosystems and smart networks of lean and agile manufacturers should thrive through policies that generate startup capital for such firms and keep them cost-competitive. By 2020, the United States should be the leader in frontier research in process technologies and manufacturing productivity, including advanced modeling and simulation. Clean and advanced manufacturing technologies should be deployed across the economy, as the risk, cost and time to commercialize and produce them at scale is reduced substantially.

The goal of the USMCI is to deliver to the administration and Congress a realistic and comprehensive solutions roadmap. A national summit will be convened in 2011 with a wide range of stakeholders committed to a diversified and technologically advanced U.S. manufacturing value chain.

## Role of TLSI

The TLSI's focus on making the U.S. innovation ecosystem more productive, strengthening partnerships and examining strategic technologies supports the goals of the USMCI. The TLSI aims to help America generate new, high-margin products. The USMCI will build on those insights and suggest strategies to capture the maximum economic return for the nation by enabling those new products to be manufactured competitively in the United States.

In many cases, the United States is no longer a producer of key technologies developed here and risks losing others (figure 10). The Council does not believe that such shifts are inevitable. Competitive production of complex technologies typically does not hinge purely on labor costs, but more on available talent, infrastructure, distribution networks, the ability to source global components cheaply, tax and regulatory costs, proximity to customers and other factors that vary depending on the product. In fact, most U.S. manufacturing foreign direct investment is in high-wage, developed nations (figure 11).[16]

According to the Manufacturing Institute, "The highly competitive nature of the global economy and the growing complexity of manufacturing supply chains increase the incentive for technology development and implementation in the manufacturing sector. An array of environmental technologies, material sciences, computer-related and just-in-time production infrastructures, as well as the growing world of nanotechnology, are among those advances that have expanded product and process innovation and have kept U.S. manufacturing globally competitive.

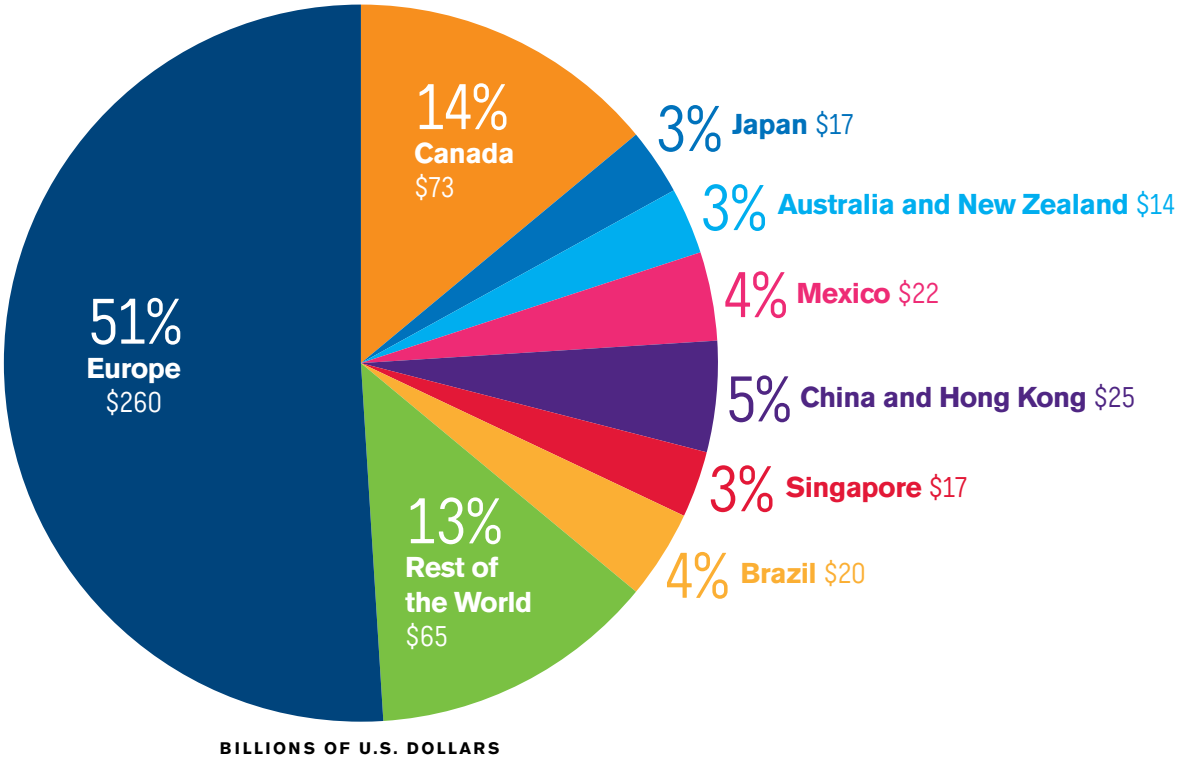
Manufacturing firms account for more than 45 percent of all R&D-performing companies in the United States. More recent data for 2007 show that the manufacturing sector continues to account for about half of all public and private R&D performance in the United States. Between 20 and 25 percent of all firms in leading-edge biotech and software development are manufacturers. And the industrial sector still dominates materials synthesis development, accounting for 70 percent of all U.S. firms engaged

16 Manufacturing Institute. *The Facts About Modern Manufacturing*. 8th edition. 2010.

**Figure 10. Leadership in Next Generation Technologies at Stake**
Source: Harvard Business Review, July 2009

| Industry | No Longer Manufactured In the United States | At-Risk of Moving Abroad |
|---|---|---|
| **Semiconductors** | • Fabless chips | • DRAMs<br>• Flash memory chips |
| **Lighting** | • Compact fluorescent lighting | • LEDs for solid-state lighting, signs, indicators and backlights |
| **Electronic Displays** | • LCDs for monitors, televisions and handheld devices like mobile phones<br>• Electrophoretic displays for Amazon's Kindle e-reader and electronic signs | • Next-generation "electronic paper" displays for portable devices like e-readers, retail signs and advertising displays |
| **Energy Storage and Green Energy Production** | • Lithium-ion, lithium polymer and NiMH batteries for cell phones, portable consumer electronics, laptops and power tools<br>• Advanced rechargeable batteries for hybrid vehicles<br>• Crystalline and polycrystalline silicon solar cells, inverters and power semiconductors for solar panels | • Thin-film solar cells |
| **Computing and Communications** | • Desktop, notebook and netbook PCs<br>• Low-end servers<br>• Hard disk drives<br>• Consumer-networking gear, such as routers, access points and home set-top boxes | • Blade servers, midrange servers<br>• Mobile handsets<br>• Optical-communication components<br>• Core network equipment |
| **Advanced Materials** | • Advanced composites used in sporting goods and other consumer gear<br>• Advanced ceramics<br>• Integrated circuit packaging | • Carbon composite components for aerospace and wind energy applications |

**Figure 11. U.S. Manufacturing Foreign Direct Investment Stock, as of 2008**
Source: U.S. Bureau of Economic Analysis, Investment Position on an Historical Cost Basis, 2008




in this area of technological development. Further anecdotal evidence has shown that other sectors of the economy have successfully adopted lean production techniques created in the industrial sector with positive implications for service performance and profitability."[17]

Because of the strong links between driving new innovations and the future of U.S. manufacturing, the USMCI will serve as an additional vehicle to endorse the findings and recommendations of the TLSI and to bind the key competitiveness recommendations from the Council in areas like energy, high performance computing and workforce development.

17 Manufacturing Institute. *The Facts About Modern Manufacturing*. 8th edition. 2010.

PART 1: SETTING THE STAGE FOR TLSI DIALOGUE 3

# Industrial Policy

Should the U.S. Government Do More, Less, or Something Different to Promote Key Technologies for National Security and Economic Competitiveness?

## Current U.S. Policies

The policy environment in the United States to promote technology is diverse and can be measured in many ways. As this paper has already detailed, U.S. federal investment comes from several agencies and is a mix of basic, applied and development activities (figure 12). U.S. federal policy supports "market-driven" research, largely through peer-reviewed basic research grants to universities across many disciplines; mission-driven R&D that supports government missions or national priorities; and specific technologies that are deemed strategic for development or deployment. This section will briefly examine federal funding through a few lenses and note some of the specific technologies that have been deemed strategic.

It should be noted that states, regions and localities also play an active role in technology promotion. Most states and many localities seek to understand and develop their potential technology strengths with an aim to create jobs and economic growth. Akron, Ohio, for example, has worked actively for many years to become a center for engineering and advanced manufacturing in polymers and biomedical products.

**Federal R&D Funding:** Many agencies undertake strategic assessments to identify technologies that are critical to their missions. The Department of Energy, for example, is working to develop and deploy new building and vehicle technologies, modernize the energy grid, and advance alternative energies like wind, solar and biofuels. The Advanced Research Projects Agency—Energy (ARPA-E) has been established to bring transformational energy technologies into practice, aiming to replicate the success of its Department of Defense model.

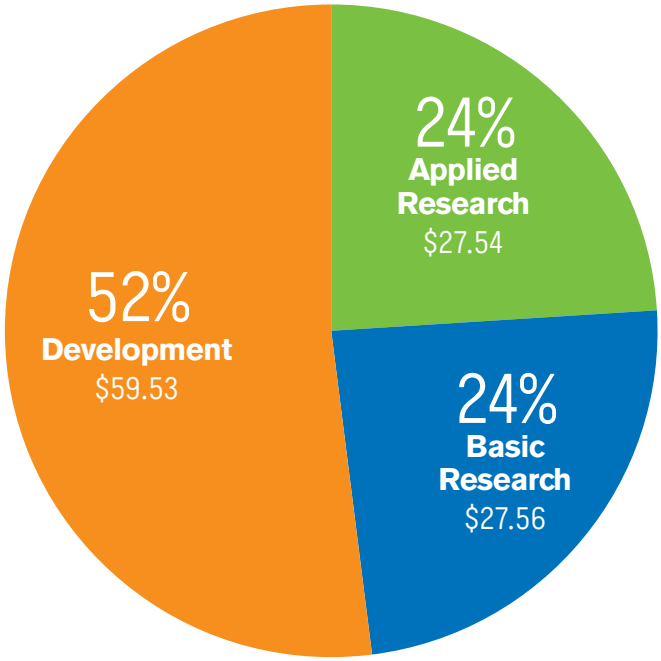
The Department of Defense, which accounts for more than half of federal R&D (figure 13), also regularly assesses its technology needs. Recent remarks by Zachary Lemnois, director of Defense Research and Engineering, cited the deployment of mine-resistant vehicles and more attack-resistant helicopters as high priorities coming from field commanders in Afghanistan.[18]

"More than at any time since the industrial revolution, we face a future that is critically dependent on our ability to rapidly field new technical concepts," Lemnois said. "We face the challenge of globalization, the increased pace of technology development, the availability of advanced commercial technologies by our adversaries and the enduring challenge of asymmetric warfare."

18 Lemnois, Zachary. Remarks to the Defense Technology and Requirements Conference. February 17, 2010.

**Figure 12. Distribution of Obligated Federal R&D FY 2008**

Source: Science and Engineering Indicators 2010




Lemnois identified specific technologies like hypersonics and airborne lasers as strategically important. He also noted two important information technology systems efforts designed to cull better battlefield decisions from large data volumes and improve the engineering design, test and construction of complex systems across the department.

Looking at federal non-defense R&D investment by function, health care R&D receives the largest share, followed by significantly lower levels of space, general science and energy funding (figure 14). Federal health care R&D expanded significantly in the mid to late 1990s, while most other non-defense functions have largely plateaued. This trend might change slightly when FY 2009 funding is included in the data to reflect a boost in physical science investment and investments made through the American Recovery and Reinvestment Act.

These metrics demonstrate the diversity of technologies pursued across government to achieve agency objectives. Federal technology policy, however, also is driven at a macro level across the various departments through the White House's Office of Science and Technology Policy (OSTP). OSTP overseas the National Science and Technology Council (NSTC), a body made up of 27 cabinet secretaries, agency heads and White House officials with significant science and technology responsibilities.

**Figure 13. U.S. R&D Budget Authority, 1987-2007**
Source: Science and Engineering Indicators 2010)

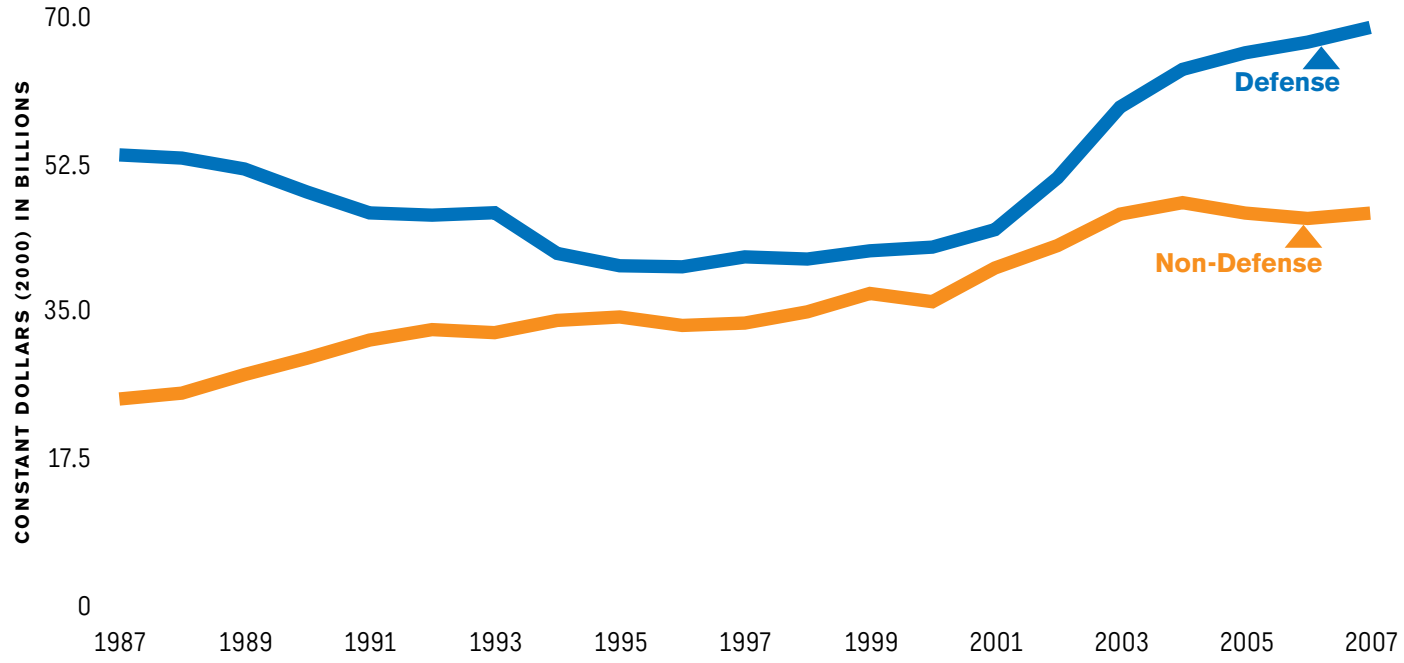
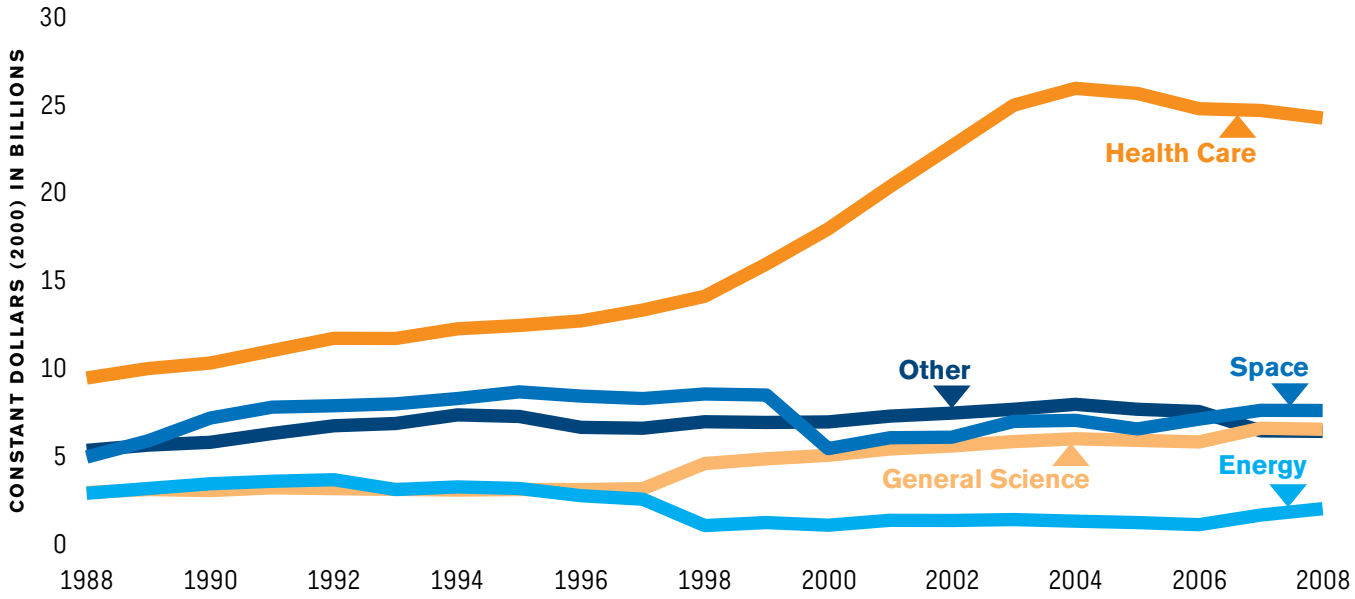



**Figure 14. U.S. Non-Defense R&D Budget Authority By Function, 1988-2008**
Source: Science and Engineering Indicators 2010



The NSTC is charged with setting clear national goals and strategies for federal science and technology investments in virtually all the mission areas of the executive branch. Informing the president and OSTP is the President's Council of Advisors on Science and Technology (PCAST). PCAST is an advisory group of leading scientists and engineers who recommend policy in many areas key to strengthening the U.S. economy and society.

**Questions on Key Technologies:** Through OSTP, NSTC and PCAST, many cross-cutting technologies of national importance have been identified. In 2009 and 2010, for example, NSTC issued reports on aeronautics; microbial forensics; ocean science; plant genomics; and federal social, behavioral and economics research. The president has issued national broadband, cybersecurity and open government initiatives. Multiple agencies are coordinating their efforts through the National Nanotechnology Initiative, and at the first TLSI Dialogue, White House Chief Technology Officer Aneesh Chopra cited the promise of applying technology to health care, energy and education challenges.

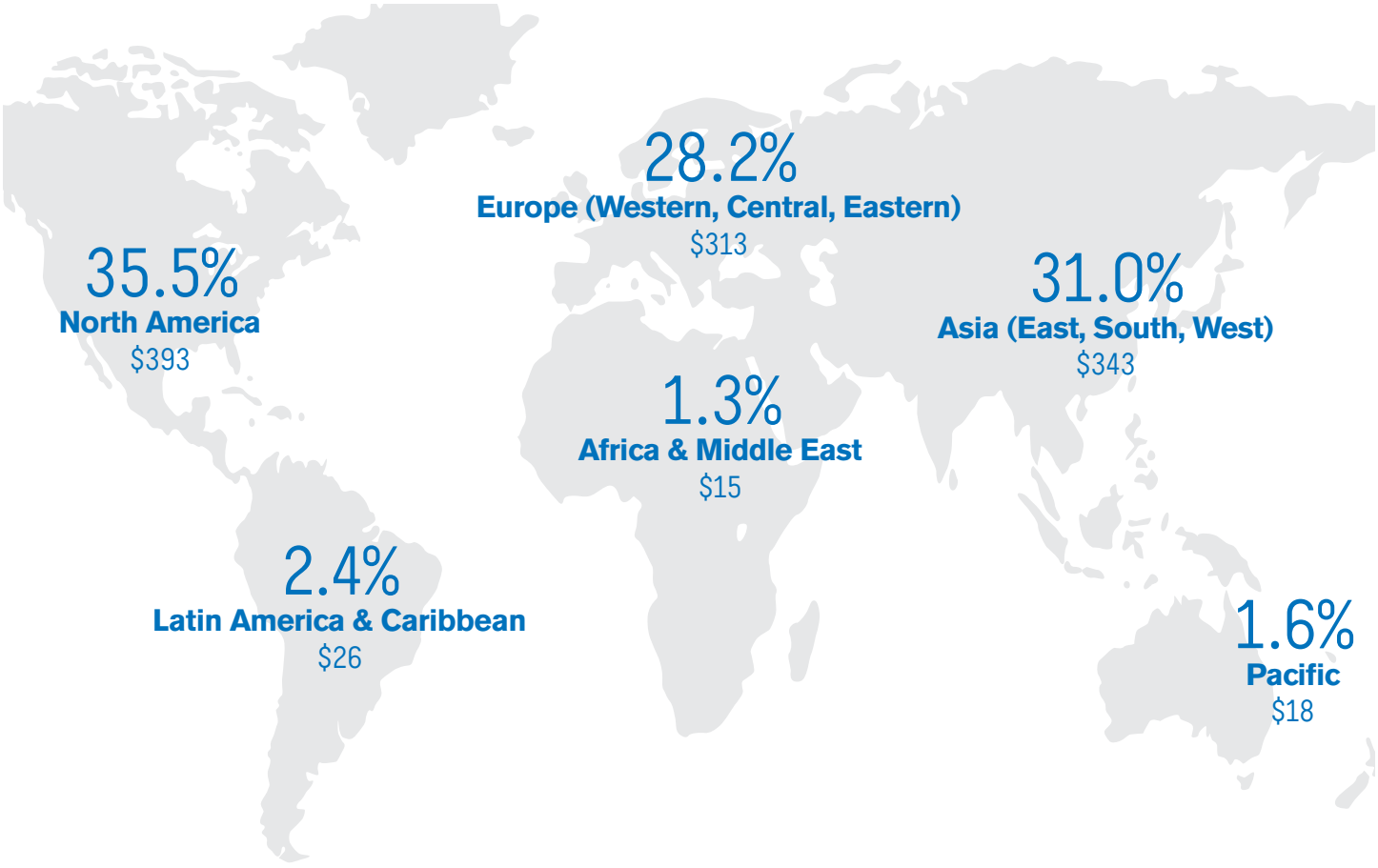
Prior to the first dialogue, the Council commissioned a survey and offered insights on which technologies are perceived as particularly strategic. Nanotechnology, biotechnology, ubiquitous computing and energy storage were included on this list.

The TLSI asks participants and observers in the dialogues to consider the following questions:

- Can we identify key technologies on which the federal government should adjust its overall strategy? If so, how should the strategies be adjusted—through funding levels, different policies or different management practices? How should change be affected—through PCAST, through agencies and/or via Congressional action?
- Furthermore, do TLSI members believe that current U.S. policies and practices place the nation at a competitive disadvantage with overseas competitors? Many nations are investing heavily in technologies that they believe will be strategic to their future and R&D expenditures are roughly even between North America, Europe and Asia (figure 15).
- Are U.S. competitors investing in or incentivizing investment in strategic technologies in a way that demands a U.S. response? If so, what should those responses be—replicating overseas policies, taking a third path and/or engaging in deeper collaboration with other nations?

**Figure 15. National R&D Expenditures and Share of World Total, by Region, 2007**

Sources: United National Educational, Scientific and Cultural Organization (UNESCO) Institute for Statistics, http://www.uis.unesco.org, accessed October 2009; and Organization for Economic Co-operation and Development, Main Science and Technology Indicators (2009/1).




PPP = purchasing power parity

Notes: Foreign currencies converted to dollars through purchasing power parities. Sources track R&D for 126 countries. Some country figures are estimated.

PART 1: SETTING THE STAGE FOR TLSI DIALOGUE 3

# Conclusion

One of the ways that the TLSI aims to achieve its goals is to offer common reference points to those participating in the dialogue. The Council hopes that the reports preceding the dialogues will inform participants of issues, viewpoints and metrics that will stimulate conversation on key issues and help identify priorities.

The topics under review by the TLSI have major implications for America's future, and national ambitions should scale to those implications. Entering the third dialogue, the Council looks forward to producing a steady stream of ideas to drive more partnerships, more commercialization and new technologies. Like innovation itself, however, the TLSI aims to do far more than generate ideas—it aims to implement them and thereby produce a genuinely more competitive and prosperous America.

# Part 2: Findings from TLSI Dialogue 3

PART 2: FINDINGS FROM TLSI DIALOGUE 3

# Opening Remarks

Samuel R. Allen, chairman and CEO of Deere & Company and newly-elected chairman of the Council of Competitiveness, opened the dialogue. He welcomed the attendees and emphasized the importance of the TLSI based on its own mission and as part of a larger, integrated competitiveness agenda pursued by the Council. "One of the most critical pillars of competitiveness is technology," Allen stated, also noting the link between technology innovation and the Council's U.S. Manufacturing Competitiveness Initiative launched the day prior to the third TLSI Dialogue.

Allen thanked the TLSI co-chairs, Mark Little, senior vice president and director of GE Global Research, and Ray Johnson, senior vice president and chief technology officer of the Lockheed Martin Corporation. Allen also introduced Klaus Hoehn, chief technology officer and vice president for advanced technology and engineering for Deere & Company. Hoehn accepted the Council's invitation to join the TLSI as a third co-chair, reflecting Allen's pledge of support for the TLSI and other Council initiatives.

Deborah L. Wince-Smith, president & CEO of the Council, thanked Allen and the three co-chairs. She recognized members present from the Council Executive Committee and noted a number of distinguished government officials who would address the group, including: Zach Lemnios, Director, Defense Research and Engineering; Brett Lambert, Deputy Assistant Secretary of Defense for Industrial Policy; Michael Kassner, Director, Office of Research (Discovery & Invention), Office of Naval Research; David

*Samuel R. Allen, Deere & Company.*

Kappos, Under Secretary of Commerce for Intellectual Property and Director of the United States Patent and Trademark Office; Arun Majumdar, Director of the Advanced Research Projects Agency—Energy; and Chris Scolese, the Associate Administrator of the National Aeronautics and Space Administration.

She also thanked Tom Cellucci, Chief Commercialization Officer of the Department of Homeland Security, for his leadership and support, and noted that Internet pioneer Vint Cerf, vice president and chief Internet evangelist for Google, would be joining the dialogue.

TLSI co-chair Ray Johnson was pleased to note that the TLSI continues to grow and welcomed the many new faces at the dialogue. He linked the initiative to current events and emphasized the promise of

*Chad Evans, Council on Competitiveness; Laura Adolfie, U.S. Department of Defense; Mark Little, General Electric Company; Zach Lemnios, U.S. Department of Defense; Deborah L. Wince-Smith, Council on Competitiveness; and Ray Johnson, Lockheed Martin Corporation.*

innovation. "We live in a new reality," Johnson said. "We understand the importance of innovation to our economy and as a nation we're very good at innovation. But, I think a new reality started about two years ago—an economic crisis to which our government and governments around the world responded. We got through the crisis. Now it's time to rebuild and create jobs."

"We also have challenges like military missions and national security threats," Johnson continued, "and challenges in areas like energy, climate change, and affordable health care. Thinking more broadly, we still face global issues like safe food and clean water in which innovation plays an important role." Johnson also offered a few words about innovation at Lockheed Martin. "We could describe our four busi-

ness area as advanced aircraft, space craft, maritime systems, and electronics and information technology, but what we provide through innovation is really humbling—an opportunity to provide products and services to our war fighters around the world, and bring them back home safely." In addition to that, we support military missions in the broadening definition of global security, creating over 100,000 jobs in the process."

"I'm proud to be a part of the Council," Johnson said. "TLSI offers great promise to move us forward. We must commit to implementing the changes we've been discussing, because what TLSI truly means is, number one, creating American jobs in a resurgent economy and, number two, solving the world's health, energy, security, and environmental challenges. I sense that everybody around the table understands that and looks forward to contributing."

TLSI Co-chair Mark Little built on Johnson's comments, offering examples of the promise of innovation at GE Global Research. "We have big dreams for things like catching cancer at earlier stages and preventing it from becoming a terrible disease, creating renewable energy sources that compete with fossil fuel on a cost basis, and finding ways to clean up water at half of today's costs—getting water to a billion people who don't have it today. We have great aspirations and I believe we can do these things, but we cannot do them alone."

Little emphasized the need for partnerships and government support through steady, constructive policies. "We need a supportive framework," he stated. "We need industrial partners. We need government partners in the laboratories, and we need small start-up companies. We need many people pulling together. The TLSI gives us a way to talk about the issues that surround these things, and to help us clarify positions that can be helpful to our industries, to our government and to our country."

PART 2: FINDINGS FROM TLSI DIALOGUE 3

# More Effective Public-Private Collaboration and Preserving America's Technology Base for Security

The Dialogue began by exploring inhibitors to greater public-private collaboration and possible steps to remove them. Attendees were asked to consider whether America is at risk of falling behind on strategic technologies that are critical to national defense and how important domestic manufacturing is to meet the security needs of the country.

Zach Lemnios, Director, Defense Research and Engineering, and Brett Lambert, Deputy Assistant Secretary of Defense for Industrial Policy, offered opening remarks. Michael E. Kassner, Director, Office of Research (Discovery & Invention), Office of Naval Research, and Alan Taub, vice president of global research and development for the General Motors Company, kicked off the conversation.


*Brett Lambert, U.S. Department of Defense, Zach Lemnios, U.S. Department of Defense, David Kappos, U.S. Patent and Trademark Office.*

**Zach Lemnios**
Director, Defense Research and Engineering

I had an opportunity to read the report, the Ecosystem Model, and I compliment the Council for putting that together and linking its technology and manufacturing initiatives. Manufacturing competitiveness really is a systems challenge—not only how we build infrastructure, but also how we develop talent, deploy technology, and optimize design environments that are common to many industries.

Secretary Gates has made acquisition reform a key priority. That means a couple of things. It means a new way to engage the defense industrial base. It means a much stronger interaction between industry, academia and government—across government. There really is innovation that we can pull from the research environment, and do that in a pretty competitive way. As Director of Defense Research and Engineering, I'm trying to drive innovation speed and agility. Those are very different characteristics from where DDR&E has been historically.

Driving innovation is a core competency in every small business. It's a core competency to many of your businesses. Delivering products at speed, transitioning from an innovative concept to a capability that can be used is a critical issue. For the U.S. Department of Defense, we must provide those capabilities to our war fighters in a time critical way. Doing that speaks to manufacturing strength. It certainly speaks to the design piece, and it speaks to an understanding of what's on the horizon. We are trying to develop in a very serious way an ability to scan the technology horizon broadly.

The Council offers the U.S. Department of Defense a demand signal that helps me gain insight into what's happening beyond the typical environment in which I interact with combat commanders. I spend a lot of time with the commanders and try to understand what their operational needs are, to try to provide them with capabilities. But at the end of the day, it really is the industrial base, it's academia, and it's industry from whom we get our ideas. I'm trying to draw that in a much more interactive way. I'm trying to build a capability that's far more agile, and I think the design piece of this is critical. We're certainly seeing that now in our industrial base.

Your ecosystem model—talent, technology, investments and infrastructure –really includes the right elements. Let me offer two or three metrics that concern me very much. The high school graduation rate in Washington, DC, is 45.8 percent. In fact, it's down 8.8 percent. In Maryland it's 73.5 percent. These are numbers for which we just can't sit still. In the fourth grade, the United States ranks 11th globally in math and 12th in science. By the 10th grade, our students are 25th in the world in math and 21st in science. So, something is happening between the fourth and seventh grade that concerns us very much. That's the feedstock for our future. That's the piece that we're trying to understand.

The department spends well over $100 million a year on STEM initiatives. The reason for that is to try to build a core capability in our future workforce. And that very much intersects with what I read in the Council's work. So those are some of the things I'm concerned about. I plan to follow the work here, and really do want to spend a little more time and engage quite deeply with the work of the Council.

**Brett Lambert**
Deputy Assistant Secretary of Defense for Industrial Policy

I'll speak briefly on two things that I think are relevant to our conversation—the valley of death and export controls. I have observed very innovative companies who enter the defense industry with great products that we need to get to the war fighter. But to become a defense supplier, companies typically must climb a summit—they do things like adding retired generals to their board and introducing Deltek systems to their accounting processes. By the time the company reaches the summit it is a government contractor, but from that point forward there is almost no way back to that nimble innovative company that also offers non-defense products and services, because the firm gets locked into an ecosystem that doesn't facilitate such innovation.

So in the defense industry we face not so much a valley of death, but a hill of death that is hard for companies to climb up or down. What I'm trying to do in our office, with the support of my peers and bosses, is to create a channel for people with innovative solutions so that they can more easily access the Pentagon. It is a challenge that the department needs to work on, and we know that.

Export control reform is important for different reasons. Some view such reform as a means to increase jobs in the U.S. I think that we in the department view it as a way to enhance our capabilities, to enhance coalition war fighting. We now have a President, a Secretary of State, Congress, a Secretary of Commerce, and a Secretary of Defense who are all pushing in the same direction. In the 20 years I've been working on this issue, I've never seen the stars so aligned in favor of making changes.

It's easy to say the system is broken, however, without coming up with solutions. I've been in many interagency meetings to come up with solutions, and I think you'll see those coming out in the next few months. We are considering at least four fundamental changes that will be our initial priorities. A challenge we will face is that we're not beginning with a clean slate, but must work with legacy systems and legacy people.

So there is going to be a transition period where we're going to have to move our expertise and experience into new realms, and that's going to take some time. But no one should doubt that this is going to happen, and I think it will be good for U.S. industry. As I like to joke, all of the people seeking to participate in the defense world are looking for a foothold in America. Export issues are more about allowing our industry to get a toehold in every other country's industry. It's good for the taxpayers. It's good for the war fighter. It's good for all kinds of reasons.

The U.S. Department of Defense needs to continue working with industry to understand new innovation efforts and issues. We also are looking forward very much to examining the U.S. manufacturing base holistically. I asked my staff to identify the last time our military fielded a system that was 100 percent U.S. content. It was in the first year of the Korean War. Since then, we have not fielded a major military system that didn't have international content or content that was outside of what would be called a military industrial base. So the dynamics of manufacturing competitiveness, of globalization, of commercialization, are not academic issues for us—they are reality and something we engage and seek to leverage. Instead of trying to keep the tide out, we want to ride that tide to our advantage.

*Michael Kassner, Office of Naval Research.*

*Alan Taub, General Motors Corporation.*

## Discussion

Kassner thanked Lemnios and Lambert. He offered background about the Office of Naval Research (ONR), noting that he is one of three directors who report to the Chief of Naval Research. Kassner oversees the Research Directorate with a budget of about $20 billion, of which about two-thirds is devoted to basic research and the remainder to applied research.

Kassner estimated that industry conducts about 3 percent of ONR basic research, with universities conducting almost all of the rest. "One thing that we haven't done as well as we might," Kassner said, "is that we tend to only involve industry when we have a broad agency announcement." Prior to such announcements, there isn't a lot of participation with industry and often firms are surprised once the broad agency announcement is released. Kassner suggested that many of the TLSI commercialization issues fall under ONR's director of transition and hoped to engage him in future TLSI dialogues.

Taub, who leads Advanced Technology for General Motors, was asked to remark on improved public-private partnerships. He asserted that a recent good example in the U.S. was facilitated by the stimulus bill. GM had approached several U.S.-based companies roughly four years ago to manufacture batteries for electric vehicles. Those that were interested, however, couldn't raise the capital. "As a result of the stimulus bill," Taub said, "there are now companies going into the battery business domestically—a key technology for transportation."

Taub also suggested that the U.S. could support more consortia for pre-competitive research like the kind that has served the transportation industry. "In the early '90s we formed the United States Council for Automotive Research (USCAR)," he explained. "The big three U.S. manufacturers work with government, particularly the Department of Energy. Industry sets the agenda and the road maps. We bring money and in-kind research to the table. The national labs participate, and I think that it's worked well to marshal the resources of the universities."

Compared to other countries, observed Taub, the U.S. government spends a larger share of its R&D on defense compared to non-defense commercialization. "I visit universities in China doing early product development work for domestic companies. You don't see examples of that here." He advocated a closer examination of the balance between defense

and non-defense investment, as well as greater university research engagement with companies, in order to support both manufacturing competitiveness and national security.

GM's global research leader also noted the importance of developing and retaining science, technology, engineering, and mathematics (STEM) talent. Large multi-national companies recruit globally, Taub noted, "but it would be nice to keep foreign-born students educated in the U.S. here."'

Taub also reinforced concerns raised in the TLSI dialogues about export control rules. "They often hit fundamentally commercial technologies. The classifications need to be looked at, as they're slowing down our ability to develop technology." He also cited the backlog in the patent office as a real problem, with the time to get a patent issued jeopardizing the protection needed by firms globally. Finally, Taub noted the importance of government's role in establishing a market for certain technologies by acting as an initial purchaser.

Thomas Cellucci, Chief Commercialization Officer for the Department of Homeland Security (DHS), offered a few observations about public-private partnerships—suggesting how universities and governments could perform better. He urged that universities do more to understand the language of government, such as technology and manufacturing readiness levels. He also emphasized that "government is not good at all in terms of articulating its needs." To remedy this problem, DHS has produced books on how to articulate detailed operational requirements.

Because agencies typically fail to offer detailed requirements and a conservative estimate of the market for the product in demand, the private sector often comes to government with solutions looking for problems, Cellucci said.

*Thomas Cellucci, Department of Homeland Security.*

Cellucci also noted the growing competition from firms overseas, explaining that non-U.S. universities and companies utilize the DHS publications on commercialization far more than American based companies.

"There are companies all over the world creating stiff competition for American based companies…They are quite good and getting better and their universities work better with the private sector in their countries."

Johnson added observations about STEM education and performance parameters for defense innovation. On STEM education, he noted a study by a Korean professor about the gap between performance on international math and science exams and students' perceptions of their skills. Korean students tend to perform well on the exams yet underestimate their abilities. American students, conversely, scored lower but gave themselves higher self-assessments. "We have to change that," Johnson said, by raising American scores and building a greater awareness of the need to improve.

Johnson also noted that as the Department of Defense works to open more flexible channels for non-defense innovators and anticipates a more resource-constrained environment, that the department carefully consider performance parameters. Johnson suggested that such standards focus more on mission performance and perhaps less on database or engineering parameters, encouraging greater innovation and more of the speed and agility sought by Lemnios.

Paul Hallacher, director of research program development at Penn State, raised the issue of public funding for government and university partnerships, noting that the federal government doesn't have a large-scale program or an agency responsible for funding and promoting academic-industry-government technology partnerships. He observed that at the U.S. state level there is little controversy about funding such partnerships, with legislators and governors from both parties routinely supporting them. Hallacher emphasized that the lack of federal support stands in contracts to competitor nations. "I think we have to list that as a barrier to these kinds of partnerships," he said.

Cellucci and Andy Karsner, CEO of Manifest Energy, pointed out two federal offices with a mission to support partnerships—a newly established $35 million office in the Department of Homeland Security, and the $2 billion office in the Department of Energy dedicated to energy efficiency and renewable energy. Karsner pressed for clarity on the nature of the problem, saying that legitimate questions could be raised about whether (1) the federal government devotes adequate resources to the task, (2) the resources are dispersed in an organized, strategic way, or (3) communication efforts are sufficient so that potential university or industry partners are aware of the resources.

*Pradeep Khosla, Carnegie-Mellon University, and Steven Ashby, Pacific Northwest National Laboratory.*

Hallacher replied that many such pilot-level programs are spread across agencies such as NIST, EDA, and DARPA, but that the United States lacks a broad-based agency with significant funding charged with this mission. Cellucci added that although pockets exist across government to foster public-private partnerships, those agencies typically do not keep their rules simple nor make it easy for people to understand what opportunities are available.

Taub shifted the conversation by adding that many national governments target specific industrial sectors for global leadership—with less concern about picking individual winners and losers as with winning a sector over a 10- to 20-year period. He noted initiatives in many Asian countries that supply long-term funding and policy support to firms and universities for this purpose. Although Taub suggested that it is not clear whether the U.S. should pursue such initiatives, he expressed concern that without them, the U.S. will continue to see its manufacturing footprint move to other countries.

Pradeep Khosla, Dean of Engineering at Carnegie Mellon University, cited semiconductors as an example of past federal government efforts to preserve a commercial sectors. He stated, however, that such

efforts are rare and often respond to a technology also deemed critical for government purposes—semiconductors, for example, play an important role in defense.

Khosla agreed with Hallacher and Taub that other countries subsidize commercial sectors targeted for leadership more than the United States. Khosla, too, was unsure whether the United States should pursue a more aggressive commercial policy, but stated, "The issue in my mind is not picking and choosing industries, but creating an ecosystem." He advocated a set of policies that better support students, retain highly-skilled immigrants, and facilitate successful commercialization.

Michael Blaustein, the technology and ventures director for DuPont Central Research and Development, highlighted a perception issue associated with large companies participating in government-sponsored partnerships with universities. He relayed a story of a DuPont executive testifying before Congress on ARPA-E being asked, "Why should a big company be feeding at this trough?" Blaustein noted that his company was working in partnership with a start up firm on the ARPA-E engagement, but at issue is whether larger firms will be encouraged to join with universities to help commercialize the results of government-sponsored research.

Tom Baruch, Founder and Managing Director of CMEA Capital, suggested additional policies such as manufacturing tax credits for plant expansion or government purchase programs for clean energies like installing photovoltaic cell panels on government buildings. He stated that encouraging innovation and entrepreneurship, coupled with a coherent set of simple, inexpensive programs would make a significant contribution.

Wince-Smith offered historical perspective about efforts by other governments to capture strategic markets, describing the challenges posed by Japan in the late 1980s that led to the U.S. Semiconductor Agreement. She noted that the Japanese strategy connected many dots that weren't integrated in the United States, such as policies and missions driving the departments of State, Defense, Commerce, and Justice.

The Council president emphasized, "We need to ensure that a spectrum of policies and regulations work together to support rather than hinder a vibrant industrial base." She raised product liability law to illustrate the point, noting that tort costs account for approximately 2 percent of U.S. gross domestic product (GDP)—almost as much as the roughly 2.6 percent of U.S. GDP spent on research and development.

In addition to the resources devoted to tort that drive up commercialization costs and consumer prices, noted Wince-Smith, product liability rules create a chilling effect to pursue higher risk commercial endeavors in America. "Clearly we don't want to have products and services that hurt consumers," she stated, "but we can protect and compensate citizens without driving away their jobs. We have to start connecting the dots."

Bart Riley, the Founder, CTO, and Vice President for Research and Development of A123 Systems, interjected that in terms of connecting the dots, the challenge for policymakers and innovation stakeholders may not be to pick winning or losing firms or to capture leadership in an industry sector. Instead, Riley drew on his experience in the advanced materials industry to suggest that a key may be to identify and support key enabling technologies.

"We saw advanced ceramics largely go offshore to the Japanese because they understood that those were enabling materials that were going to take them forward in electronic packing in solar cells and a number of other things," Riley said. Companies in the materials space can find great ideas at uni-

*Tomás Díaz de la Rubia, Lawrence Livermore National Laboratory, and Daniel Goldin, Intellisis Corporation.*

versities he stated, but the challenge with enabling technologies is to forge partnerships that help many firms in many sectors to integrate those materials into their products, systems, and devices.

"It's something that as a nation we can't forget about—whether the goal is water purification, energy generation, storage transmission, environmental remediation, or national security. At fundamental levels it comes back to having a position in these advanced enabling materials," Riley asserted.

Melvin Bernstein, vice provost for research at Northeastern University, offered his perspective that the climate for public-private partnerships is improving. "Frankly, we see the best environment in decades, both in terms of working with companies and in the signals and programs coming from government. The expectation now is that you will partner. I can't speak for all colleges and universities in the United States, but I can speak for those who are thinking about these kinds of problems," he said.

Bernstein acknowledged continuing problems and challenges, but noted that a new generation of faculty is emerging that is inclined more favorably toward commercialization. "The kinds of things that we are willing to do, whether it's master agreements with companies, whether it is building consortiums regionally and with the government—these are things that bode very well for the future."

Daniel Goldin, president and CEO of Intellisis, cautioned against an over reliance on government. "One must be very careful engaging government into the commercial sector however attractive it looks," Goldin said, "because it becomes irreversible if the government gets too deeply involved." The former NASA Administrator supported comments made by others that government ought to create demand for strategic products and create an enabling environment, but he noted that commercial trends can be transitory. "Twenty years ago it was Japan. Now, it's China. Entrepreneurship is what drives America and we have to be very careful that we don't change our approach to business just because it looks good in China."

Goldin also supported calls for making regulations simpler and addressing tax and trade policies that inhibit U.S. competitiveness. He also echoed Johnson's call for government agencies to favor mission requirements over detailed performance requirements that can impede innovative solutions.

Walter Copan, the managing director for technology commercialization and partnerships at Brookhaven National Laboratory, relayed an observation he gleaned working on a global study of technology invention and adoption. Looking at renewable energy technologies, the authors find that without a stable policy framework and an environment where businesses can count on long-term investment returns, the technologies will not be adopted—even in the markets where they originate.

"We have to look at the entire business climate in a way that considers long-term investment horizons," Copan said, "and implement policies informed by what drives market behavior."

Taub kicked off the final topic of the first section of the Dialogue by asking for clarity on the TLSI mission and the metrics to determine "whats broken and how do we define success?" Little replied that the TLSI has multiple objectives and the conversation had wandered across them. In general, the TLSI has a broad mission to make American innovation more productive for the private and public sectors, with a particular emphasis on improving partnerships to enable more technology to be commercialized from research at universities and national laboratories.

The first part of the Dialogue, Little said, centered on those partnerships and on preserving America's technology base, including technologies that are strategic for defense needs. Wince-Smith added that the ultimate issue is how to drive productivity and increase the standard of living, prosperity and security for the United States. Science and technology leadership is at the heart of growing America's economy, she said, and should be marshaled to address many of America's biggest societal challenges.

Lemnios elaborated on public-private partnerships, using SEMATECH to illustrate the importance of capturing future technology nodes that drive competitiveness. "What started out as an effort to build manufacturing capability in this country turned into a program that supported the supply base of the semiconductor industry," Lemnios said. He noted a recent visit to SUNY, Albany, where he observed a university environment offering "a million square feet of clean room that would be a state-of-the art facility at any manufacturing environment."

Lemnios asserted that the major benefits generated by public-private SEMATECH investments are the design tools and tech base used by many chip manufacturers today. "All of that has been transitioned to the private sector," Lemnios said, but it exists because a public-private partnership was established. The success metric was to build the capability assessed by the member companies. "And then, government went off to solve other problems." Lemnios stated that partnerships must be clear about what they are trying to solve and that the government must have a clear transition strategy to the private sector.

Jim Davis, vice provost for information technology and the chief academic technology officer for UCLA, also represents a group of companies and universities in a manufacturing initiative. His group believes that a great deal of innovation potential lies in finding new ways of doing things—that process innovation is as important as product innovation. "That's another set of dots that really should be connected," Davis noted, who urged a holistic approach for TLSI. When you think about the "how" part of innovation rather than the "what," there is a technology infrastructure and a talent set to develop.

Lambert suggested that America can pursue defensive and offensive strategies. "We far too often have relied on the defensive—trying to protect as opposed to being aggressive." He believes that the current Administration and the U.S. Department of Defense, however, are more interested in being on the technology offensive.

The second point Lambert stressed is the importance of speed in the marketplace. America's differentiator in the global economy, he said, will be how effectively we can be innovative and deploy technologies with greater speed. Talent will be essential to

achieve that objective. "We have to focus our efforts on high wage jobs and high skills," Lambert said. "We must enhance the labor pool to make ensure we have the best high skilled workers in the world."

Tony Tether, former director of DARPA and a distinguished fellow at the Council, offered an additional metric to evaluate public-private collaboration. Tether suggested that one of the best uses of public money is to find ways to remove constraints on innovation in strategic areas like materials research, biology, and semiconductors. Key to removing such constraints is improving measuring technologies that support multiple innovations and drive progress for many private researchers.

The ability to accurately measure extremely small events like a protein folding, said Tether, could support many efforts. NSF, NIH, and DARPA have helped develop such measuring tools and technologies. "To me, that is collaboration between the public and private sectors where the public money is well spent," he said. Thus, identifying strategic measuring objectives and developing them through public-private partnerships could be a success metric promoted by TLSI.

PART 2: FINDINGS FROM TLSI DIALOGUE 3

# TLSI Working Groups

Little and Johnson laid out the next organizational phase of the TLSI, explaining four proposed working groups and how they will be used to organize and develop a set of recommendations for the initiative. Little explained that the TLSI recommendations also will serve as the technology component the Council's manufacturing initiative, offering an integrated competitiveness agenda and an additional vehicle to promote TLSI priorities.

Johnson reviewed the groups and invited Dialogue attendees to volunteer to co-chair or join them. The groups are:

- **Accelerating Innovation**, which aims to improve the movement of ideas from laboratory to market, including government markets. Johnson thanked Steven Ashby, deputy director for science and technology at the Pacific Northwest National Laboratory, who agreed to serve as a co-chair. The working group will consider best practices in government, university and industry labs and recommend changes to administrative, regulatory, budget or legal processes.
- **Innovation Outreach**, which aims to tell the innovation story. The group will put forward a plan to reach out to key audiences about the value of innovation, particular policymakers, noted Johnson, in addition to students and the American public. This group still needed a volunteer to serve as its chair. Hallacher volunteered to participate.
- **Regulation-Policy**, which aims to establish more coherent federal laws and regulations that make commercialization less expensive, better incentivized, and more strategic. Johnson thanked Khosla, who agreed to chair this working group.
- **Talent**, which aims to ensure that America develops, attracts, and retains world class scientific and technical talent in the United States. Bernstein agreed to serve as chair for the Talent Working Group, Johnson noted.

Wince-Smith added that many of the TLSI topics are at the heart of the Council's U.S. Manufacturing Competitiveness Initiative (USMCI) that is tackling challenges under four policy pillars of talent, technology, investment and infrastructure. She described the TLSI as a critical think tank, and anticipates additional people involved in USMCI joining TLSI, "which will be great for both initiatives."

Chad Evans, senior vice president of the Council, clarified that the working groups would take a deeper dive on specific topics and that the Council would support the groups by organizing logistics and capturing the substance of the conversations. He introduced Chris Mustain, a senior advisor with the Council, who will work with Evans to ensure that working groups are supported and that participants' time invested in the groups is fruitful without being burdensome. Johnson echoed Evans comments, complimenting Council efforts to capture ideas put forward by TLSI participants.

Khosla encouraged the working groups to include industry, university and lab representatives. He also inquired about the timeframe for working group activities and whether additional people not yet involved in the TLSI could engage in the working groups. Evans replied that the fourth TLSI Dialogue would be in October or November and that the working groups would present preliminary findings or recommendations at that event. Evans also noted that some working group ideas could be rolled into the December findings of the USMCI and that engaging individuals outside the TLSI through the working groups would be a welcome way to expand TLSI's peer network.

Wince-Smith reminded attendees of the Council's longstanding work on high performance computing (HPC), and introduced the effort's leader Cynthia McIntyre, a senior vice president at the Council. "We have been working for many years to accelerate this capability for competitiveness and to build the partnerships that take the use of modeling and simulation down to our supply chain as well as among the big users," Wince-Smith said. Modeling and simulation is an accelerator of innovation, she emphasized, and the Council's HPC work should be linked to TLSI—another area of connecting the innovation dots.

PART 2: FINDINGS FROM TLSI DIALOGUE 3

# Intellectual Property Policy and Practices: How to Encourage Higher Rates of Commercialization

Johnson kicked off the next conversation on intellectual property. He noted that it is an essential policy area where change is needed—critical to protecting firms from global infringement and critical to how universities and industries collaborate. The TLSI co-chair offered four questions to frame the conversation:

- How can IP help build a vibrant 21st century manufacturing sector in the United States?
- How can the IP system and U.S. Patent and Trademark Office better assist in moving innovation more rapidly to the marketplace?
- How well does the U.S. intellectual property regime serve U.S. competitiveness, and what are key strengths and weaknesses?
- What non-legislative steps regarding IP might innovation stakeholders take under current law to encourage more collaboration and commercialization?

Johnson introduced David Kappos, Under Secretary of Commerce for Intellectual Property and Director of the United States Patent and Trademark Office. "David brings 20 years of experience and global leadership in IP before being confirmed in his current post," Johnson said, relaying that Kappos served as Vice President and Assistant General Counsel for Intellectual Property at the IBM Corporation.

*David Kappos, U.S. Patent and Trademark Office.*

**David Kappos**
Under Secretary of Commerce for Intellectual Property and Director of the United States Patent and Trademark Office

Thank you for permitting me to join today and listen to the fascinating discussion this morning. I'm always happy to talk about intellectual property and would like to start by explaining how IP is linked to national competitiveness and innovation. We've talked this morning about the critical juncture at which our nation stands. We recognize that the United States is at another inflection point like we've been in the past, and that the way through this inflection point will be based on innovation.

It will certainly not be based on low cost manufacturing, and it won't be based on many of the skills that got us here in the past. It will be based, however, on the key skill that has defined our nation for well over 200 years, which is innovation—going through change and moving boldly forward to remake what we've done. I truly believe that we've come to a point where innovation is the only remaining sustainable source of competitive advantage for any developed world economy.

In my 26 years in the private sector, I observed the distance between innovation and the marketplace shrinking monotonically over time. My one year in the public sector has enhanced that view and confirmed that it's shared by innovators all over the world. I made a number of trips overseas recently, including to China, where we now have the world's largest filer of Patent Cooperation Treaty applications—Huawei Technologies. So everybody understands that innovation is now the source of competitive advantage and that it's moving faster. That means that intellectual property is becoming not only a necessary instrument, but in many cases the only effective instrument for gaining advantage from innovation before it moves into the low cost arbitrage commoditization machine. Intellectual property is fast becoming the world's single normalized currency for innovation—the vehicle for protecting innovation.

Intellectual property is fast becoming the world's single normalized currency for innovation.

IP is not well regulated or as well understood as it should be. There isn't a Moody's or an S&P that can rate it effectively. So we've got a lot of work to do. For many years, we've had low cost arbitrage that has been a key factor in determining where manufacturing would move and where R&D facilities would be located. Many of you participated in these decisions. I participated for many years in deciding where to locate a new plant, where to put the new R&D lab, where to put the new collaboratory. Labor was a part of that equation.

But as I look forward, I see the equation moving more to a dependence on intellectual property, effective protection, and effective management. It is the ability to control what happens to intellectual capital, innovation, which essentially walks out the doors of our factories and R&D facilities every night and hopefully walks back in the next morning. But, it doesn't always walk back in the next morning. Maybe it walks to an overseas competitor. Patent protection, but also trade secret, copyright, and brand protection, are absolutely critical to value capture in light of the huge investments that are being made.

The ease with which those investments can otherwise inure to the benefit of others is certainty about intellectual property rights in general and certainly about patent rights. That makes the patent a form of currency—a currency that unfortunately is lacking in many ways right now. IP's currency will allow businesses, whether we're talking about owners of IP or manufacturers (often one in the same) to move products and services into the marketplace.

We need strong enforcement and protection, but responsible corporate citizens also want performance and clarity in the system to avoid infringing on the property of others, just like we try not to walk across our neighbor's property unless we've got permission. We all want to do the same thing with IP, but it remains very difficult. We must do better, because the companies that create two out of every three jobs in the U.S. are those most reliant on patents—startups and small and medium businesses—also the firms that are attractive to larger companies for mergers and acquisitions.

We're starting to see a new trend that relates directly a nexus between innovation and IP and manufacturing. I'm referring to it as a "new democratization" of manufacturing that's enabled and facilitated by intellectual property. Let me explain what I think is starting to go on. It starts with a genetic sort of predisposition that Americans seem to have, which is that we've always been problem solvers. We make things, and we make little things big things. We've been great at manufacturing over our history.

Invention does little good unless someone moves from the idea stage to the building stage, which is innovation and manufacturing. We must to continue to have a vital manufacturing sector and I applaud the Council's leadership in this area. As Abraham Lincoln put it 160 odd years ago, the patent system adds the fuel of interest to the fire of genius for the U.S. manufacturing sector. That's true today.

The idea of democratization in manufacturing is that we're beginning to see a move away from the 19th Century requirement for immense capital resources and a move away from the 20th century focused on low cost labor. Instead, we're seeing more dependence on imagination and ambition and access to IP rights as drivers for success and manufacturing in the 21st century. Right now, the little guy and the big guy can manufacture at small scales, medium scales, and large scales much more quickly than we could in the past because it's really easy to fire up the tools we've got through much lower cost manufacturing equipment. I haven't seen this outside the United States to a great extent yet. Maybe some of you around the table have.

As I travel around the U.S., I'm amazed at what little guys are making—very high tech devices, or low tech things using high tech techniques because they've got access to manufacturing gear that no one had access to even as recently as 10 to 15 years ago. In the past it might have cost $100 million to build things that now you can build with $1 million dollars of equipment. As a result, there's an opportunity for our country to undergo a dramatic democratization of manufacturing. This trend also is great for big companies because if you're conducting R&D at a place like GE, when it comes down to the 501st research project you don't necessarily have the resources to tool up a giant line.

I'd also like to comment in response to what has been said about the long time that it takes to get patents out of the USPTO—moving from the aspirational level to the operational level and trying to make the trains run. I didn't say, "On time." We've got to start with making them run at all. We understand that our job is to move intellectual property through the USPTO much more quickly. In fact, if we're going to replace hopefully all and more of the 8 million jobs that we lost in this recent recession, the USPTO is a great place to start. Harvard Business Review recently identified the USPTO as the greatest job creation agency you've never heard of. CNN Money put out a recent article saying, "Do you want to know where to create jobs? Start with the USPTO." The reason is that we have about 718,000 patent applications sitting

unprocessed at our agency, not to mention the 500,000 or so that we're working on at the moment. That's over 1.2 million if you add those numbers together.

There are unquestionably gobs of jobs to be created, and products and services that you could put out in the marketplace—and your government is sitting on them right now. That doesn't make anyone in this room happy at all, starting with me. If you haven't seen it, there was a survey by London Economics that estimated the lost or foregone innovation cost of all of those patent applications in the billions of dollars per year for the U.S. economy alone, and many more billions for other economies. So the stakes are high and I think they're probably dramatically underestimated.

I hope that we're starting to turn that around. I've tasked the USPTO team with bringing that backlog down to below 700,000 applications by the end of September. We can all watch together whether we're able to do that. I do ask for your understanding. It's going to take us years to work off the backlog of 700,000 plus applications, considering the amount of intellectual energy that we have to spend on each application. We're not going to be able to get it all done in 2011 or even in 2012. Under our current plan, if we do most of the things we're trying to do correctly, we'll get there by 2015. So this is a fairly long-term step.

One step we announced earlier this month is a rather ambitious proposal that we've got out for comment. The Patent Application Backlog Reduction Stimulus Plan would allow applicants to have greater control over the priority with which their applications are examined. We'll have three tracks. First, a fast track 1. We'll also have a track 2, which is status quo. We'll even provide a track 3, which is slower than what you get today but applicants will have the choice to spend a lot less money. Some small innovators may want to spend their energy and resources on marketing and follow-on innovation rather than the patent approval process.

We have about 718,000 patent applications sitting unprocessed at our agency, not to mention the 500,000 or so that we're working on at the moment. That's over 1.2 million.

The USPTO can administer such a program as long as the scope of track 1 is reasonable, perhaps 20 or 25 percent of our workload. In fact, we're currently getting green technology applications out on an accelerated track, typically in a few months. A California company actually applied under this program last December; the patent was issued within two months, and the firm began producing and hiring by March of this year.

So, we think that we can do some things to put the speed of processing in your hands, and not in an anachronistic first in, first out buffer that the USPTO has used since Abraham Lincoln uttered the words I quoted earlier. Over time, I hope that tracks 1, 2 and 3 will converge a little bit because we'll get faster at doing everything. In the meantime, we want to start speeding up the process for everybody who wants us to speed things up. Thank you.

## Discussion

Johnson began the conversation by asking whether the administration has a common understanding that addressing the backlog would create a large number of jobs. "Are resources so constrained that they can't apply staff to seize this opportunity? I mean, what is more important than jobs today in our nation?"

Kappos replied that it is becoming well known, that the secretary of commerce and the president understand that there is a strong nexus between moving intellectual property through the USPTO, creating jobs, and enabling U.S. companies to compete. As a recent appointee, Kappos noted his initial efforts to get the machinery of the USPTO moving in the right direction, citing processing speed as an example. "It's gone up substantially. We're issuing record numbers of patents, and we're rejecting record numbers of patents. The number of touches per patent application has gone down significantly from nearly 3.0 when I started to about 2.3," he said. "When you multiply that by over a million actions a year, you get tremendous leverage from such improvement."

As a result, USPTO is collecting more money this year than last year—about $250 million more on a base of about $2 billion. "The problem is, of course, operating in the government is unlike operating in a company—I don't get to use any of that money," Kappos stated. He explained additional efforts that have improved processes and raised efficiency, but noted that USPTO does not get access to the incremental income generated by such efforts.

Taub suggested that many patent applicants would be willing to lend their voices in support of USPTO capturing such efficiencies in order to lower processing costs or deploy the human capital needed to reduce processing times and backlogs.

Wince-Smith complimented Kappos on his presentation and asked him to share his thoughts on the global environment for IP protection, including the Trade Related Aspects of Intellectual Property Rights (TRIPS) treaty and issues with China.

Kappos explained that more than 160 countries have signed the TRIPS treaty that establishes a global baseline for intellectual property protection. "I think it is fair to say that TRIPS unfortunately hasn't quite lived up to its potential," he said. The problem is that although there has been improvement in intellectual property laws overseas, there has been little improvement in the enforcement regimes. "In fact," he emphasized, "only incremental improvement in enforcement regimes in the face of rapidly escalating ways that intellectual property and products of IP intensive industries can be counterfeited and pirated."

The USPTO Director noted that Western European intellectual property systems were essentially as good as the one in the United States before TRIPS and they remain that way. Most of the problems lie in developing countries.

China has made progress at putting IP laws in place that Kappos described as world class, certainly functional. The problem, he continued, is that the laws are being used to the benefit of local industry in ways that are harmful to U.S. innovators. As an example, he cited China's use of a design protection law that some refer to as a petty patent. "It's the ability without examination to submit an innovation to the China patent office and have it registered."

U.S. entities hardly use that law while China-based entities use it dominantly, said Kappos—hundreds of thousands of these utility models submitted each year. "It would be benign except for the fact that what's happening on some scale is that Chinese entities are actually taking inventions from U.S. utility patent applications. These are real patent applications, real inventions being submitted by the companies in this room, copying the drawings and submitting them for utility model protection in China unexamined."

**Figure 16. A Comparison of Various Types of Intellectual Property**
Source: Bay Area Intellectual Property Group

| | Trade Secret | Copyright | Trademark | Design Patent | Utility Patent |
|---|---|---|---|---|---|
| **What is protected?** | Know-how | Original expression of an idea | Customer's notion of your good or service's source | Visible appearance | Products, processes, compositions, functions |
| **Typical things protected** | How to make product, hidden high-tech methods, & etc. | Written material: computer programs, books, plays, poems; art: sculptures, paintings, photographs, etc. | Names, logos, internet domain names, designs, & etc. | Unique shape/ styling of articles like product packaging, figurines, etc. | Tools, devices, machines, computer programs, games, processes, formulas, internet, electronic, chemical and business methods etc. |
| **What are others prohibited from doing?** | Unauthorized use or dissemination by someone who has been let in on the secret | Copying the expression | Confusing the consumer | Making something looking the same or similar | Using the claimed invention |
| **How is the right established?** | Use in trade | Authorship | Use in trade | Examination | Examination |
| **What is needed to get protection?** | Know-how must be well defined, not publicly known, and protected | Tangible use of the expression | Mark must distinctive, and not confusingly similar to another | Visible appearance must be new and not obvious | Invention must be new, useful and not obvious, and you must teach how to make and use it |
| **Geographic coverage** | Country of origin or by other countries by treaty | Worldwide | Country filed in | Country filed in | Country filed in, or worldwide if PCT filing |
| **Duration of protection?** | Until disclosed to the public | Life of author plus 50 years | 10 years, or as long as it is in use | 14 years (US) from grant | At most 20 years from filing |

A U.S. innovator typically won't know this has occurred until they are subject to a lawsuit in China. Usually the U.S. entity can invalidate the lawsuit, said Kappos, but the lawsuit can result in an injunction in the interim between the action on the lawsuit versus the action on the patent. "It hasn't exactly resulted in more effective rights enforcement from the perspective of a U.S. entity," he asserted, noting that there are other examples of problems in China.

Johnson continued the dialogue by inviting comments from Keith Blakely, chief executive officer of NanoMech; Spiros Dimolitsas, senior vice president and chief administrative officer of Georgetown University; Klaus Hoehn, vice president for advanced technology and engineering for Deere & Company; and Bart Riley, the founder and chief technology officer of A123 Systems.

Blakely offered the perspective of a smaller firm on intellectual property issues and commercialization. He noted Kappos' comments about the number of

*Keith Blakely, NanoMech, and Tom Ballard, Oak Ridge National Laboratory.*

jobs created by small companies and the reliance on larger companies to acquire such firms or license their products and technologies.

He built on the idea of IP as currency, noting that small businesses can borrow money to buy equipment, but find it very difficult to borrow money to buy a patent. "Part of the reason is that there is a great degree of uncertainty as to what the value of that that asset is, and yet, patented intellectual property, represents one of the few assets that a small business can own that truly begins to level the playing field with much larger organizations." Unlike human or capital assets, Blakely said, only intellectual property is regarded by other countries and legal systems as a unique right.

Blakely relayed two stories about the value of intellectual property in different forms. The first business he started in 1981 applied for a patent on equipment that the company thought would revolutionize the manufacture of sub-micron ceramic powders. Patent applications at the time were not published, thus preserving confidentiality while the examiner determined what would be allowable in the claim.

After about 18 months, the firm received the first notice of allowance of claims. "We had a business choice to make at that point, which was do we patent this device and let the world see how we were able to manufacture these new materials, or did we hold it as a trade secret?" Blakely said. Because they weren't planning on selling the equipment and because the product was not distinguished by the equipment that manufactured it, the issue of policing and identifying infringers was going to be a near impossibility, he explained.

"If we allowed a patent to issue, we were going to teach every one of our competitors just what we were doing and how we were doing it. So, we elected to keep it as a trade secret and abandoned the patent application." Over a 20-year period, Blakely said, the company improved on the equipment and maintained it as a trade secret, building a successful business.

The NanoMech CEO also shared how he worked with a Moscow research institute that had developed an advanced coating that had not been replicated anywhere in the world. In that case, because the material was so unique, the firm pursued U.S. and international patents, which were issued over a period of two to three years.

"Having the patent on that composition matter allowed the company to monetize the asset in a way that I had not anticipated to be very likely," Blakely said. "We licensed the technology from the laboratory and once the patents were issued, began to license production of the coating to companies in Japan, Europe, India, and Singapore that on average represented three to five million dollars." In this case the patents were the key to success because they gave licensees the ability to synthesize the coating in their home markets and protect them from competition.

"So, treating intellectual property and patents as the same thing is something we have to be careful not to do. Treating IP more as a currency, however, is

something that would be great to explore further," Blakely said. He noted that the venture capital community often uses patents as a measure of their chance to earn a return on investment. Acquiring patents, however, is a very expensive process for small companies, particularly outside of the United States. "There is a trade off of your cash assets for an intellectual property asset that perhaps brings new money to the table."

A further strain on a small company's cash position is that having a patent doesn't prevent infringement or a challenge to the patent, Blakely said. "For a small business the issue becomes very quickly, how deep are your pockets? Our legal system does not penalize companies for initiating or losing civil lawsuits that they might have known from the outset they were going to lose—diminishing the value of an issued patent if you're a small company," he stated.

Dimolitsas offered a university perspective, noting three concerns he has regarding intellectual property and commercialization at Georgetown:

- Are we aware as an institution of all the innovative work underway with commercial potential?
- Has the work we're aware of advanced to the point where it could be attractive—and if not, can we advance it to the point that it is attractive?
- For our most attractive work, how can we find a customer and how do we maximize the value proposition?

His objective at Georgetown has been to take the commercialization office to a level where it is not only engaged in developing research, but also an active player in the strategy and execution of building partnerships. Through this engagement, Dimolitsas believes the office has become more able to determine what might be come valuable, often before it is created. He also noted that he can obtain and manage disclosures from principle investigators (PI) or faculty members more effectively.

*Chad Evans, Council on Competitiveness, and Spiros Dimolitsas, Georgetown University.*

Dimolitsas stated that the university offers commercialization incentives to PIs and faculty members, typically from 50 to 100 percent of the potential benefits from an invention. His institution has been able to locate champions to move inventions from basic research to something of commercial value, and from every dollar that comes into Georgetown's Intellectual Property Office, a portion is dedicated to a separate account to invest in high potential technologies. Another role played by university commercialization offices, explained Dimolitsas, is to leverage their broader view of an institution's research portfolio to bond technologies together in ways that could create more value.

He concluded by raising a structural concern. "We have effective markets to sell financial products, original art or consulting services, but we do not have an efficient market for intellectual property where buyers and sellers come together," Dimolitsas said. "When you are looking for intellectual property, you more or less have to guess who might be doing what, and then dig into their web sites or their organizations. There is a need for a global market."

*Klaus Hoehn, Deere & Company.*

> "What we're really trying to do is create a capital market for inventions akin to the venture capital market that supports start-ups and the private equity market that revitalizes inefficient companies. Our goal is to make applied research a profitable activity that attracts vastly more private investment than it does today so that the number of inventions generated soars."
>
> **Nathan Myhrvold**
> *The Big Idea: Funding Eureka!*
> Harvard Business Review, March 2010

Hoehn built on the Kappos' concept of IP as a global currency and Dimolitsas' comment about creating a more efficient IP market. Hoehn recommended an article by Nathan Myhrvold in the March 2010 edition of the Harvard Business Review. In the article, Myhrvold outlines a vision for creating a market in which investment funds spur innovation by competing to buy IP for resale to buyers who know how to apply it, possibly bundled with other patents. Hoehn believes that the idea has promise and hopes that such a market is created in the United States.

Hoehn offered insight into how IP issues influence industry decision-making when working in partnership with a U.S. university. A company like Deere, he said, spends roughly $4 million a day on R&D. "I spread a couple hundred thousand dollars around universities, mostly in the States, to develop certain technologies," Hoehn relayed.

As the technology matures, however, IP issues often force companies before investing additional millions of dollars to commercialize the technology to make one of two choices: (1) move the technology in-house or (2) engage a university outside the United States that offers greater IP flexibility.

"It's sad but it's true," Hoehn said. "I understand, having run a university institute for 15 years in Germany. You try to create IP as professors because that's all you have." From an industry standpoint, however, a firm finds it difficult to invest over $100 thousand in research and then not own the IP. "We need to work together to resolve this problem," he stated, "We in the U.S. are on the wrong path and the world has moved on."

He stated that institutions like Mumbai IT are consciously "flanking" universities in the United States by offering more flexible IP terms in their corporate partnerships or by not even seeking IP ownership. Such institutions, said Hoehn, offer young talent and in return seek a modest royalty and employment opportunities for their students, either through a start up firm or through hiring by the partnering company. Hoehn is concerned that more regions of the world will perceive this constraint in the U.S. model and exploit IP as a currency for their benefit.

Riley began his portion of the discussion by sharing a brief narrative of his company, A123, which started approximately nine years ago as a spin off licensing

*Bart Riley, A123 Systems.*

three patents from MIT. Although the first patent the company sought to commercialize didn't succeed, A123 built a generation of products around their patented nanophosphate lithium ion battery technology.

"Those of you who have developed material technology know that it generally takes a long time to go from laboratory to manufacturing," Riley said. "We developed a set of products for Black & Decker and needed to come up with a manufacturing strategy in a very short period of time, essentially two-years."

A123 manufactured first in China. To protect the IP, the firm split the factory into sub-factories that could ship product between the two. "Not a single person there would understand the full recipe," Riley explained. "In a year, we went from a green field to a qualified manufacturing facility able to produce ten tons of nano materials per month. That is pretty remarkable and something we need to keep in mind in terms in understanding the global landscape. When you set your mind to do something in Asia, it can happen very, very quickly."

Riley noted three factors that have been essential to the firm's market success and IP strategy: (1) the original MIT patents and those subsequently filed, (2) speed, and (3) keeping processing details as a trade secret.

He then discussed how IP practices could help the U.S. manufacturing sector. A123 is leveraging stimulus funding to build its first mass production factories in Michigan. "Our plan is to invest in manufacturing know how and innovation for automation so that manufacturing is part of our differentiation that drives down costs and enables us to build future factories in the United States. In materials, closely combining the design of the material with manufacturing techniques will be a key point."

Riley raised the idea of process technology centers. The IP challenge, he noted, is that although a firm might patent know how, many foreign countries have weak discovery processes to protect manufacturing processes effectively. He advocated making the discovery standards for processed technology IP patents strong and level around the world. Riley also applauded the green tech program mentioned by Kappos to speed patent examinations for strategic technologies.

Riley concluded by remarking that the national laboratories represent a strategic capability in the American innovation system—generating a significant volume of IP. He suggested that some policy changes might be explored to support U.S. based organizations and U.S. competitiveness, noting examples in the battery space where licensing occurred overseas.

PART 2: FINDINGS FROM TLSI DIALOGUE 3

# Conversation with Arun Majumdar, Director, Advanced Research Projects Agency for Energy (ARPA-E)

**Arun Majumdar**
Director of the Advanced Research Projects Agency—Energy

Thank you Deborah and the Council on Competitiveness for inviting me and for leading on issues which are really important to the nation—technology commercialization and public-private partnerships.

As many of you know, ARPA-E is one year old. It's fair to say that some things have gone well, but this is a long road. Congress gave us the mission to address energy security, greenhouse gas emissions and technological leadership. We have to get this right. Before the Recovery Act, America manufactured only 1 percent of the global market for lithium batteries, which we invented. John Goodenough of UT Austin invented the cathode for lithium batteries, and yet we've captured only 1 percent. To me, that is a Sputnik moment and something we're trying to change.

There are additional wake up calls like the clean up in the Gulf and the infrastructure being built in China to manufacture and utilize alternative energy like solar. The decisions we make today truly will set the course for our children and grandchildren.

Let me also share some good news from my vantage point at ARPA-E. The innovations that we're seeing from the American R&D community are absolutely amazing. There are really good ideas being developed that I did not know about before I came to this job. Our agency seeks to unleash this innovation and we are already observing a maturity in the

*Arun Majumdar, ARPA-E, and David Kappos, U.S. Patent and Trademark Office.*

partnerships formed to develop critical solutions. For example, we selected in our battery program a project that crosses two different industries working in partnership with a national lab. That is exactly the kind of a partnership ARPA-E seeks to catalyze.

Another positive development is that if you go to U.S. colleges and universities today, you find that the students have made energy a top priority and have broken down the boundaries between science, engineering, business, public policy and law to tackle these challenges. I did not find this in China. I did not find this in India. This is a unique grassroots movement in the United States and a source of great hope. We need to harness it for our future.

At ARPA-E, we are considering how to scale innovation in the United States. Our goal is to enable business. Clean energy has to be profitable, but that requires further technology advances. For example, if solar energy could be generated at a dollar-a-watt, it would scale without subsidies. But it is not there today—it's about three to four dollars a watt. We also must reduce the cost of carbon capture, requiring new science and new technology.

As a new organization, the first thing ARPA-E must do is recruit the best people and I'm happy to report that we have got some really good people. Our statute specifies that program directors in ARPA-E can only serve for a few years. That is a good thing that has attracted outstanding talent. Many talented people don't want to come to Washington, D.C. for a long time. They want to start their own company and create businesses.

We have a finite budget, of course, so we have to invest strategically. We're developing not just an ARPA-E strategy but a national strategy and I welcome your input. The strategy will consider energy security—we have to produce oil and import less. We found a lot of natural gas and must manage issues associated with it. We must consider the system architecture of our grid infrastructure to see if there are new ways to create businesses and new ways of trading. We're looking at many scenarios and identifying common technological gaps. Storage is a gap. It's a big gap whether you're investing in transportation or grid. Where are other big gaps? ARPA-E is going to have a lot of workshops around the country to solicit your views. This is a long road for us and we welcome the participation of the Council and its members. Thank you.

## Discussion

Johnson thanked Majumdar. He observed that the difference between today's energy challenges and the original Sputnik moment was the fear felt by the American public that spurred action. Although Johnson agreed with Majumdar about the severity of the problems, he stated, "Even with the BP disaster in the Gulf, I don't feel like we've been able to create an enthusiasm around energy or sustainability as a rallying point."

Majumdar expressed hope that the Gulf spill would be a pivot point in U.S. policy and that whether through fear or optimism, Americans can be engaged in a more robust public dialogue.

Wince-Smith asked whether ARPA-E's investment strategy includes a path for co-investment and investment from private sector manufacturing and venture firms. "This is something we take very seriously," Majumdar replied. ARPA-E has started a commercialization team that is working to establish the right metrics to measure the agency's long term success. "We are supposed to hit some home runs and people want to know when the equivalent of the Internet will emerge from ARPA-E," he said. The ARPA-E Director is working to manage expectations, yet also create challenging and attainable goals such as global market share targets in strategic technologies. "We are asking, do we have the right vectors aligned over the next two to five years to hit the home runs? If we have 10 to 50 vectors going maybe a few will succeed."

Majumdar and his team are working with the private sector and other offices in DOE on how to hand off technologies and enable scaling by the private sector, including policies such as loan guarantees. ARPA-E also is working with the military to see how defense needs might facilitate pilot manufacturing that could stabilize key technologies.

*Deborah L. Wince-Smith, Council on Competitiveness.*

Khosla advocated a vigorous policy research effort in support of technology research and development. "There are significant technology challenges that lead to policy implications," he said. Khosla urged the administration to conduct empirical research that would inform not only a detailed objectives for challenges in grid, solar, wind, and other technologies—but also policies calibrated to achieve them.

Taub concurred with Khosla. "One thing from my perspective that is missing is a gold standard system analysis. The best I have been able to uncover is a swim lane analysis for each renewable in the energy sector on the consumption or production side. They have never really been leveled across the sectors. I think that's a research project we need to truly judge the options." Taub emphasized that the Department of Energy must take ownership to lead and produce a full system model because private sector actors don't extend across each lane.

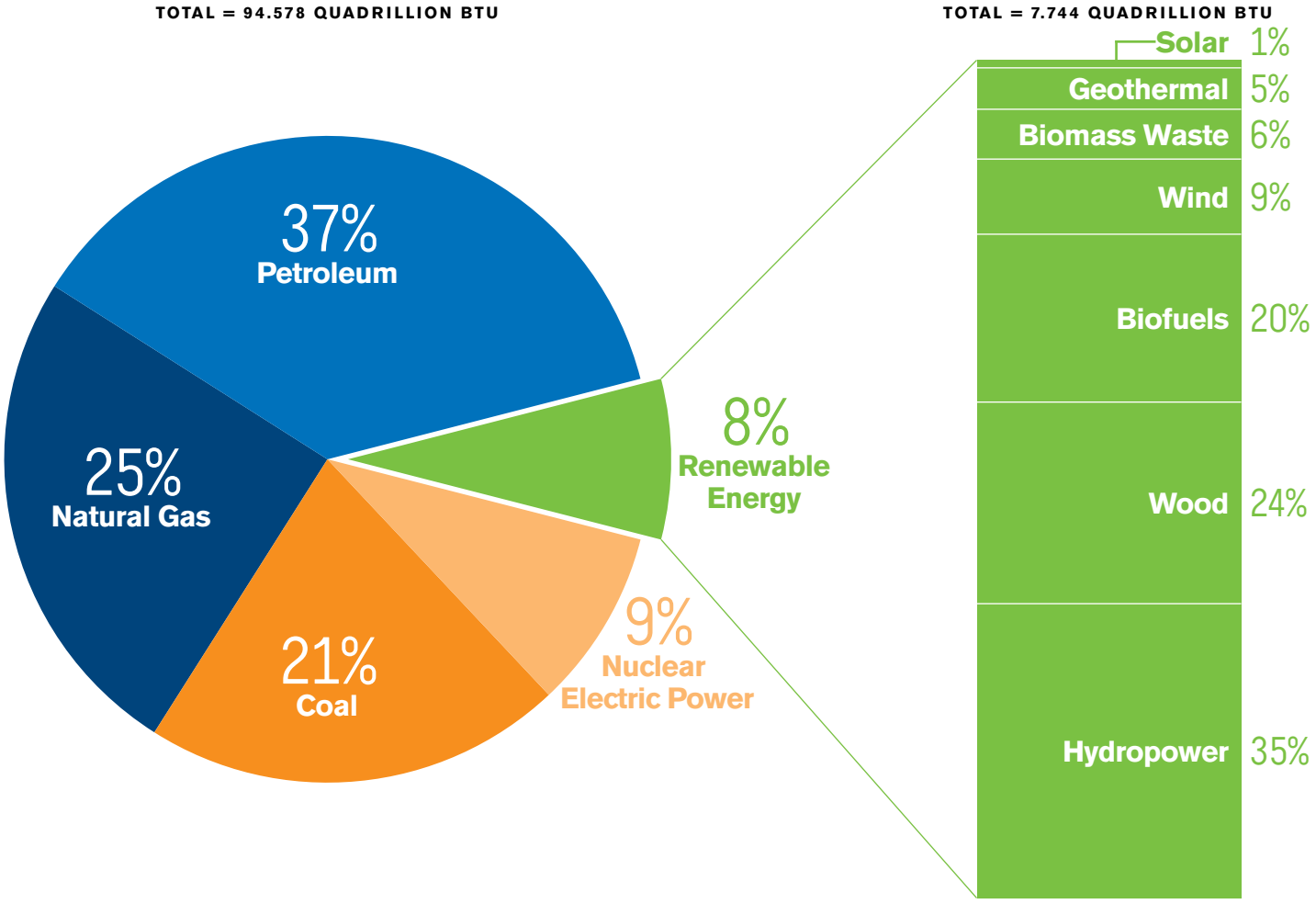
Majumdar noted that the Energy Department's Policy and International Affairs Office would conduct such work and acknowledged that more needed to be

done on a national strategy and long term road map. He praised the Council's leadership on energy issues and encouraged it to continue.

In 2010 the National Academies released a report, *America's Energy Future: Technology and Transformation*, which was the culmination of an effort that began in 2007 to understand some of the challenges noted by Khosla and Taub. The Academies report draws on data released by the U.S. Energy Information Administration and other sources "to inform policymakers about technological options for transforming energy production, distribution, and use, to increase sustainability, support long-term economic prosperity, promote energy security, and reduce adverse environmental impacts."

Bernstein noted comparisons drawn between ARPA-E and DARPA, but raised a major difference. DARPA has the U.S. Department of Defense, a customer

**Figure 17. U.S. Energy Consumption by Energy Source, 2009**
Source: U.S. Energy Information Administration, *Annual Energy Review 2009*, Table 1.3, Primary Energy Consumption by Energy Source, 1949-2009 (August 2010).




Note: Sum of componenets may not equal 100 percent due to independent rounding.

to whom they can transfer technology. He asked Majumdar how successful he anticipates ARPA-E will be given that difference.

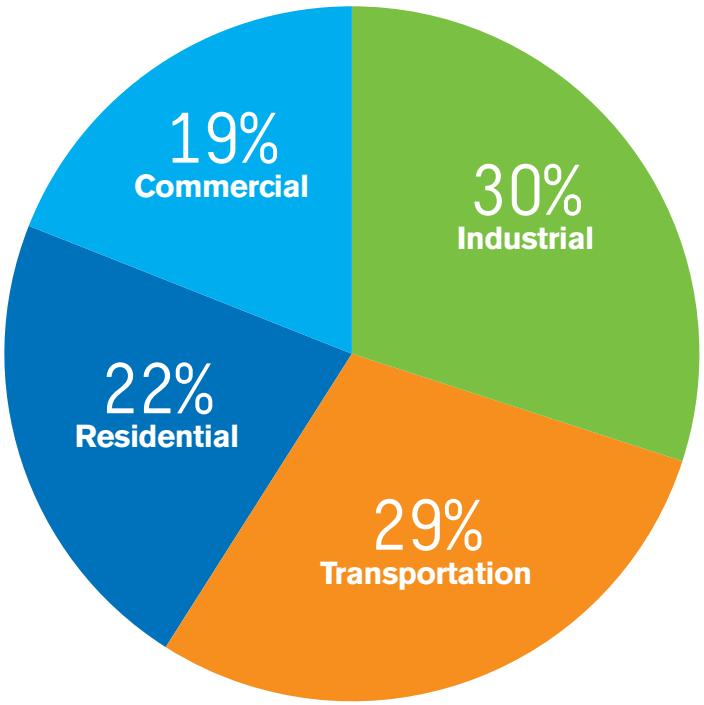
Majumbar responded that it is too early to tell, but that ARPA-E is interacting as closely as possible with the investment and business communities to find paths to success. He added, "If you look at all our program announcements, you'll find that each one has a technology target and a cost target." The cost targets distinguish ARPA-E from DARPA, asserted the Director.

"We say that if you cannot get your next generation battery at 400 watt per kilogram cell level and at $250 a kilowatt hour don't come to us. When we create our programs, we research what the market is like and that's part of the job of the commercialization team."

Wince-Smith posed the question of how to ensure that new energy technologies are manufactured in the United States. Majumbar stated candidly that he doesn't have a complete answer to this complex issue, but offered a few observations. "In China they have taken the VC model to almost a new level, and they use land to attract business and invest in them, even finding apartments for the workers."

"I hope we can create a competitive landscape in the United States—create the demand for some of these clean technologies. The government is the biggest purchaser of energy. Can we use a fraction of that purchasing power to create demand for next generation technology?" If such demand were established, suggested Majumbar, tax credits and loan guarantees for domestic manufacturing would be likely to follow.

**Figure 18. Share of Energy Consumed by Major Sectors of the Economy, 2009**
Source: U.S. Energy Information Administration, *Annual Energy Review 2009*.




Little noted that government incentives such as Energy Star credits have stimulated GE to transfer greater activity into manufacturing facilities in the United States. Much more interesting, suggested Little, is a push by people in the United States—management and factory workers—to streamline the efficiency of plants. "I hope that we can get the manufacturing side so productive we can actually do more things cost-effectively in the Unites States."

PART 2: FINDINGS FROM TLSI DIALOGUE 3

# Commercialization Models and Mobilizing Capital for Innovation

Little then kicked off the discussion on commercialization models and mobilizing capital for innovation. He posed the questions: what are the basic models for commercializing technology, what might be done to make these more viable, and how well have America's competitors closed the gap?

Little introduced Erik Stenehjem, director of industrial partnerships at the Lawrence Livermore Laboratory, who filled in for Tomás Díaz de la Rubia, deputy director for science and technology at Lawrence Livermore. Stenehjem was followed by remarks by Tom Ballard, director of partnerships at Oak Ridge National Laboratory; Tom Baruch, founder and managing director of CMEA Capital; Andy Garman, founder and managing partner at New Venture Partners; and Ken Howery, co-founder and managing partner of the Founders Fund.

*Erik Stenehjem, Lawrence Livermore Laboratory.*

**Erik Stenehjem**
Director of Industrial Partnerships
Lawrence Livermore Laboratory

The basic model for technology commercialization at national laboratories hasn't changed much since the days of the Bayh-Dole and Stevenson-Wydler acts. Technology commercialization offices have been established that, first, gather up records of invention. Inventors are encouraged to disclose in many cases at universities through incentives—35 to 40 percent of the revenue made from a particular patent would be returned to the patent's authors. So records of invention are obtained and evaluated. They are patented if it appears that they have any real credibility, a group of people known as commercialization managers are assigned to particular pieces of intellectual property. They talk to the inventor and find out what the invention is supposed to do.

The interesting thing about my national laboratory, a nuclear security lab, is that 85 percent of the things that we develop are designed to go boom—they don't have any other application. So the job of the commercialization manager actually was to reverse engineer technology developed by the scientist and look at it as an entrepreneur to unlock any latent value hidden in that asset. We recently did this with an accelerator.

An accelerator typically is a long, large, and very expensive device that throws things at enormous speeds, usually particles. We developed an accelerator that would fit roughly within my arm span that had enormous defense implications, but also could be transformed into an accelerator that throws protons. Throwing protons at cancers enables you to very accurately target the cancer. There is virtually no damage done to the body as the proton passes to the target. The idea is to put these units in thousands of hospitals instead of only the few places currently in the United States. The cost and size of the larger accelerators limit their application.

So it takes a lot of effort, but that's the basic model. We look for value hidden inside a piece of technology that might be commercially relevant, and then we go out and try to sell it. We're not very good at that in some cases. It's a difficult, difficult job. Industry is often not aware of where we're located and what we're doing and that's not industry's fault—that's ours. Very often, we come up with breakthrough technologies. For example, a new fabric on which you pour saltwater and fresh water comes out the bottom. That may be too radical and different for an existing industrial firm to take on, so it's the kind of thing around which we wrap a startup. We have to demonstrate that it works; we go through the scale up; we do all those kinds of things.

The basic model is under assault, though, as it should be. Earlier we discussed Nathan Myhrvold's broad vision for what intellectual property could become. Part of what Myhrvold is trying to accomplish with Intellectual Ventures is to imagine the future and then identify the gaps that exist between today and how we get there. What are the inventions needed to make that future possible? He then contracts out with laboratories, universities and research institutes to fill those gaps. So, it's not all about simply maximizing value of intellectual property. It's

about creating intellectual property. There are public auctions now for intellectual property. Ocean Tomo is a firm that takes IP to auction. ThinkFire is a licensing and advisory company. So the private sector is exploring how it could monetize the value of intellectual property.

Let me tell you a little bit about what Lawrence Livermore is trying to do with its technology transfer and its partnerships with industry. There are ways to use these private sector models. We took 122 pieces of IP to auction through Ocean Tomo. We're in discussions with Intellectual Ventures. But, we're insisting that when they use our intellectual property, they provide us with the protections that we need in order to make a deal work. Free access to expertise is probably the best contribution that we've been able to make.

We also have identified eight serial entrepreneurs. They've started a minimum of two companies and have street credibility on Sand Hill Road. We work with them on a weekly basis. They have badges that get them into the laboratory. They go over all of our publicly available technologies and look for opportunities to take them into the marketplace and they're doing it. It's working. It was an idea started by Andy Karsner in the Department of Energy. We just amped it up a bit. So there are strategies that are working—there are ways the transfer can be made more effective and commercialization faster. A big one is maturation funding.

Let me back up to explain that we deal with orphan technologies. Federal funding comes to us to produce a thing. When the thing is produced—whether it was designed to go boom or whatever—the funding stops. A concept I think we should consider in all federal agencies would be to enable them to advance work with commercial potential. Don't stop funding it. If we did something like that, we could push innovations through to the goal line. We wouldn't have a lot of technology transfer offices and people who have to reverse engineer technologies. We would find logical relationships with industry because we would have the funding to prototype. Thank you.

*Tom Baruch, CMEA Capital.*

*Tom Ballard, Oak Ridge National Laboratory.*

Ballard began his remarks by recalling that the Oak Ridge National Laboratory changed the name of his office two years ago from "Tech Transfer and Economic Development" to simply "Partnerships," reflecting the changing culture noted by Stenehjem and Dimolitsas. It is about a win-win philosophy, he noted, not about getting the best deal. New cultures should be linked to improved tech transfer mechanisms that increase public-private collaboration.

Ballard also agreed with Dimolitsas that tech transfer organizations and those that manage intellectual property have been reactive more than they've been proactive. His office at ORNL, for example, has a person involved in each of the hub proposals. "We were one of the three bio-energy science center winners from DOE," he stated, "and two weeks ago we won in the nuclear simulation hub—$125 million in each of these. We're moving up stream, not only helping drive the research but also knowing earlier on what's coming." Ballard believes his team will be in a better position to commercialize emerging technologies.

He applauded DOE efforts such as the ARPA-E program and hub strategy. "The federal government is really driving federal agencies to work together in ways that will improve commercialization." He also concurred with Stenehjem on the importance of supporting orphan technologies to maturity.

Ballard concluded by noting that over the course of his 41-year career, collaboration between universities, industry, and government frequently operates like a singles bar. Like Wince-Smith's admonition to connect the dots, Ballard stated that the parties often seek out their own interests disconnected from the others'—missing out on opportunities due to a lack of knowledge or shared commitment to a goal.

Baruch emphasized that the key issue is how to innovate faster in America. He suggested three strategies:

1. **Discovery.** "How do we enhance the discovery process?" asked Baruch. He believes the answer is to apply exponential technology around Moore's Law and Genomics—using technology to speed the testing and discovery of new materials for innovative industrial products or pharmaceuticals. CMEA is involved with a number of companies now engaged in that sort of activity, said Baruch, such as Wildcat Discovery, Codexis, and Simex Technologies.

*Ken Howery, Founders Fund.*

*Andy Garman, New Venture Partners.*

2. **Entrepreneurship.** "We must connect intimacy with the marketplace to the discovery process," said Baruch. The best way to do that is by inserting experienced entrepreneurs early on—helping to guide the discovery process toward commercially viable products and services.
3. **Business Model.** U.S. firms should be open to new business models that minimize the amount of capital investment required and allow innovators to capture the high ground in the value chain. "Our business is all about the mathematics of compound interest, and our ability to compete globally is a function of time," emphasized Baruch.

Garman drew on his experience commercializing technologies from big institutions to suggest a few best practices for those institutions. His first priority would be developing communities between researchers, sources of capital (venture and angel investors), and entrepreneurs. "Many labs are big walled institutions that haven't interacted very well with the outside world, so it's a two-way directionality that is needed to enhance access for entrepreneurs and capital sources," Garman said. He also encouraged researchers to move out of the labs more frequently to learn first-hand about real world challenges and commercialization opportunities. "It might inform their choices," he suggested.

Garman's second priority would be to create cultures in the labs that reward commercialization, which means fast streamlined processes. His third objective would be to focus resources in the labs on big impact ideas. "Too many suffer from lots of small projects that even if they succeed may not have real economic or societal impact—that's reflected in the selection process and how projects get reviewed over time."

Fourth, Garman urges that labs reconsider the metrics on which they are evaluated, with a higher emphasis placed on value creation rather than traditional metrics like patents or licenses written. "They could look at capital raised, job creation and revenue streams generated by resultant commercial projects." He noted the level of frustration expressed in the Dialogue with the way that commercialization offices work. "There should be a rethinking of how to transact with the outside world, quickly and on sensible economic terms," he said.

Finally, national labs, universities, and corporate labs can increase their level of openness and collaboration. "The really big and interesting disruptive technologies are coming from work across disciplines," asserted Garman. Institutions should be more open both to external innovation stakeholders and to collaboration between their own internal divisions. "Historically a lot of institutions have been stovepiped where medical researchers work over here, mechanical engineers work here, and material scientists work over here," he noted. Continued progress can be made he suggested.

Howery discussed how risk capital and public-private partnerships go together. "I believe the two are intertwined, and that the structure of private-public partnerships is important if they are to encourage risk capital investment." Howery offered the collaboration between NASA and SpaceX as an example of a partnership that led to investment by private capital. His firm, Founders Fund, was the first outside investor in SpaceX.

SpaceX is a commercial space company developing a family of launch vehicles and spacecraft. Howery stated, "It's been a great partnership both for NASA, SpaceX, the American taxpayer, and the private investors. The SpaceX partnership had a number of traits which were important to us as a venture fund getting comfortable investing. I think those traits can be generalized to create other win-win collaborations that encourage private capital investments."

The first trait, he noted, is that a substantial amount of private capital was invested before the government got involved. SpaceX founder Elon Musk put $100 million of his own cash into the company before it signed a contract with NASA. It helped eliminate the principal-agent problem, Howery said, and with NASA's involvement transformed the enterprise into something viable. "NASA's involvement was critical for our fund investing and then later another venture fund, DFJ." Eventually, the company may launch an IPO and bring more private capital into the company.

The second important trait of the deal, he said, "is that SpaceX was a real investment by the government, not a purchase or a give-away." Howery illustrated his point by noting that for the cost of an Ares launch tower, SpaceX developed its Falcon 9 over-the-rocket hardware, the Dragon spacecraft, and three launch sites. "This ultimately saved tax dollars that the government could use elsewhere."

Founders Fund valued the alignment of interest between NASA and SpaceX, which lowered political risk. "This project fit with the government's long-term goals," Howery said. "NASA is supposed to push frontiers. By outsourcing cargo delivery to private companies, they can refocus on their mission getting to Mars, building a space ship, or other bigger projects."

The final trait important to Howery was that the government was not the only customer. He relayed that SpaceX signed the largest commercial space contract ever with Iridium for $500 million. "This ensured that the government's deployment of capital was aligned with both the public and market expectations, which tends to be the most beneficial social outcome. This also diversified revenues, further reducing investment risk. NASA leveraged the taxpayer dollars into hopefully eventually net cost savings for the taxpayer and into additional private investments."

Howery estimated that a shuttle launch cost about $450 million, which roughly equals the size of the Commercial Orbital Transportation System contract of which SpaceX got a portion. "This is helping to make commercial space flight a reality," he said, "which over a series of Ares launches will save conservatively $2.5 to $5 billion." Howery closed by pos-

ing the questions, are there further ways to leverage government money to encourage more risk capital into industries and which industries would make sense in addition to space?

## Discussion

Ballard opened the conversation by noting that General Motors has created a venture capital fund and asking Taub whether he had any insights that he might be able to share with the Dialogue participants. Taub replied that GM opened a Silicon Valley office about four years ago. As vehicles take on more information and entertainment functions, he explained, GM realized that non-automotive suppliers and non-automotive technology startups struggled to "penetrate fortress GM." The company discovered, however, that startups wanted to collaborate with them rather than receive money. In 2006 and 2007, explained Taub, venture capital (VC) firms were meeting their investment needs.

Taub asked the group whether conditions have changed. "We're getting indications that it's harder for startups to raise capital, and we saw our fund as possibly giving us the ability to do some bigger deals." He asked participants whether they have observed the same shift over the past 18 months, noting that GM's aim is not to be an early angel investor, but to invest at the next stage.

Baruch replied by he has observed the same investment contraction at both the early and more mature stages of commercialization. He also noted a great deal of consolidation occurring in corporate labs. "The function of creating ideas and discoveries is really moving into the university sector," he asserted, "and, there needs to be a capability of pulling that out." Baruch believes that more industrial companies will create venture funds if venture capital firms don't fulfill that function.

Taub observed that when GM re-launched its VC fund, its benchmarking indicated that the move was contrary to many other large companies that were closing down their funds. Little stated that GE, in addition to expanding its research, remains in the VC world with successful funds in energy and health care.

Mehmood Khan, Senior Vice President and Chief Scientific Officer of Pepsico, indicated that he established a venture capital fund in a previous job and oversees one now at Pepsico in partnership with Unilever. Khan described the collaboration as an interesting evolution of the model with two large partner companies that have mostly complementary businesses. He, too, believes that industry is undergoing consolidation "because many R&D organizations are running out of new big ideas."

Khan described the investment environment as high-risk, with growth coming almost exclusively from startups in the tech arena. To illustrate the environment, he described a culture of high-turnover innovation in consumer industries. "In Japan alone," said Khan, "about 200 or 250 new beverages will get launched a year. Of those, the average shelf life is about 45 days."

He also observed that the relationship between smaller innovators and large companies is complex in ways beyond managing the value of IP. Some innovators worry about collaborating with a larger firm if they perceive a risk of being confined by that relationship, he said, even if the large firm initially represents a potentially lucrative customer. Khan indicated that such innovators struggle to evaluate their best long-term value proposition.

Such factors—risk, turnover, a lack of big ideas, and the desire by small innovators to partner with more than one firm—are driving the model Khan described of multiple firms investing together. "It's almost to a point where you set up strategic investment partners

before you get into specific investments," he said, rather than having a single opportunity drive partners together.

Cellucci expanded on a point made by Howery that public-private partnerships should be win-win. "There is also risk-risk involved," he said, perhaps explaining why many in the private sector rely more heavily on acquisitions than on shared partnerships with the public sector. While commercialization is not new to the Dialogue participants, Cellucci noted, the process is new to many in government who often don't recognize that they can leverage huge potential markets.

The Department of Homeland Security (DHS), for example, leverages stakeholders such as the Transportation Security Administration, Customs Border Protection, and first responders like firemen and emergency medical technicians. "There are over 25.3 million people who get about $3 billion a year from Homeland Security," Cellucci said. DHS also administers an Infrastructure Protection and Disaster Management Division that spans 18 critical infrastructures like water systems, communications, energy facilities, and transportation systems. "There are many market opportunities," he emphasized.

"There is so much available in the private sector, not only in the U.S. but around the world," he said. Cellucci asserted that government could use more of its leverage and resources to buy products and services developed by the private sector, rather than funding new development itself. His experience is that creating open and transparent clearing houses spur entrepreneurship, leading to faster deployment of technologies and more rapid, efficient commercialization. "The reality is that a lot of the companies, as well as the government, are not familiar culturally with such a process," he said. Cellucci said one of his biggest challenges is a bureaucracy that has operated a different way for 30 years and views change as a threat to existing positions and budgets. He advocated more measurement of results and leadership able to drive cultural and management change.

Davis observed that most of the dialogue centered on inventions and capitalizing inventions. "I want to ask a few question about the infrastructure that would support this," he said. Davis emphasized the importance of high performance computing but, also raised the idea of regional centers accessible to multiple companies, especially small and mid-tier firms. "Could these capabilities be made available on a real time basis to manufacturing operations?" he asked. "There's a notion that we may be able to build infrastructure across industries or industry segments, making U.S.-based innovation and manufacturing more competitive." He invited Dialogue participants to comment.

Stenehjem assumed that Davis was referring to proof of concept centers envisioned by OSTP and Commerce. He believes the new idea will require a certain amount of marketing and outreach to be effective and to help stakeholders understand how a center would operate. Questions exist about how firms would get access and under what terms universities and labs would develop nascent technologies for private sector commercialization.

McIntyre added that through shared facilities "the federal government can enable small to medium sized manufacturers, as well as other companies, to use modeling and simulation for competitive advantage." Such firms would benefit from modeling and simulation, she said, but typically lack the expertise, software, or hardware—or even awareness of its availability.

McIntyre explained that high performance computing could drive efficiencies in design, discovery, and manufacturing. She informed the group that the Department of Energy is considering a simulation summit in October, and urged TLSI members to consider participating.


*Cynthia McIntyre, Council on Competitiveness.*

Paul Hunt, Senior Associate Vice President for Research and Graduate Studies at Michigan State University (MSU), suggested additional forms of shared infrastructure that that could be made available through proof of concept centers. Pfizer donated a building to MSU that is offered for pilot plant chemical scale ups for small companies. "Centers might offer accelerators or other useful resources," he suggested.

Dimolitsas built on Cellucci's theme of changing the culture of commercialization, in his case in a university environment. Dimolitsas emphasized the importance of engaged university management outside the technology commercialization office. Management, he said, that "can and wants and does bring expertise to the table rather than leaving it entirely up to the commercialization office" makes a big difference in the institution's culture and rate of commercialization success.

Ashby concurred with Dimolitsas and commented briefly on the TLSI Working Groups. He praised ideas put forward by Stenehjem, Cellucci, and Garman, pledging to explore them further as part of the Accelerating Innovation Working Group. Many good ideas were outlined in earlier dialogues, said Ashby, and he was pleased that the third Dialogue added new dimensions to also be fed into the working groups.

PART 2: FINDINGS FROM TLSI DIALOGUE 3

# Spirit of Innovation Awards

Wince-Smith introduced Nancy Conrad, the chairman and CEO of the Conrad Foundation. "Nancy is an innovator and a new member of the Council. The Conrad Foundation honors Nancy's late husband, Pete Conrad, the astronaut," Wince-Smith explained. "Nancy has put together a unique entrepreneurial activity involving students, labs, experts, and creative thinkers around real world ventures in science and technology." The foundation's premier program is the Pete Conrad Spirit of Innovation Award, Wince-Smith noted, and she thanked Conrad for joining the TLSI Dialogue to discuss her program and for strengthening America's entrepreneurial culture.

Conrad thanked Wince-Smith and opened by noting that in many ways, "what we are doing with young students synthesizes everything we've talked about today relating to industry, government, IP rights, or venture capital. We've put together a model that we're implementing right now." The foundation's approach blends education, innovation, and entrepreneurship. The Spirit of Innovation Awards program, supported by Lockheed Martin and others, challenges high school student teams to submit product ideas in aerospace, energy, and cybersecurity.

Teams reaching the semifinals and finals receive awards and are considered for additional mentoring and entrepreneurial education. Winning submissions receive support to patent, develop and actually implement their ideas. "We give kids a white paper to create products using science and technology, engineering and math to solve real world problems," Conrad explained. "It's online, 21st century education that is also multi-disciplinary, problem based, hands-on learning."

*Nancy Conrad, Conrad Foundation.*

She cited a challenge that asked students to create a product for use in renewable energy. "What came back to us was extraordinary—so extraordinary that some of our kids have caught the attention of leaders in government such as Jon Wellinghoff, Chairman of the Federal Energy Regulatory Commission.

One of our teams was featured in *Popular Science Magazine*. They developed a product that harnesses energy from heat vents deep in the ocean through a generator and creates electricity. They have three patents and a team of experts working with them to take their product to the commercial marketplace."

"They own their IP," Conrad stressed. "We take care of the costs and expenses, but they own it. We ask them to license their product and stay in school. The team I'm telling you about (Daniel Asturias and Isaac Harwell) is from Katy, Texas. They have companies cued up to look at what they have done. It's pretty amazing and represents an opportunity, a model, to grow our next generation of innovators."

Conrad shared how the foundation advances the legacy of her late husband. "The story of Pete Conrad is one of a young man thrown out of school in the 11th grade because he couldn't read or spell. He had dyslexia in a day when they didn't know what it was. His mother took him to another school that had a reputation for dealing with problem kids. An educator took him under his wing and recognized his potential. Pete ended up with a scholarship to Princeton and became an aeronautical engineer. He went on to fly four flights in space, including the second landing on the moon. He was awarded a Congressional Space Medal of Honor for his rescue of Skylab."

"Pete went on to create four companies working on the commercialization of space, as Ken talked about today with SpaceX," she said. "All of this happened because an educator took a kid under his wing and gave him a moon shot. We take kids today under our wing, give them their shot, and grow an innovative workforce for the 21st century." Conrad invited TLSI participants to join in the foundation's efforts. "We would love for you to serve as coaches, mentors, or sponsors. It's easy and these kids need your expertise. Thank you."

## Discussion

Wince-Smith thanked Conrad, declaring that "this is certainly a model that we want to highlight at the Council. We have a goal of creating a nation of innovators." Little also complimented Conrad and the work of the foundation. He asked how many students are now in the foundation's network and whether it serves exclusively high school students.

The foundation is entering its third year, replied Conrad. "We started very small with about 20 teens. Last year we had about 600 in our community. This year we hope to have around 1,000 teens participate." She believes the foundation has built a unique structure around collaboration, working with organizations like Sigma Xi and the National Science Teachers Association. "We've also reached out to science centers, museums, and to the KIPP and Green Dot schools."

Conrad confirmed that the foundation only serves high school students, but someday may expand into middle schools. "We are working on a project now with NASA to target middle school students. It will be a simplified version of our existing programs as we go to the younger grades."

Vint Cerf, Vice President and Chief Internet Evangelist with Google, also complimented Conrad. He asked whether the Conrad Foundation is documenting information that will allow its programs to scale, be sustained, or be replicated for other purposes. "It would be really valuable to document what works and doesn't work, or under what conditions things worked or didn't work." Conrad agreed, confirming that the foundation had just implemented metrics gathering to measure performance and learn more about the students participating in its programs.

PART 2: FINDINGS FROM TLSI DIALOGUE 3

# Spotlight Conversations with Vint Cerf of Google and Chris Scolese of NASA

Johnson introduced the Dialogue's final speakers. Vint Cerf, he noted, is widely known as a father of the Internet for developing its fundamental protocols. "He's going to talk to us today about creating conditions for innovation to succeed," Johnson said, "and will be joined by Chris Scolese, the Associate Administrator of the National Aeronautics and Space Administration (NASA)."

*Chris Scolese, NASA, and Vint Cerf, Google.*

**Vint Cerf**
Vice president and chief Internet evangelist, Google

I appreciate the opportunity to participate and would like to make four or five points. The first thing I would observe is that although this is the Council on Competitiveness, it's important to recognize that competing sometimes infers a zero sum game. I like positive sum games. That means cooperation and collaboration which is why I liked what we heard from Nancy.

The second thing is that I'm kind of resistant to the term "technology transfer." In some sense the only things that transfer are people and products. Something in a lab—that's really hard. That's why the notion of a valley of death is so important for this discussion.

I want to use the Internet's evolution as an example. Before the Internet and before the ARPANET there was something called the Automatic Digital Network, or AUTODIN. This was a message switching system that was very important for military operations. You had to get messages out to different destinations. You had elaborate sign-off procedures to make sure that authorized parties released messages. You had various levels of urgency. The point is that that system was designed and built behind a particular application. Message switching is an application.

The Internet is based on a different technology called packet switching—there isn't any application. Packet switching is a way of moving bits around in little bags called packets. You build the application on top and don't have to change the network in order to build those applications. When I tried to get the Internet to move out of the academic realm, which is where it emerged thanks to funding from DARPA, I chose to go to the makers of computers—IBM, Hewlett Packard, Digital Equipment Corporation, and to Berkeley where the Berkeley Unix release lived.

I urged them to build commercial versions of the TCP/IP protocols and by good fortune, all of them had labs. There was an IBM lab, a Digital Equipment Corporation lab, an HP lab. The labs implemented those protocols for their operating systems, not the commercial guys, not the engineering department. In the case of Berkeley, a freely distributable version of TCP/IP for Unix was implemented. The consequence of having it available from the labs was pretty amazing because when it became apparent that there was a market for this stuff, these companies all had software available that they could sell because it had been implemented ahead of time.

Many steps had been taken. The National Science Foundation Network (NSFNet), which aimed to link all the universities around the United States, had received a lot of attention. Congress supplied funding for the National Research and Education Network. Senator Al Gore was instrumental in getting that legislation to move ahead. Yet in 1988, 15 years into the development of the Internet, I asked, "What's stopping us from having this stuff commercially available? Why can't I have this in my house?" The answer was that no one offered commercial Internet service. It was all government funded. So I went to the Federal Networking Council and I asked, "Would it be OK if I connected a commercial email service to the Internet as an experiment?"

My purpose was partly to figure out if we could get the commercial email services to work with the Internet. The other purpose was to break the policy of no commercial traffic on the Internet. Amazingly, they gave me permission to do that for a year. So we hooked up MCI Mail. As soon as we did that, all the commercial email service providers said, "Wait a minute. Those guys at MCI can't have this privileged position." So they hooked up to the Internet, too. The consequence was because they could all interact with the Internet they could talk to each other, which they couldn't do before. On top of that it was apparent that there was a commercial market. In that same year, 1989, three Internet service providers popped up—the Ethernet (now part of Verizon), Surfnet, and PSINet.

What was interesting about that is that only six years later, the NSFNet was cancelled because it wasn't needed any more. Universities could buy the services they needed commercially. All of this only happens if you are persistent about creating conditions that allow commercialization.

Oddly enough, I face a similar dilemma right now. For the last dozen years or so, colleagues at NASA labs have been working on an inter-planetary extension of the Internet (InterPlaNet), a new set of protocols that overcome the fact that it takes 20 minutes for data to travel from here to Mars, and the TCP protocols don't work in a 40-minute round trip time. We developed a new set of protocols that would work and tested them in deep space. But after a dozen of years of work, we still have to make the protocols easily available to people who build missions and spacecraft. Tactically, I don't know whether we can use the same strategy that got the Internet deployed broadly, i.e. putting implementation in the hands of the people who provide products and the services off the shelf.

There is a similar example at Los Alamos in the company licensed to make carbon matter to thread using millimeter long carbon nanotubes. That's really long when you consider the narrow diameter of a carbon nanotube. They can be spun into thread and then woven into fabric.

This is the strongest, stiffest material ever made. If it could be produced in quantity it could be used for automobiles, aircraft, and the like because it is lighter and stronger than steel. The lab showed the fundamental ability to produce the fibers—you could measure their characteristics. But there wasn't a sufficiently larger pilot to make enough of the material for people who might try it out for airframes, tennis rackets, or products. The problem is that there wasn't a good avenue, at least that I could see, to move the technology from the lab to production, or at least prototype production that the venture capital folks would see it as an opportunity.

Somehow you have to weigh the risk factor to get past that valley of death. If we are worried about that part of our economy, then we are going to have to find tactics that will allow us to push close enough to the point where venture capital feels comfortable with investments. We have interesting opportunities to take advantage of the research that this country is performing, but we need to commercialize these opportunities and not be afraid to take some risk.

**Chris Scolese**
Associate Administrator of the National Aeronautics and Space Administration (NASA)

I want to talk about the valley of death and perhaps begin by defining it. It's when you develop a technology or capability that clearly has applicability outside of the lab, but it's going to cost something in order for it to be used. In the parochial world of NASA, that means applying the technology to a mission. In the outside world, it means being accepted by commercial industry and used more broadly. We have examples of technologies crossing over, such as commercial communication satellites. That started off as a government experiment.

We've been trying to figure out how we can more frequently cross that valley in both the NASA and broader world. One of the key metrics is cost/benefit. If it's going to cost you a lot and the expected benefit is not large, you're not going to move forward. If the cost is small but the potential benefit is large, then you do it. If both cost and benefit is large, then typically governments will take a leading role.

Nancy spoke about the moon—there were a lot of technologies to develop that cost a lot of money for the Apollo program, many of which we're using in the Shuttle. We also found some incredible applications outside of NASA, such as defibrillators. Portable defibrillators started off through our efforts to figure out how to deal with an astronaut in distress. Although I'm not familiar with the documentation, NASA notes on its website that we developed the first fire detectors because they were needed on space craft. We had them on Skylab.

Another example is technology that we're going to use on Mars, hopefully in about two years. With the Mars Science Lab, there's an instrument called SAM (Sample Analysis at Mars—we're not terribly clever with names any more). SAM is a medium-sized box that serves as a complete lab for identifying chemical and biological agents. The nano-technologies were developed in cooperation with a company that now applies them in blood and gas analyzers. If you ride Washington's Metro trains you may notice gas analyzers in the stations. Part of that technology came from our effort to go to Mars.

Remote sensing capabilities are another example. It's been close to 40 years since the launch of Landsat 1. The Landsat Program is a series of Earth-observing satellite missions managed by NASA and the U.S. Geological Survey. We're now on Landsat 7 and building another. In this case, we have commercialized the use of data gathered by these satellites. There's a huge market in the agribusiness world for using that data to predict crop health and crop yield around the world. Farmers and investors want to know what crops to invest in to get the biggest bang for the buck.

I'm not really offering solutions today. I'm merely asking the question, "How can we commercialize technologies more frequently, more effectively?" NASA will continue to invest in missions and to develop mission-specific technologies that occasionally wander off in a good way. How we can get them across the valley of death? How do we convince communities to accept something like TCP/IP for space as Vint described?

## Discussion

Cerf began by noting that "infrastructure is often the orphan child because it's not a mission thing. It's something that everybody relies on and nobody wants to pay for." There are several examples of infrastructure where government played a key role, he said, though not necessarily the same role. Cerf cited railroads, for which government devised a land grant system to encourage development, and the telephone system that achieved universal service through a regulated monopoly.

Electricity and airplane service were further examples, Cerf said. The key is to figure out how to produce infrastructure that enables others to add value. In the modern IT world, he noted open source software or open platforms as examples. "When Google releases things like Android or the Chrome Browser and makes the software freely available, or offers application profile interfaces (APIs) for Google Earth and Google Maps, our intent is to let other people take advantage of those interfaces and monetize, use, or adapt them as they wish." Such infrastructure is an important step to get past the valley of death, asserted Cerf.

Khosla agreed with Cerf and offered a provocative thought. "Imagine if all the IP owned by the U.S. government, which is pretty much the same as IP that is owned by all nationally funded laboratories, was put in the public domain like open source infrastructure, with perhaps some caveats that nobody could capture that IP and bar anyone else from commercializing it." Khosla also postulated an alternative regulatory regime under which the government could reward firms that show a level of commitment or job creation by granting limited or exclusive IP rights for a period of time.

"I think it would open up innovation in ways that we are not seeing," he stated. The idea might be radical, said Khosla, but he urged TLSI participants to consider it. "We heard about intellectual property being the new currency." Open source IP could have a foundational impact on innovation like open source software, shared infrastructure, and pre-competitive research, he suggested.

Scolese replied that at NASA's IP is open. The main restriction in the United States to using government IP is international traffic in arms regulations (ITAR), he said. "If the IP is developed and paid for by NASA, it's available to anybody with certain restrictions." The Department of Energy faces the same problem, said Scolese. "This Administration is working to address ITAR, and we hope they do."

Ashby posed a question to Cerf, asking him about his efforts to establish the Internet. "If you were taking that experience and transplanting it to today's environment, what would be easier and what would be more difficult?"

Cerf observed that when he and Bob Kahn did the original design work for the Internet, they made it publicly visible. "The only reason that we got away with that in the middle of the Cold War is that nobody noticed. Like Grace Hopper said, it's better to beg forgiveness than ask permission." In fact, Cerf said, the real rationale for not trying to confine knowledge about the network design was that the pair wanted it to become an international standard. "We wanted it to become commercially available even from the beginning." Cerf and Kahn knew that if there were viable paths for companies to pursue proprietary strategies they would. "We knew that we wouldn't get anywhere unless we erased all the barriers," he emphasized.

Cerf's second observation was that there was a happy confluence of events. The invention of Ethernet coincided with the invention of Internet. "Bob Metcalfe's lab at Xerox Park was a mile and a half from my lab at Stanford and we knew each other, our students knew each other." He also noted the

shift from big mainframes to work stations, the development of the Unix operating system, and the invention of e-mail.

"The thing that I've seen happen dramatically is that when people share information you get a multiplier effect that you could not get any other way. A lot of what has happened in the Internet is a direct result of people sharing information," Cerf stressed. He noted the rapid adoption of the World Wide Web. "One of the reasons it exploded into use is that when you got a browser and saw a web page that you thought was really cool, you could see the source code that made that web page just by clicking on 'show source.' People learned to be web masters by copying each other's HTML code."

Cerf emphasized that countries which share information have fared far better than regimes that try to suppress such sharing. He also noted a number of technology trends that will make societies more reliant on information sharing, such as the growth in the number and ability of networked devices, increasing capacity in the network thanks to optical fibers, and satellite broadcast of IP packets.

Scolese shared some of his experiences as well. "About ten years ago when I was with GE, we started looking at cycle time on new product development. For major products, it was 10 to 15 years." GE, Scolese said, discovered that many of its business processes slowed down new idea development and that the company had to do a better job of linking people with problems to those with solutions. "We tried to organize an innovation process."

A critical element, Scolese said, is for research organizations to become open enough so that people with problems to solve can observe the capabilities and activities of the organization—enabling scientific thought to be connected earlier to potential practical applications. The alternative is to rely on internal actors to divine such leads, resulting in slower product development.

Cerf noted that standardization is another important ingredient for commercialization. "When you have standardized interfaces, you enable inter-operability that was not planned. When you see propagation and applications on the web, it's a consequence of the standardization that allows somebody's Java code to work in every browser. Of course, this also gives rise to viruses and other bad stuff that happens. But, it is an example of creating an environment where it's easy for people to innovate."

Scolese shared two more examples of how data supplied by satellites were used to solve problems. Using satellite and ground data, scientists were able to learn about the migratory habits of birds infected with avian diseases—enabling health officials to locate at risk populations and to understand better the risk of the spread of such diseases. In another case, satellite data solved a mystery of downed power and telephone poles in some western states. Data revealed that cattle herds would scratch on poles and eventually down them. Small spikes around the poles solved the problem.

Wince-Smith asked how the explosion of devices and network capability will impact health care, and what security and privacy issues might arise. Cerf replied that the issue splits into different variations. "First of all, the equipment used to do tests on biological samples can be networked, and we could get much, much better information out of them than we get today.

"Second, the aggregation of health data can certainly tell us a lot about our population's health statistics that we don't necessarily get today. Having more information about individual health would improve clinical health trials as well," he noted. He acknowledged concerns about the privacy of medical information, but remains optimistic about the ability to protect that information while also making aggregates of it usefully available.

Hospitals generally don't share the data about outcomes, Cerf stated. Such data is needed, not only to compare health care facilities and protect public health, but to improve clinical trials. "We need to understand what works and what doesn't work for certain populations being treated."

Cerf noted, too, how networked devices can be used as sensors, including mobile phones. They could do anything from sensing motion (or a lack of it), to changes in the environment or a person's health. The device also could use positioning and other data to warn of potential hazard areas.

Scolese described experiments on the medical effects of space flight and the use of the Internet to provide telemedicine, taking advantage of the controlled population on the international space station.

Díaz de la Rubia asked about the vulnerability of the Internet to cyber attack and how this might impact the future look of the Internet or regulatory frameworks that govern it.

Cerf answered that 30 years ago the technologies that might have secured the network were classified. Today it's a different story, and he reviewed number of steps being taken. The biggest weaknesses now, said Cerf, are operating systems that are still very vulnerable and browsers that are naïve. He also noted that individuals have to be responsible in their security practices.

PART 2: FINDINGS FROM TLSI DIALOGUE 3

# Conclusion

Johnson thanked the Dialogue participants and the Council on Competitiveness. He noted that many people already had volunteered to serve on working groups and thanked them for stepping forward. Little, too, thanked the participants and reminded them that the purpose of the TLSI "is not just the discussion—it's to come to meaningful conclusions and to push recommendations forward to reality."

# TLSI Dialogue 3 Participants

Dr. Ray Johnson, *Co-Chair*
Senior Vice President and Chief Technology Officer
Lockheed Martin Corporation

Dr. Mark Little, *Co-Chair*
Senior Vice President and Director of GE Global Research
General Electric Company

Mr. Mike Adams
Vice President, Corporate Strategy and Development
Constellation Energy Group

Ms. Laura Adolfie
Director, STEM Development Office, Research Directorate
Department of Defense

Mr. Montgomery Alger
Vice President and Chief Technology Officer
Air Products and Chemicals, Inc.

Mr. Samuel R. Allen
Chairman, Council on Competitiveness
Chairman and Chief Executive Officer, Deere & Company

Dr. Steven Ashby
Deputy Director for Science and Technology
Pacific Northwest National Laboratory

Mr. Thomas Ballard
Director of Partnerships Directorate
Oak Ridge National Laboratory

Mr. Tom Baruch
Council Executive Committee Member
Founder and Managing Director
CMEA Capital

Dr. Melvin Bernstein
Vice President for Research
University of Maryland

Mr. Keith Blakely
Chief Executive Officer
NanoMech

Dr. Michael Blaustein
Technology and Ventures Director
DuPont Central Research and Development

Ms. Rochelle Blaustein
Senior Advisor for Technology Transfer
Department of Energy

Dr. Thomas Cellucci
Chief Commercialization Officer
Department of Homeland Security

Dr. Vinton Cerf
Vice President and Chief Internet Evangelist
Google Inc.

Ms. Nancy Conrad
Council Member
Chairman and Chief Executive Officer
Conrad Foundation

Dr. Walter Copan
Managing Director, Office of Technology Commercialization and Partnerships
Brookhaven National Laboratory

Dr. Jim Davis
Vice Provost, IT and Chief Academic Technology Officer
Professor Chemical Engineering
UCLA

Dr. Tomás Díaz de la Rubia
Deputy Director for Science and Technology
Lawrence Livermore National Laboratory

Ms. Lesley Dickie
Director, SAP Competency Center
Raytheon Company

Dr. Spiros Dimolitsas
Senior Vice President and Chief Administrative Officer
Georgetown University

Mr. Chad Evans
Senior Vice President
Council on Competitiveness

Mr. Andrew Garman
Founder and Managing Partner
New Venture Partners LLC

The Honorable Daniel Goldin
Distinguished Fellow, Council on Competitiveness
Founder, Chairman and CEO
The Intellisis Corporation

Dr. Paul Hallacher
Director, Research Program Development
Pennsylvania State University

Ms. Sheryl Handler
Council Executive Committee Member
President and Chief Executive Officer
Ab Initio

Dr. Klaus Hoehn
Vice President, Advanced Technology and Engineering
Deere & Company

Mr. Ken Howery
Council Member
Co-founder and Managing Partner
Founders Fund

Dr. Paul Hunt
Senior Associate Vice President for Research and Graduate Studies
Michigan State University

The Honorable David Kappos
Under Secretary of Commerce for Intellectual Property and Director of the United States Patent and Trademark Office
Department of Commerce

Ms. Amy Kaslow
Senior Fellow
Council on Competitiveness

The Honorable Alexander Karsner
Distinguished Fellow, Council on Competitiveness
Chairman and Chief Executive Officer
Manifest Energy

Dr. Michael Kassner
Director of Research
Office of Naval Research

Dr. Mehmood Khan
Senior Vice President and Chief Scientific Officer
PepsiCo, Inc.

Dr. Pradeep Khosla
Dean of the College of Engineering
Carnegie Mellon University

Mr. Brett Lambert
Director of Industrial Policy, Office of the Assistant Secretary of Defense for Acquisition
Department of Defense

The Honorable Zachary J. Lemnios
Director, Defense Research & Engineering
Department of Defense

The Honorable Arun Majumdar
Director, ARPA-E
Department of Energy

Professor Reza Malek-Madani
Director of Research and Scholarship
U. S. Naval Academy

Ms. Merle McKenzie
Senior Advisor to the Associate Administrator
National Aeronautics and Space Administration

Dr. Harold Morgan
Senior Manager, Industrial Partnerships
Sandia National Laboratories

Mr. Brad Nelson
Office of the Under Secretary of Defense for Acquisition, Technology & Logistics
Department of Defense

Dr. Mark Peters
Deputy Laboratory Director for Programs
Argonne National Laboratory

Mr. James Phillips
Council Executive Committee Member
Chairman
NanoMech

Dr. Bart Riley
Founder, Chief Technology Officer and Vice President of Research and Development
A123 Systems, Inc.

Mr. Chris Scolese
Associate Administrator
National Aeronautics and Space Administration

Dr. Erik Stenehjem
Director, Industrial Partnerships
Lawrence Livermore National Laboratory

Dr. Alan Taub
Vice President of Global Research and Development
General Motors Company

The Honorable Anthony J. Tether
Distinguished Fellow
Council on Competitiveness

Dr. Tom Uhlman
Founder and Managing Partner
New Venture Partners LLC

Dr. Wolf von Maltzahn
Deputy Vice President for Research
Rensselaer Polytechnic Institute

The Honorable Deborah L. Wince-Smith
President & Chief Executive Officer
Council on Competitiveness

**ADVISORS, OBSERVERS AND COUNCIL STAFF**

Mr. Dean Acosta
Communications Director
Lockheed Martin Corporation

Mr. Bill Bates
Vice President
Council on Competitiveness

Mr. Drew Bond
Vice President, Public Policy
Battelle

Mr. Bill Booher
Executive Vice President and Chief Operating Officer
Council on Competitiveness

Mr. Aaron Fuchs
Manager, Global Initiatives
Council on Competitiveness

Ms. Becky Jaques
Research Associate
Council on Competitiveness

Mr. Mohamed Khan
Vice President
Council on Competitiveness

Mr. Sam Leiken
Vice President
Council on Competitiveness

Mr. Peder Maarjberg
Public Affairs Specialist
ARPA-E

Mr. Jack McDougle
Senior Vice President
Council on Competitiveness

Dr. Cynthia McIntyre
Senior Vice President
Council on Competitiveness

Mr. Chris Mustain
Council on Competitiveness

Ms. Mildred Porter
Council on Competitiveness

Mr. Mike Schwenk
Vice President and Director, Tech Deployment and Outreach
Pacific Northwest National Laboratory (Battelle)

Ms. Betsy Thurston
Vice President
Council on Competitiveness

Mr. Gourang Wakade
Policy Director
Council on Competitiveness

Mr. Sam Yakulis
Technical Assistant
Lockheed Martin Corporation

# Examine.

**Dialogue 4:**
**Preliminary Findings and Recommendations from the TLSI Working Groups**

**November 5, 2010**
**Lockheed Martin Center for Innovation**
**Suffolk, Va.**

# Letter from the President

On behalf of the Council on Competitiveness, it is my pleasure to release the fourth report of the Technology Leadership and Strategy Initiative (TLSI). The TLSI engages technology leaders from America's premier companies, universities and laboratories to chart a course for more effective research collaboration and greater commercialization of technologies.

The initiative is led by Ray Johnson, senior vice president and chief technology officer of the Lockheed Martin Corporation; Mark Little, senior vice president and director of GE Global Research for the General Electric Company; and Klaus Hoehn, vice president, advanced technology and engineering for Deere & Company.

This report has two parts. Part one sets the stage for the dialogue. It details the findings and preliminary recommendations of the TLSI Working Groups. I thank the working groups for their dedication and intellectual engagement that will help us turn lofty objectives into a practical pursuit of an agenda that is so important for our nation and citizens.

Part two captures the ideas put forward in the fourth TLSI Dialogue held November 5, 2010, in Suffolk, VA, at the Lockheed Martin Innovation Center. The Council thanks the entire team at the Innovation Center and Ray Johnson in particular for making it available. Participants discussed the working group proposals, helping to refine and augment them moving forward.

The Council also expresses its sincere thanks the U.S. Department of Defense for its support. The Council is committed to help the Department bring new technologies into practice faster and more efficiently—thereby strengthening America's industrial base and our national and economic security. The TLSI dialogues are designed to be an open exchange of ideas. The opinions and positions presented in this report are those of the Council on Competitiveness or the individual who offered them. The opinions and positions in the report do not reflect official positions of the Department of Defense or other government agencies.

Sincerely,

Deborah L. Wince-Smith

**Deborah L. Wince-Smith**
President & CEO
Council on Competitiveness

# Executive Summary

America's top technology leaders—representing companies, national laboratories, universities, institutional investors and government agencies—are exchanging views through a series of dialogues launched by the Council on Competitiveness' Technology Leadership and Strategy Initiative (TLSI). The dialogues have assessed the global innovation landscape and considered which laws, regulations and practices should change to make America a more competitive and productive innovator nation. TLSI Dialogue 4 is designed to home in on a set of priority recommendations put forward by four special TLSI working groups formed after TLSI Dialogue 3 in June 2010.

TLSI Dialogue 4 will take advantage of the capabilities of The Lockheed Martin Center for Innovation in Suffolk, Va. Participants will review preliminary recommendations and submit comments, ratings and/or new ideas in real time.

Council members are determined to measure the TLSI ultimately in deeds, not words. Like the Council's path-breaking National Innovation Initiative, the TLSI believes that action is needed not only from Congress and federal agencies, but from public and private stakeholders outside of the nation's capitol.

Animating the TLSI is a shared understanding of the big picture. Beyond the details of revised export control regulations, licensing practices or strategies to supply talent lays the core mission of the Council: to ensure a bright future for America, driven by strong productivity growth and a rising living standard for Americans. Commercializing and deploying new ideas in the United States produces more than profits—it generates jobs, solves great challenges and enhances quality of life.

# Part 1:
# Setting the Stage for TLSI Dialogue 4

PART 1: SETTING THE STAGE FOR TLSI DIALOGUE 4

# Introduction

One might not expect a Harvard Business School professor to impart advice such as, "If any information is to be exchanged over whiskey, let us get it rather than give it."

Harvard Business School Archives

*Georges Doriot.*

Such wisdom, however, was dispensed to a generation of American business leaders by a man who defied many expectations and changed the way companies were formed, giving America a decisive advantage in commercializing new technology. He also urged students to "always remember that someone somewhere is making a product that will make your product obsolete" and advocated a culture of continuous innovation.

Born in Paris in 1899, the father of the American venture capital industry came to the United States in 1921 to earn a Master of Business Administration. He worked at an investment bank and began teaching at Harvard. In 1940, he became an American citizen and was commissioned the following year in the U.S. Army. Throughout World War II, he served as the director of military planning, leading research and development efforts that found substitutes for critical raw materials and developed innovative items like water-repellent fabrics, better cold weather gear, sunscreen, insecticides and K-rations.[1] In recognition of his contributions, he rose to the rank of Brigadier General and was awarded the Distinguished Service Medal, the highest U.S. military award given to a noncombatant.

Brigadier General Georges Frederic Doriot was on course to change American business. After the war, he not only resumed teaching at Harvard, he co-founded and was named president in 1946 of the first modern venture capital firm, the American Research and Development Corporation (ARD), based in Boston.

ARD was envisioned as a vehicle to help revive the New England economy after the war. Doriot and his partners believed that worthy ideas and small companies with potential lacked the capital and management savvy to flourish. Budding entrepreneurs of the

1 Ante, Spencer E. *Creative Capital: Georges Doriot and the Birth of Venture Capital.* Harvard Business Press. 2008.

time were stymied by conservative bank lending practices and a scarcity of wealthy family investors. ARD ushered in a new, organized way to launch startups. It proved that a public venture firm could earn significant money by nurturing and investing in small, unproven companies.[2]

Doriot's most notable success at ARD was his investment in Digital Equipment Corporation. Over 25 years, ARD financed and nurtured more than 100 startups in many fields. ARD executives and Doriot's students would go on to establish additional venture capital firms and found major startups.

Author Spencer Ante describes Doriot as the prophet of a new "Startup Nation." He writes, "In the second half of the 20th century, the United States experienced a historic transformation, in which a society dominated by large corporations…shifted to a nation driven by venture-backed startups such as Digital Equipment Corporation, Intel Corporation, Microsoft, Starbucks and many others. Ever since, those small, innovative companies have created new markets and millions of high-paying jobs, while also forcing old industries to become more efficient and productive."[3]

The TLSI builds on Doriot's legacy and seeks to re-energize the American innovation enterprise to meet the competitive realities of today. Through its working groups, the TLSI aims to:

- Accelerate the pace and volume of technology commercialized from universities and national laboratories;
- Remove regulatory barriers throughout the innovation process;
- Ensure a supply of STEM and entrepreneurial talent to create and deploy 21st century technologies; and
- Convey the value of innovation to policymakers, students and the public.

2 Ante, Spencer E. *Creative Capital: Georges Doriot and the Birth of Venture Capital.* Harvard Business Press. 2008.

3 ibid.

PART 1: SETTING THE STAGE FOR TLSI DIALOGUE 4

# Preliminary Findings of the TLSI Working Groups

The four TLSI working groups—Accelerating Innovation, Regulation-Policy, Talent and Innovation Outreach—have hosted a series of calls during the past several months to begin organizing the ideas put forward in the dialogues and to propose recommendations for the larger TLSI to consider.

Although there is a modest degree of overlap in the group missions, each group is advancing distinct agendas that, when acted upon, promise to spur greater collaboration between innovation stakeholders and improve the productivity of such collaboration.

This report summarizes the efforts of the working groups to date. The working group chairs and the Council welcome the feedback of TLSI participants to augment and refine the ideas presented.

PART 1: SETTING THE STAGE FOR TLSI DIALOGUE 4

# Talent Working Group

**Mission:** Develop world class talent to fuel innovation.

The TLSI Talent Working Group is aware that many groups across the country focus on talent issues, particularly those related to STEM talent. Rather than launching a new initiative, the working group aims to put forward a few fresh ideas and to promote or partner with promising initiatives.

The Talent Working Group is coordinated with the other TLSI working groups. Participants are aware that the Accelerating Innovation Working Group will table recommendations related to entrepreneurial skill gaps and that the Regulation-Policy Working Group will address issues related to immigration, visa and ITAR policies that limit America's ability to benefit from highly-skilled foreign nationals.

**Overview:** Working group members noted a number of outstanding programs.

The Learn to Compete Initiative (Figure 4) is the Council's primary program to expand the pipeline of STEM talent. Launched earlier this year, the initiative is identifying replicable P-12 education models with proven track records and will promote the establishment of additional schools across the country that employ those models.

DonorsChoose.org offers an online tool that connects teachers seeking supplies or project support with donors worldwide.

Northeastern University has a long-standing co-op program under which students alternate semesters of academic study with semesters of full-time employment related to their interests. Similar forms of experiential learning where students work at companies, labs or venture firms could help teach commercialization skills and knowledge that is difficult to convey in a classroom setting.

The Conrad Foundation sponsors the Spirit of Innovation Awards. High school students are challenged through competitions to use science and technology to create real products in aerospace, clean energy and cyber security. Winning teams receive cash prizes and support to develop their product.

Many working group members expressed interest in learning more about the Change the Equation Initiative and possibly having the Council partner with them. Under Change the Equation, more than 100 major companies are coordinating their efforts related to STEM education. The organization's first year goals are to:

- Begin spreading a small number of programs that work to 100 sites across the country where student performance is low and corporate philanthropy is limited;
- Create a scorecard to assess STEM education in all 50 states. This first scorecard will provide a baseline from which to measure states' progress in coming years;
- Identify and share principles for effective business involvement in STEM education;
- Help its member companies improve their own programs through self-evaluation tools; and
- Be a leading advocate for STEM education in the United States.

Similar to the Change the Equation goals, the working group also noted that the federal government would benefit from an inventory and assessment of the many STEM education programs authorized across the government. A recent inventory at the Department of Defense identified at least 130 STEM efforts just within the Department. Analyzing which programs are working well and where gaps might exist in preparing students and teachers would very likely improve the overall effectiveness of federal efforts.

The Talent Working Group also is discussing the role of community colleges and their role in innovation and commercialization. Community colleges typically serve an older and more diverse population and often have relationships with other local universities. Community colleges also tend to be tuned in to the needs of its community and can help fill skill gaps, be they for certified technical workers or skilled tradesmen like welders and electricians.

**Figure 4: The Council's Learn to Compete Initiative**

The newly launched Learn to Compete Initiative identifies and promotes highly replicable, scalable and affordable P-12 education models with well-established track records. These best-of-breed models feature STEM-infused curricula, collaborative problem solving and creative solutions.

Learn to Compete models do more with less and can affect change quickly. Among the exemplars is a Northern California K-12 school in its ninth year that serves a majority minority population of 1,200 children.

Students move through an inter-disciplinary, experiential approach based on mastery, not pace. Technology is a means, not an end, and the online curriculum enables teachers to share their improvements in real time. Graduation requirements include 200 hours of internships and summon a powerful sense of "can do" in students, who engage with mentors in their chosen fields (they work on science labs, on factory floors, in architectural engineering firms, with patent lawyers, as welders' assistants, in medical centers, etc.)

The results include:

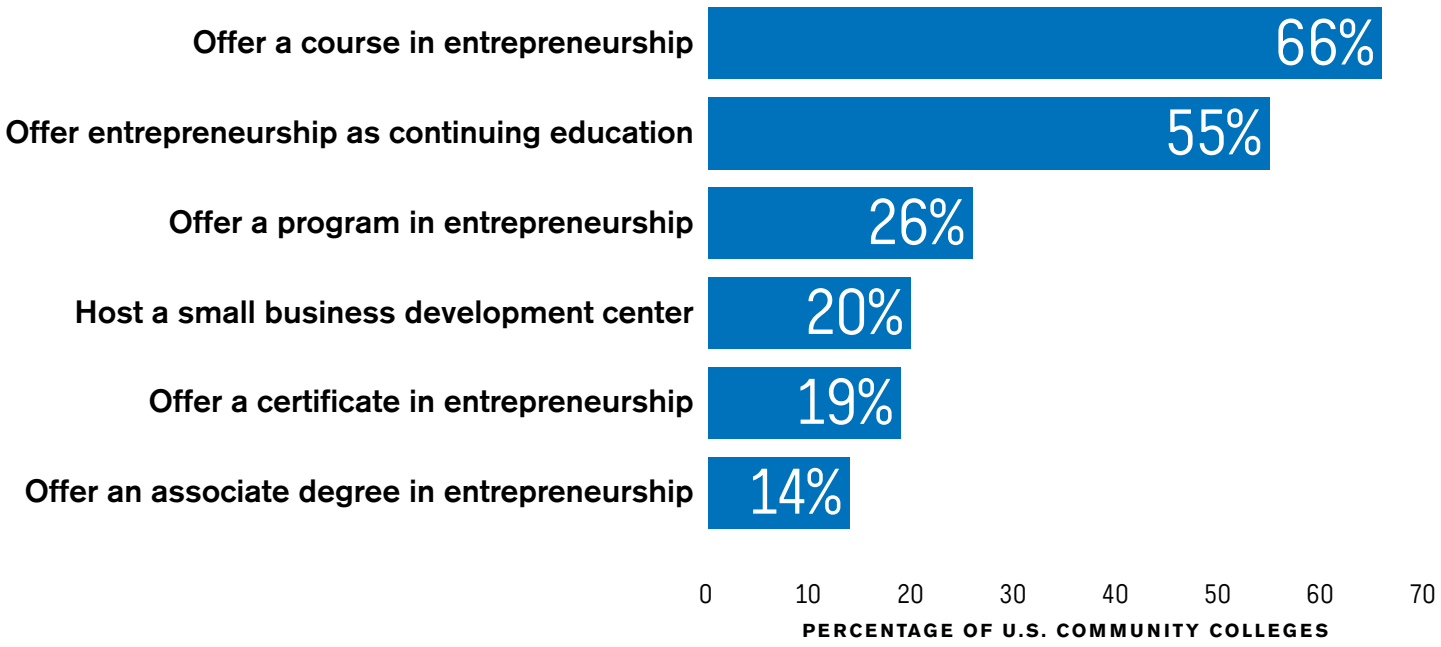
- Higher test scores than other public schools;
- Lower cost per student;
- No drop outs, no social promotions;
- Life skills: financial literacy, entrepreneurship and responsibility in the workplace;
- Students with a first career path, graduating with connections and sometimes a job; and
- College credits earned in high school by most students.

The aim of the initiative is to build innovation pipelines of scientists, technologists, engineers and mathematicians by establishing a Learn to Compete school in every state capital and in the shadow of every national and defense lab.

The working group suggested that the Council could survey its university members on their relationships with community colleges and the role community colleges play in innovation. If there is significant interest, the Council could convene a meeting to explore how community colleges could be leveraged more effectively for technology commercialization. The American Association of Community Colleges is a national affiliate member of the Council.

Finally, the working group has discussed the role of mature workers in filling critical skill gaps. The Council provides technical and policy assistance in 10 states under the Department of Labor's Aging Worker Initiative. Older workers in STEM fields also can serve as mentors for new talent, in many cases supporting women and minorities who are underrepresented in many technical fields. Retired STEM professionals might even serve in elementary schools, somewhat like an adjunct professor, for one or two periods per day.

**Figure 5: U.S. Community Colleges and Entrepreneurship**
Source: National Association for Community College Entrepreneurship, based on 2007 study by the University of Illinois



PART 1: SETTING THE STAGE FOR TLSI DIALOGUE 4

# Accelerating Innovation Working Group

**Mission:** Improve the speed and number of ideas that move from laboratory to market, including government markets.

The Accelerating Innovation Working Group is pursuing its mission in three stages. First, participants have produced a draft list of objectives (Figure 1) that seek to overcome the larger stumbling blocks to commercialization perceived by the group. Second, under each objective the working group will insert a series of recommendations that are specific enough to be actionable. Many preliminary ideas have emerged from the exchanges between members and are reflected in Figure 2.

Finally, where data is available, the working group intends to offer evidence of why its recommendations should be priorities and/or would be effective in achieving the group's mission.

**Overview:** Most of the recommendations of the Accelerating Innovation Working Group center on how to commercialize more ideas from national laboratories and universities. Central to that challenge is encouraging greater collaboration with industry and investors, particularly by engaging on commercial terms with more rapid cycle times from lab to market.

Members made clear their continued support and appreciation of pure, discovery research that advances knowledge without a clear commercial objective. Whether by design or good fortune, however, a great deal of research at universities and government labs has potential value to meet private or government demand. In those cases, the commercialization process has underperformed, hampered by practices and policies that too seldom spark collaboration with industry or attract investment, often fail to bring key skill sets into the process, and impose burdensome cost and delays.

The working group identified attributes that are most likely to breed success, such as engaging broad communities around clearly defined outcomes and negotiating quickly the terms of collaboration. Each party should have a realistic sense of the value they bring to the endeavor and structure incentives to favor collaboration and commercialization. Successful commercialization efforts typically have a champion technologist who draws on many skills outside his or her area of expertise. Such individuals should be encouraged and efforts should be made to train champions of the future.

Arching over the innovation / commercialization effort is a body of laws, regulations and funding decisions that influence a project's long-term stability, available resources, capital requirements, talent supply, intellectual property protection and time to market.

The Accelerating Innovation Working Group raised some of these policies, recognizing that their work would likely dovetail with recommendations put forward by the Regulation-Policy and Talent working groups.

The Sarbanes-Oxley Act enacted in the wake of corporate scandals in 2002 is one example and a good transition to the work of the Regulation-Policy Working Group. Large firms have been able to absorb the higher compliance costs associated with the law, but the negative impact on smaller firms has been severe, requiring them to raise significantly more capital before they can make an initial public offering (IPO).

**Figure 1: Accelerating Innovation Objectives**

1. **Define shared outcomes that motivate and coalesce teams.** The outcome must be specific and clearly understood by all team members. The technical requirements and schedule must be agreed upon with meaningful milestones. By focusing all members of the team on a shared outcome, there is less chance for stovepiping and a greater probability of success.
2. **Build communities focused on shared outcomes.** Bring together researchers, entrepreneurs, economic development professionals and venture capitalists from industry, academia and government (including federal and national labs) to work together seamlessly. All members must be engaged from the start to ensure proper focus and ultimate success.
3. **Agree upon the value proposition.** All participants must understand the true value of their contribution to the proposed commercial enterprise. Universities and labs must realistically value their intellectual property, and companies must understand how universities and labs can fit into their business models.
4. **Provide stability with respect to expectations and resources.** Participants need to know that the rules will not change in the middle of the game. This allows them to plan ahead and to commit leveraged resources with reduced uncertainty. This is especially important for longer-term collaborative R&D.
5. **Bridge the gaps within the innovation pipeline.** The innovation pipeline consists of three distinct phases: discovery, development and commercialization. Each typically requires a different skill set and personality type. To accelerate innovation, it is necessary to more rapidly progress from one phase to the next. This requires bridging the gaps at the interfaces. In particular, one must bridge both the discovery-to-development gap as well as the development-to-commercialization gap (aka the valley of death).
6. **Create an innovation-friendly regulatory environment.** Government must revamp regulations that impede innovation. This includes knocking down barriers to the creation of public companies, especially early stage investment, and ensuring the protection of intellectual property via an overhauled patent process.
7. **Enable the sharing of intellectual capital and property.** Institutional barriers to the sharing of people and their ideas (that is, intellectual property) must be eliminated. Too much time is spent on setting up the collaboration as opposed to collaborating.
8. **Identify and nurture entrepreneurial champions.** Foster entrepreneurial talent at all career stages, but especially early in the training of students in science, engineering, business and law, to prepare the next generation of innovators. These people must be interdisciplinary in their thinking and persistent in the pursuit of their visions. Institutions must put in place proper reward structures, including incentives, to encourage the development and interaction of such talent across the disciplines.

**Figure 2: Accelerating Innovation Preliminary Recommendations**

### 1. Define shared outcomes that motivate and coalesce teams

- government agencies should offer more detailed technical specifications, with clear milestones and an estimate of the market potential of the technology
- increase federal dollars devoted to use-inspired research, i.e. basic research that is informed by a market pull or public need
- structure government-sponsored competitions in order to tap the resources and ingenuity of private entities to help achieve public goals more efficiently

### 2. Build communities focused on shared outcomes

- establish "openness" procedures at labs and universities to engage potential partners and make information on research projects available
- universities and labs should jointly market their technologies through large consortia
- invite investor and industry representatives regularly to research facilities and establish policies and programs that encourage researchers to engage partners outside the lab or university environment
- agencies and industry should reach out to universities and labs regularly, communicating their needs at early technology readiness levels
- create multidisciplinary teams that draw on a variety of technical and business disciplines
- coordinate federal funding streams to innovation hubs that center on a particular set of challenges and condition hub location on funding and policy support by state and local governments

### 3. Agree upon the value proposition

- labs and universities should utilize technologies that streamline negotiation of agreements and navigate legal issues more quickly, yet still allow flexibility to meet the commercial realities of different collaborations
- labs and universities should pursue more flexible IP policies that value industry engagement over license revenue
- the National Academies or other independent groups should study how value is created across the innovation process from invention to commercialization

### 4. Provide stability with respect to expectations and resources

- make the R&D tax credit permanent
- prioritize R&D investments, including basic research, in the federal budget versus other spending options, recognizing the return on that investment in sustained job creation and economic growth

### 5. Bridge the gaps within the innovation pipeline

- establish links in labs and universities to a pool of diverse talent beyond technical disciplines, including design, development, manufacturing and marketing
- universities should establish regular interactions between their engineering & business schools, venture firms, and companies
- state and local officials, local chambers of commerce , and research institutions should offer regular forums and incentives to engage angel investors and venture firms with local researchers

- train and attract more individuals skilled in developing and running software to model, simulate, validate, and test on multiple projects
- support efforts to evaluate and improve the art of teaching commercialization

### 6. Create an innovation-friendly regulatory environment

- reform Sarbanes-Oxley regulations to lower compliance burdens on smaller firms, thereby enabling more IPOs
- institute changes to the patent process that reduce backlog, provide clarity and reduce cost
- continue to tax carried interest at the long term capital gains rate, rather than raising the tax and discouraging venture investment
- develop better innovation metrics, particularly those that measure innovation outcomes, in order to drive better public policies and management practices by all innovation stakeholders
- offer universities supplemental grants and/or flexibility on the current cap on reimbursements for administrative costs in order that they may fund more robust tech transfer functions and work related to proof of concept, market analysis, or mentoring
- modify the R&D tax credit to allow industry to take a full credit for research investment performed outside the company in partnership with a university or lab

### 7. Enable the sharing of intellectual capital and property

- ease restrictions on how labs and universities may share IP across partner organizations
- eliminate restrictions on project-based sharing of human resources, allowing for multiple forms of collaboration
- encourage universities to use more creative financial models, including windfall pricing, for transferring intellectual property

### 8. Identify and nurture entrepreneurial champions

- establish new performance goals and incentives at labs and universities (including tenure reform) that reward commercialization
- evaluate performance incentives and tech transfer policies across the United States and overseas to identify best practices
- establish formal procedures for lab and university employees that ease their ability to establish firms and transition to the private sector
- teach entrepreneurship to engineering students, as they are most frequently the future champions of new technology enterprises

Paul Holland, representing the National Venture Capital Association, testified before a House subcommittee in March that "the need for capital does not end with venture investment. The goal of many venture-backed companies is to one day thrive as a publicly traded entity. However, the last decade, and the last three years in particular, have been especially hard for venture-backed IPOs…While much of this lackluster environment can be attributed to the financial crisis and skittish investors, we believe that there are fundamental structural issues that need to be more closely examined. The implementation of Sarbanes-Oxley, the separation of research and investment banking, and decimalization—among other factors—have all contributed to a market that is not receptive to small cap IPOs…(Venture capitalists) will spend more time with existing companies, wait longer to take them public and complete fewer new deals. We do not want these good companies to wither on the vine if we can jump start the IPO market once again."[4]

4 Holland, Paul. Supporting Innovation in the 21st Century Economy. Testimony before the House Subcommittee on Technology and Innovation. March 24, 2010.

PART 1: SETTING THE STAGE FOR TLSI DIALOGUE 4

# Regulation–Policy Working Group

**Mission:** Lower the barriers to commercialization by reforming federal laws and regulations to make commercialization less expensive, faster, better incentivized and more coherent.

The Regulation-Policy Working Group is organizing its work along two broad paths. First, it is examining U.S. policies that impact innovation and collaboration between stakeholders. Second, it is reviewing policies pursued in other nations and comparing them to those of the United States.

**Overview:** The group recognizes that several groups have issued reports recommending policy changes to create a more supportive policy environment for innovation and commercialization. Members began their work by reviewing a 2008 report issued by the President's Council of Advisors on Science and Technology (PCAST), on which a number of Council members served. The report focused on university-private sector partnerships and issued recommendations (Figure 3), from which the working group identified five priorities:

- maintain federal support for basic research;
- update and enhance the R&D tax credit;
- develop guidance and educational tools on IP and tech transfer practices for university and private sector partners;
- modify or clarify tax-exempt policies that may deter industry-supported research on university campuses; and
- improve tools and metrics to measure the outputs of innovation to guide policies and incentive structures.

Many regulations that apply to university-industry partnerships either conflict, lack coordination, or breed confusion.

The PCAST priorities flagged by the Regulation-Policy Working Group are consistent with points raised by the Accelerating Innovation Working Group. Like PCAST, TLSI participants emphasize the importance of federal investment in basic research and the R&D tax credit.

PCAST also urged that the Department of Commerce lead an effort through the multi-agency National Science and Technology Council to engage stakeholders and develop guidance to facilitate better tech transfer between federally funded universities and industry.

The Treasury and the Office of Science and Technology were encouraged to lead a task force to assess tax exemption issues and suggest reforms. Some Internal Revenue Service (IRS) policies, noted PCAST, outline conditions under which universities may accept funding from the private sector to support research in facilities built utilizing tax-exempt bonds. The IRS requirements were found to conflict with other regulations, limit assigning IP rights in potential collaborations, deter university use of tax-exempt bonds and act as a barrier to establishing partnerships.

**Figure 3: 2008 PCAST Report—University-Private Sector Research Partnerships in the Innovation Ecosystem**

| Recommendations | Lead Agency or Agencies |
|---|---|
| Maintain the essential role of the federal government to support basic research | Multiple agencies |
| Update and enhance the R&D tax credit | Treasury |
| Develop guidance and educational tools on IP and tech transfer practices for university and private sector partners | Commerce, in coordination with National Science and Technology Council |
| Modify or clarify tax-exempt policies that may deter industry-supported research on university campuses | Treasury, in coordination with OSTP |
| Develop a task force to assess other tax policies impacting innovation | Commerce in lead with other agencies |
| Enhance federal-state coordination to promote innovation and university-private sector partnerships | Commerce, Energy, Education, NSF, NIH, and OSTP |
| Streamline oversight structures and conflict of interest requirements while ensuring the integrity of research and preserving public trust | National Science and Technology Council |
| Evaluate the impact and scalability of open innovation models | National Science and Technology Council |
| Federal agencies should expand the use of prizes to address certain challenging research questions | Multiple agencies |
| Build on successful university, government and private sector initiatives to enhance research partnerships | NSF and Commerce |
| Enhance opportunities and incentives for researchers to move between academia, industry and government | Multiple agencies |
| Develop improved tools and metrics to measure the outputs of innovation to guide policies and incentive structures | Multiple agencies |

The Regulation-Policy Working Group confirmed that many regulations that apply to university-industry partnerships either conflict, lack coordination or breed confusion. Participants urged a review and coordination of U.S. rules established by intellectual property law, the Bayh-Dole Act, IRS regulations and the export control regime.

The final priority flagged in the PCAST report was to develop improved metrics to assess innovation outputs. The working group supports such efforts, noting examples like the STAR METRICS initiative. The Council, through its flagship benchmarking product—the *Competitiveness Index*—will focus in this space in 2011.

The Regulation-Policy Working Group also identified priorities not included in the PCAST report, such as:

- Reforming International Trafficking in Arms Regulations (ITAR) control lists that often cede U.S. leadership in technologies because the lists do not keep pace with market realities. The White House issued a plan in August 2010 to revamp ITAR controls.
- Reducing ITAR restrictions on foreign born students participating on certain research projects. TLSI participants understand the need to restrict access to projects that have clear national security implications, but believe current restrictions apply beyond that threshold.
- Expanding H1-B visa quotas and awarding green cards to foreign-born students earning degrees at U.S. universities in science, technology, engineering and mathematics (STEM) disciplines.


The **STAR METRICS Initiative** is a federal and university partnership—led by NSF, NIH and OSTP—developing an empirical framework to measure the outcomes of science investments. Measures are being developed in four broad categories: (1) economic growth, (2) workforce outcomes, (3) scientific knowledge, and (4) social outcomes.

- In reviewing international differences in innovation policy, the working group found a wide variance in the metrics used to compare national innovation performance and potential, many of which were not tightly linked to actual value creation. In general, however, many reports note that aggressive investment and policy reform—such as in China—coupled with little reform in the United States has resulted in a slippage in American leadership.

One widely cited study found that although the United States ranked 6th in innovation performance across 16 metrics, it ranked last among 40 countries in progress made on those metrics during the past few years.[5]

5 Atkinson, Robert and Andes, Scott. The Atlantic Century, Benchmarking EU & US Innovation and Competitiveness. Information Technology and Innovation Foundation and the European-American Business Council. February 2009.

The working group noted differences internationally in how governments address the "valley of death" issue where American entrepreneurs struggle to sustain funding that bridges the gap between basic research and applied proof of concept work. The United States has traditionally refrained from investing public funds in this area, not wishing the government to pick winners and losers in the marketplace. A few programs, such as the Defense Advanced Concept Technology Demonstrations, perform this function to achieve a public need, but generally America leaves this role to the private sector.

Many governments overseas, however, do invest heavily in this type of bridge funding in an effort to capture leadership in strategic industries. If the United States chooses not to make these types of investments, the working group suggests that it offer incentives aimed at increasing the flow of angel and venture capital to help more entrepreneurs cross the valley.

The Regulation-Policy Working Group deferred to the Talent Working Group on a frequent concern raised in international innovation comparisons—the development of STEM talent and the performance of U.S. secondary students on international math and science assessments.

PART 1: SETTING THE STAGE FOR TLSI DIALOGUE 4

# Innovation Outreach Working Group

**Mission:** Tell the innovation story to key audiences—particularly policymakers, students and the public.

The Innovation Outreach Working Group agreed to identify a limited number of activities that would have a measurable impact. At this stage, the group's focus is on policymaker and student outreach. Success on those fronts can be leveraged for more general public outreach.

**Overview:** *Policymakers*—Outreach on innovation to policymakers has a number of dynamics, including:

- which lawmakers and officials are most strategic;
- how to operationalize the effort;
- how would success be measured; and
- what is the message to policymakers.

The working group discussed each of these questions.

Many of the TLSI recommendations will require action by federal government officials or members of Congress. The Council can organize events and meetings to educate officials and lawmakers about TLSI issues. For example, the Council could host a series of events with the various agencies that oversee the thicket of regulations (IP, ITAR, Bayh-Dole, IRS) flagged by the Regulation-Policy Working Group as impeding university-industry partnerships.

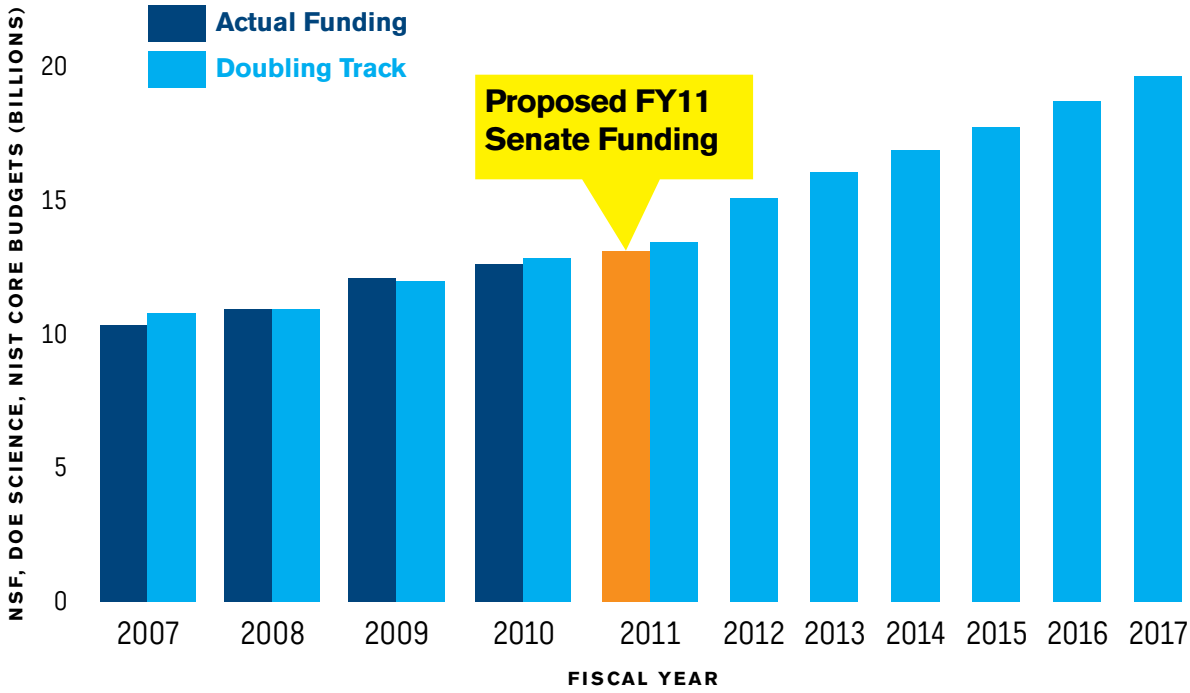
The Innovation Outreach Working Group is particularly interested in Congress. The 2010 elections are expected to bring a large number of new lawmakers to Washington who will be largely unfamiliar with innovation-related issues. The group suggests two strategies that would reach out to members of Congress, focusing first on new members, the leadership, and the chairs of key committees and subcommittees. The first strategy would be for the Council to organize events and meetings in Washington with target members, much as it would with administration officials.

The second part of the strategy is more far reaching—creating permanent structures to educate members of Congress in their home states and districts about science, innovation and commercialization. The idea is to create advisory councils that would draw on local business, university and investor communities to educate a member of Congress about innovation in their backyard and to link that activity to federal policy decisions. In many cases, the creation of such councils could be a matter of connecting a few existing groups and having one or two of the groups organize the advisory council and manage its activities. As with outreach in Washington, the development of such councils could focus first on new members, the leadership, and key committee and subcommittee chairs.

Successful outreach should be measured not by the number of meetings or groups established. Success should be measured in policy outcomes. For example, the TLSI supports the pledge made by Presidents George W. Bush and Barack Obama to double funding by fiscal year 2017 for the National Science Foundation, the Department of Energy's Office of Science, and the research and construction budgets of the National Institute of Standards and Technology. Progress toward that goal can be measured in each fiscal year (Figure 6).

The working group plans to develop messaging for policymakers that can be shared widely. Ideally, such messaging would have a few key components and

**Figure 6: Progress Toward Research Funding Pledge**
Source: Innovation Advocates, LLC




be kept as short and lay-person friendly as possible. Message components for a member of Congress should include:

- Background on the innovation / commercialization process, including things like how it works in general, who are the actors, and who funds and performs different activities. Many members of Congress and their staffs, for example, are not familiar with distinctions between basic research, applied research, and development;
- Why they should care. The role of innovation / commercialization should be explained in terms of job creation, company formation, great challenge solutions and U.S. competitiveness—with examples. Offering a local example from the member's home state or district is very valuable; and
- What they should do / what policy change is needed. Members and staff want and expect "The Ask." This part of the message will often vary depending on the member's committee assignment

The Council is developing draft messages that will be reviewed by the working group and the larger TLSI. The Council also has strong relationships with communications and design firms that can help hone the messaging for maximum impact and effectiveness.

*Students*—Given the number of private and government programs that work to encourage students to consider careers in science and technology, the working group has discussed how it might highlight some of the top programs and evaluate the effectiveness of their approach and messaging.

The group noted the Conrad Foundation's Spirit of Innovation Awards, supported by Lockheed Martin and others, and the People's Choice Awards given by the Intel International Science and Engineering Fairs. Participants also praised a number of corporate programs to reach students, noting that many firms have invested significant resources to develop and assess such programs. The working group encourages the Council to act as a forum to collect and disseminate some of the best ideas on this topic from its membership.

*Public*—The Innovation Outreach Working Group believes that it can leverage work with policymakers and students to inform the public of innovation / commercialization issues. For example, local science and innovation advisory councils could follow up on their sessions with lawmakers by meeting with the editorial board of local media sources, generating greater awareness of the importance of these issues to local economies and building support for action by policymakers.

Similarly, promoting the achievements of students in these fields through media sources can establish the public's perception of those students and innovation in general as a hopeful part of their future. Johnson introduced the chair of the Talent Working Group, Mel Bernstein, vice provost for research at Northeastern University. Bernstein emphasized that the working group understands the importance of its subject matter. "At the end of the day, the nation and the world will survive and prosper based on our ability to invest in people, prepare them for the changes that are occurring, and give them the tools they need."

# Part 2: Findings from TLSI Dialogue 4

PART 2: FINDINGS FROM TLSI DIALOGUE 4

# Opening Remarks

Ray Johnson, senior vice president and chief technology officer for the Lockheed Martin Company, welcomed the dialogue participants to the Lighthouse facility. He explained that Lockheed Martin designed the facility to enhance innovation. It enables in-person and networked collaboration between the company and its customers and partners. Most innovation occurs across disciplines, Johnson explained, and "most warfare challenges require multidisciplinary systems."

Chad Evans, senior vice president with the Council on Competitiveness, extended thanks to the Lockheed team for offering the collaboration tools of the Lighthouse to the TLSI. Tools which enable a more robust capture of ideas and encourage greater interaction. For example, the Lighthouse collaboration tools enabled TLSI Dialogue 4 participants to access supporting documents, submit comments and questions, and interact through threaded conversations in real time as the dialogue was in progress.

PART 2: FINDINGS FROM TLSI DIALOGUE 4

# Talent Working Group

Johnson introduced the chair of the Talent Working Group, Mel Bernstein, vice provost for research at Northeastern University. Bernstein emphasized that the working group understands the importance of its subject matter. "At the end of the day, the nation and the world will survive and prosper based on our ability to invest in people, prepare them for the changes that are occurring, and give them the tools they need."

Bernstein relayed that the working group recognizes that several groups are working to address talent issues related to K-12 and STEM (Science, Technology, Engineering and Mathematics) education. "There are a tremendous number of studies and reports that have gone before us," he stated. The Working Group decided to promote noteworthy efforts and programs and to focus its energies on a smaller set of priority issues where the Council might have an impact.

### Promote High-Potential STEM Talent and Entrepreneurial Initiatives

Bernstein reviewed some of the programs highlighted by working group members, including the Council's Learn to Compete initiative (summarized in part 1 of this report, along with other programs of interest). He noted that universities and companies run numerous programs designed to engage and improve STEM education at all levels.

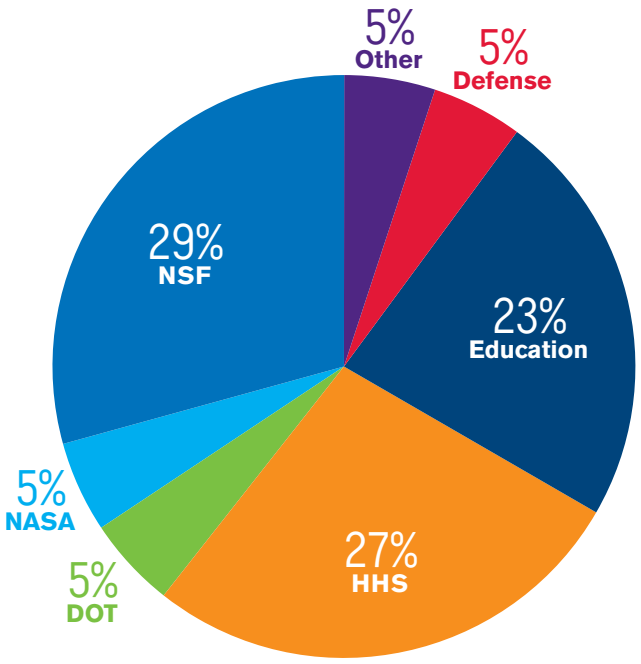
The federal government also has made several attempts to promote, incentivize and replicate successful local education models nationwide (e.g. Race to the Top, No Child Left Behind). Those efforts must continue, Bernstein observed, but policymakers and educators still face many complexities in measuring and assessing the benefits of such programs.


*Mel Bernstein, Northeastern University.*

Bernstein also shared study results that counted the number of federal STEM programs to be roughly 100-200, depending on how they are counted. Both studies[6] found the annual funding for those programs to be approximately $3 billion. The largest funding sources are the Health and Human Services Department, the National Science Foundation and the Education Department (Figure 7). The studies reinforce that the United States has enormous investments in these areas, Bernstein said, "a rich environment with support from the federal government, the states and companies. The real issue is how do we make the whole greater than the sum of its parts?"

6 US Government Accountability Office, *Federal Science, Technology, Engineering, and Mathematics Programs and Related Trends*, GAO-06-114, October 2005 and US Department of Education, *Report of the Academic Competitiveness Council*, 2007.

**Figure 7. Funding Sources for Federal STEM Programs**
Source: Government Accountability Office




"As the largest part of the nation's higher education system, community colleges enroll more than 8 million students and are growing rapidly. They feature affordable tuition, open admission policies, flexible course schedules… and they are particularly important for students who are older, working or need remedial classes. Community colleges also work with businesses, industry, labor and government to create tailored training programs to meet economic needs like nursing, health information technology, advanced manufacturing and green jobs."

**President Barack Obama**
October 5, 2010
White House Summit on Community Colleges

## Leverage Community Colleges for Innovation

The working group also considered the role of community colleges. Bernstein noted the rapid enrollment growth at community colleges and explained that they offer an important bridge for many students to transition into a four-year college or university. Most universities have articulation agreements with community colleges, whereby a curriculum is offered for strong students to move seamlessly into the university community.

"We believe that community colleges are an untapped resource for the U.S.," Bernstein said. President Barack Obama, reminded Bernstein, is promoting increased investment in community colleges to leverage their capabilities. He also noted community college efforts to foster entrepreneurship help people in small businesses.

## Enable Mature Workers

The working group is discussing the importance of mature workers. "The drive towards innovation, creativity and worldwide marketplaces are usually described in terms of productivity increases and the ability of workers to change," Bernstein observed, "That's not going to happen without significant effort and investment." He challenged TLSI participants to

consider how to engage mid-career and late career workers so they can gain or teach skills needed for a technology-driven economy. "We have a large, vital group of people who are struggling to be in the workforce."

## Discussion

Johnson thanked Bernstein and kicked off the discussion. Johnson noted the inventory of STEM programs and wondered how good a return Americans are getting for their investment. Part of the solution, he suggested, would be to do a better job of instilling a passion for STEM fields in students' minds and making stronger linkages to future jobs. One of Lockheed Martin's contributions to that challenge, he said, was the corporation's sponsorship of the USA Science and Engineering Festival.

Jim Phillips, chairman of NanoMech, also asked about the number of STEM programs, wondering whether the inventory of programs has changed substantially and calling for some kind of central control or strategy to manage the inventory more effectively. Bernstein replied that the number of programs has probably not changed very much and agreed that there has been a natural desire in Washington "to keep evaluating and assessing rather than making decisions."

*Update: after the TLSI 4 Dialogue, the White House Office of Science and Technology Policy released a new inventory of STEM education programs and plans to release a STEM strategy in January 2012. The 2011 inventory counted 252 STEM programs across 13 federal agencies valued at $3.5 billion annually.*

Bernstein observed that despite a rich pool of data, it remains difficult to analyze workforce needs on a national basis and train students accordingly—particularly in science and engineering disciplines.

Nancy Conrad, chair and CEO of the Conrad Foundation, returned to Johnson's theme of instilling passion in students for science and entrepreneurship. "A core part of the problem is we've got an old system in which we just push facts into kid's heads. It's hard to generate that passion when all you do is take a test and spit out facts," she asserted. Conrad believes that there are opportunities to adjust how we teach children to encourage passion and creativity, particularly through a greater emphasis on problem solving.

Phillips inquired about community college programs to teach entrepreneurship. "Is there a way," he asked, "for entrepreneurs in the community to teach those classes so students get a true sense of what it's like to start up a business from people who are experienced doing it?" Phillips stated that there is a shortage of teachers with that knowledge set and wondered whether the TLSI could catalyze action on this point. He expressed concern that community college graduates may be trained, but still lack knowledge of "how to start up a business, whether it's a dry cleaner or a tech start up."

Bernstein endorsed the idea and speculated that some level of entrepreneurial instruction as Phillips described does occur in some community colleges. Bernstein noted that community colleges rely more on part time instructors and practitioners than traditional colleges and universities. But, like most of the American educational system, Bernstein observed,

efforts are highly localized and probably vary widely across the country. Phillips believed that more business leaders would like to be engaged in teaching entrepreneurship than are now engaged with community colleges and reiterated that this could be an opportunity for the Council to lead.

Johnson asked for thoughts about whether more parents today are encouraging students with lesser academic backgrounds to pursue a university education, when those students might be better served by a trade school or community college. Might those students, he posed, be better off entering the workforce as skilled laborers rather than earning a degree that does not confer workforce skills. He added that the answer to his question might depend on America's future in manufacturing.

"Certainly, I would not argue against people studying philosophy," Bernstein replied, "but I agree that there is a need for students to understand what their education is preparing them for." Universities should offer students a picture of the outside world in various fields, he noted, and he believed universities have moved a long way to address that need.

Phillips urged TLSI participants to view video and other materials related to *Two Million Minutes*, a documentary developed by Bob Compton. Two million minutes is the time a student spends in junior high and high school. The documentary compares how those minutes are spent in China, India and the United States. Students are interviewed about their daily activities and what is important to them. Students from China and India in the documentary were more focused on academics in general, and STEM disciplines in particular, Phillips said.

Andy Garman, founder and managing partner of New Venture Partners, shared what he has observed as a board member of Harvard's School of Engineering and Applied Sciences. "We had the chance to spend the day with a number of faculty members teaching some of the more broadly attended courses there. There is an explosion of interest amongst the Harvard undergraduates in computer and applied science courses there. I think the driving reason is that a few professors have rethought the whole pedagogy. In the old science teaching model, somebody stood up at the blackboard and wrote equations, and then students went home and solved problems. They're not doing that anymore," he said.

Garman described a collaborative classroom environment where students are challenged with sophisticated thinking problems. The students then break into groups to work out solutions in discussions facilitated by professors. "It's exciting, what they're doing there," Garman emphasized. Part of the STEM solution, he suggested, is retraining sciences and engineering teachers to energize students into selecting those disciplines. Conrad agreed, and noted that improved teaching methods are being adopted more rapidly in colleges than in K-12 grades.

PART 2: FINDINGS FROM TLSI DIALOGUE 4

# Accelerating Innovation Working Group

Keith Blakely, chief executive officer of NanoMech, led the conversation for the Accelerating Innovation Working Group. He noted that the group's mission is to improve the movement of ideas from labs to market and acknowledged the leadership of Steven Ashby, who chairs the working group and is the deputy director for science and technology at the Pacific Northwest National Laboratory.

Blakely explained that the working group has developed a set of objectives and several recommendations to achieve them. (The objectives and recommendations are detailed in the first part of this report.) The group plans further work to refine, narrow and prioritize the recommendations.

Blakely reviewed the objectives and highlighted several of the recommendations. He discussed, for example, the value of government-sponsored competitions to develop technology applications, and the promise of federal innovation hubs that marshal funding streams from several agencies to achieve a critical mass of people and resources devoted to common objectives in a distinct geographic area.

The Accelerating Innovation Working Group also is encouraging flexible IP practices that favor greater industry engagement, steady federal investment in research and development, and relief for smaller firms from the regulatory compliance costs of the Sarbanes-Oxley law that hinder initial public offerings.

## Discussion

Paul Hallacher, director of research program development at Penn State University, asked whether the working group had discussed fairness in how technologies are transferred from federal labs. Blakely responded that the working group had not taken that issue up specifically, but recognizes the challenge of ensuring that policies are not biased toward large or small companies. He noted the human element in finding a path to market and expressed hope that the multiple improvements put forward will create a more level playing field.

Bernstein alerted the group to a new report issued by the National Academies entitled *Managing University Intellectual Property in the Public Interest*. If adopted, many of the report recommendations would be game changers, he said. Bernstein read a passage from the report (Figure 8) that advocated new licensing practices for universities.

Over the last number of years, Bernstein said, several universities have begun to think more creatively about how intellectual property is handled and are showing greater flexibility. "If we had an environment where interesting advances supported by industry were part of the educational research objectives, it would be much easier to agree on the IP issues."

Blakely agreed and noted that many universities are seeing the value of organizations that have close ties to the university, but are outside of the university bureaucracy and act as a middle man between the institution and other key actors in the financial, industrial or entrepreneurial community. "If universities find creative ways to work with those organizations,"

*Chris Mustain, Council on Competitiveness, with Jim Phillips and Keith Blakely, NanoMech.*

**Figure 8.**
Source: *Managing University Intellectual Property in the Public Interest*, The National Academies

"Patenting and licensing practices should not be predicated on the goal of gaining significant revenue for the institution. The likelihood of success is small, the probability of disappointed expectations high, and the risk of distorting and narrowing dissemination efforts is great."

Blakely said, "they are much more effective in creating licensing value for themselves later on through economic growth in a particular area."

Phillips complimented the working group for synthesizing several high-quality ideas. He emphasized that a key innovation hurdle at universities is that the chief advancement incentive for professors is to publish rather than commercialize. He linked the push to publish with the cost and delays associated with the U.S. patent system. "You've got universities publishing incredible ideas that are being turned into patents in China. It's a scary issue for the future of this country."

Blakely acknowledged the strong link between the patent process and commercialization, "but part of what the group recognized was that if we had a lot more interaction from the early stages forward, the value of that intellectual property in combination with the trade secrets that bring a product to market are part of what creates a competitive advantage for the end user. By creating the collaborations and interactions, there is a greater probability of having something to protect and from which you create value that is not readily available to others who have not participated in that process."

Mark Peters, deputy director for programs at Argonne National Laboratory, also complimented the report of the working group. He asked Blakely whether the group had discussed the criteria by which it might narrow the recommendations.

Blakely responded that the narrowing process was still underway, and that he welcomed input from the Dialogue participants. Chris Mustain, a senior advisor to the Council on Competitiveness, added that the working group was likely to prioritize through several lenses, including the potential for action and the expected impact of the recommendation. Mustain also

noted that the group might follow a model used by the National Innovation Initiative. Under this model, the recommendations could be categorized not only by objective, but also by the primary action agent. "You could conceive of an agenda for universities, labs, industry and government…As we encourage the federal government to make legislative and regulatory changes," Mustain said, "the Council also could work with its members and key stakeholders to advance non-governmental objectives."

Rochelle Blaustein, senior advisor for technology transfer at the U.S. Department of Energy, added that the working groups realize that their ideas overlap to some degree, affording an additional opportunity to narrow the recommendations. Bernstein confirmed that he has spoken already with Ashby to address some of the overlaps between the Talent and Accelerating Innovation Working Groups.

Johnson concluded the discussion by sharing lessons observed through Lockheed Martin's India Innovation Growth Program. "The first lesson is that good ideas come from everyplace," he said, "but the source of the innovation may not be the key." Johnson believes that two critical gaps must be bridged:

1. The innovator typically knows nothing about business. The education process should include getting more people thinking about business aspects.
2. Once innovators think about business aspects, they struggle to connect to businesses.

The Indian Innovation Growth Program, Johnson said, offers training as ideas emerge—partnering innovators with experts in commercialization. "They teach the entrepreneur how to go to market, how to price their product, how to build a business plan, etc.." The chamber of commerce in India helps make business connections.

*Ray Johnson, Lockheed Martin Corporation and Chad Evans, Council on Competitiveness.*

Johnson also observed that the portability of technologies from market to market is typically not a commercialization barrier. "The problem is that components of the business plan in market A generally don't apply in market B, C or D—things such as contracts, finance and marketing. We know that the primary reason that new businesses fail is not that the technology was inferior or wasn't sophisticated enough. Generally speaking, failure stems from a lack of sophistication in the management team and business plan."

PART 2: FINDINGS FROM TLSI DIALOGUE 4

# Regulation–Policy Working Group

Mustain filled in for Pradeep Khosla, dean of engineering at Carnegie Mellon University and chair of the Regulation-Policy Working Group. Mustain relayed that the group built on some of the ideas put forward by the President's Council of Advisors for Science and Technology (PCAST) in a report on university-industry partnerships. (Details from the PCAST report and the priorities identified by the working group are spelled out in the first section of this report.)

Mustain highlighted a concern that Internal Revenue Service (IRS) policies deter collaboration between universities and industry. Because using tax-exempt bonds to build research facilities confers a public benefit, Mustain explained, the IRS restricts partnerships in those facilities with private entities. The IRS rules, however, conflict with regulations from research agencies that encourage or require plans for private sector engagement as a condition for grants for research or facilities construction. The working group has called for a review of IRS, intellectual property, export control, Bayh-Dole and agency regulations to remove conflicts and encourage greater university-industry partnerships.

Other working group priorities reviewed by Mustain included international trade in arms regulations (ITAR) and rules for high-skill immigration. The working group also explored how governments around the world provide bridge funding over the commercialization "valley of death" compared to the United States. "Many countries provide funding in an effort to capture strategic industries," Mustain said. "Can the United States find alternative means to bridge the valley in strategic technologies without picking winning and losing firms?" he posed. The working group is considering this question.

## Discussion

Phillips emphasized how important it is for America to retain highly-skilled foreign graduates of U.S. institutions. "It doesn't seem like we're solving the problem," he stated. "I realize that 9/11 made this problem, but perhaps the pendulum has over swung." He asked what is being done to reform immigration law.

Mustain agreed that immigration reform is very important, but also a politically difficult issue. Reform opponents still cite security concerns, and with a higher unemployment rate, many members of Congress believe that Americans should fill open high technology positions without perhaps fully understanding STEM shortages or how long it takes to train a person to have STEM qualifications. Other members of Congress are determined to use the need to reform rules for high-skill legal immigrants as leverage to address illegal immigration.

"At a time when we're relying so heavily on foreign-born talent in the STEM fields, it's really a difficult challenge," Mustain said. He noted that pro-immigration groups like Compete America have developed materials that make a good empirical case why H-1B candidates are not taking American jobs—in fact those individuals have proven instrumental in creating American jobs. "The problem has been making that message resonate politically to a degree that it wins enough votes to pass a reform package."

Phillips expressed frustration that the problem remains unsolved. "How do we get in front of Congress and factually represent that those staying here after they graduate create a tremendous number of jobs and become teachers where we cannot find teachers in these subjects? This is a huge issue. By the way, all four of NanoMech's scientists are from


*TLSI Members voting on and prioritizing preliminary recommendations of the Working Groups.*

abroad—India, China, Ukraine, and Scotland—all speak fluent English, all have become American citizens, and three of their wives are scientists and teach at U.S. universities. We have got to fix this."

Evans stated that the power of the Council is its network of people. "So to your point about how do we get in front of Congress, I think one of the ideas that we want to explore is bringing Council members up to the Hill as we did in 2005 and 2006 to enact the America COMPETES Act. It was a multi-year effort, but it was sustained by members participating in what we called innovation days." Evans suggested that once the TLSI prioritizes and issues recommendations, the Council can create a series of engagements on Capitol Hill to make the case put forward by Phillips. The fact that many members of Congress are new, Evans said, means that there is an opportunity to hit a reset button on immigration and create a new narrative. The Council can be the leader in shaping that story by creating "crisp recommendations that will sell on the Hill and with the administration, and then leverage people like you to make that sale. We owe you a plan to make that happen."

PART 2: FINDINGS FROM TLSI DIALOGUE 4

# Innovation Outreach Working Group

Hallacher led the conversation for the Innovation Outreach Working Group, filling in for his colleague at Penn State University, Hank Foley, vice president for research. Hallacher explained that the working group seeks to convey the value of innovation and commercialization to three primary groups: policymakers, students and the general public.

Noting that Congress has several new members, Hallacher relayed that the working group needs to be strategic and target messages to appropriate members in leadership, on appropriations committees and on relevant authorization committees. Other priority members include those with significant technology interests in their districts.

"How to operationalize this outreach became a focal point for discussion," Hallacher said. The group agreed that the most effective way to educate members of Congress is in their home districts, he said. The working group would like to encourage permanent advisory councils in members' home districts to advise them on matters of science, engineering, technology and innovation. Representatives from industry, universities and/or government labs would make up the councils and be designated to offer advice independently of who holds the congressional seat. "Maybe these councils could offer a semi-annual dinner meeting with the member in the district," Hallacher suggested. "Obviously, you're not going to do this in 435 congressional districts immediately, but pilot it in a couple of strategic districts and states where there are key members and such entities don't exist."

Hallacher noted that the Innovation Outreach Working Group emphasized the importance of effective messaging around the recommendations of the other working groups when reaching out to policymakers. He also urged that once recommendations are issued, the Council should establish metrics to measure how well the recommendations are being implemented and host working meetings with members and congressional staff to educate them about TLSI priorities.

Recognizing the challenge of doing something meaningful to encourage more students to embark on studies and careers in technology and entrepreneurship, the working group advocates promoting and partnering with successful programs, much like the strategy of the Talent Working Group. Hallacher highlighted the Conrad Foundation's Spirit of Innovation Awards as an example.

To reach the general public and engender support for investment in research, the working group urges the Council to leverage its members and the local advisory councils in key congressional districts, Hallacher said. Those groups can reach out to the editorial boards of local media sources to tell the innovation story in those areas. They also might leverage science museums and other relevant local institutions.

Hallacher believed that a market exists for such ideas among the general public. He noted that Penn State is leading a federal energy innovation hub during the next five years focused on energy efficient buildings. "The press interest in this activity has been enormous," he said.

*Michael Blaustein, Dupont Central Research and Development and Paul Hallacher, Penn State University.*

## Discussion

Evans agreed that the turnover in Congress presents an interesting opportunity. "No member of Congress has a legislative director or aid that spends their time solely on innovation," Evans said, "and leaders like former Lockheed Martin CEO Norm Augustine would say that most members don't care about these issues."

One of the things the Council did about a decade ago was to engage a bipartisan team of senators (Frist and Rockefeller) in a forum on science and technology. "It was an education effort to bring together members of Congress and their staff on very specific topics, such as cyber security or the human genome," Evans explained. The Council would host lunches or meetings on technology topics pending in Congress at that time. "We selected topics they were thinking about on which they needed expert advice. Even if staff left a meeting still not knowing exactly how to advise their member of Congress, they knew the opinions that mattered and whom to reach out to in the future. So you began to create a community of interest that would care and come back to the next meeting," Evans continued. The forum grew from about 15 people attending to more than 100.

Evans expressed interest in mapping out an agenda of technology interests and inviting TLSI members to come to Washington, DC, at strategic times in the legislative cycle to educate members of Congress.

Evans also supported the working group's suggestions to engage the media. "There are very few journalists whose sole job is to think and write about innovation," he said. The Council helped catalyze an innovation journalism program at Stanford, Evans shared. "Our hope is to create a cadre of journalists who will focus on innovation globally." The program has been underway for approximately four years and would be a perfect community to hear what TLSI participants are saying. "They are thirsty for stories, and we have a lot we can share with them," Evans asserted.

PART 2: FINDINGS FROM TLSI DIALOGUE 4

# U.S. Manufacturing Competitiveness Initiative

Evans transitioned the Dialogue to its final topic, the linkage between the TLSI and the Council's U.S. Manufacturing Competitiveness Initiative (USMCI). The USMCI, Evans explained, is based on four pillars: technology, talent, investment and infrastructure. The TLSI will serve as a technology think tank to the USMCI and contribute to its recommendations. Evans introduced Jack McDougle, senior vice president at the Council and leader of the USMCI, to share information about the initiative.

McDougle thanked Evans and offered background information on U.S. manufacturing. "Over the past 20 to 30 years," McDougle said, "there has been a conversation in the United States that we are moving more towards a knowledge driven economy, and we don't need to make things anymore. This vision is not really an accurate or desirable image for our economy," McDougle asserted. Although America is facing intense competition all over the world, the United States has been the No. 1 producer of manufactured goods for the past 110 years. Challenges are coming not only from China, but also from less expected places such as India, South Korea, Brazil and other locations.

"What's interesting," McDougle observed, "is that the United States set out after World War II to create a more prosperous global economy based on market principles. Now that it's happening, what are we doing about it? We are pointing fingers, laying blame, re-trenching and talking about penalizing our companies that expand globally." This outlook, he suggested, is not a positive approach to shaping the future of manufacturing in the United States. "Our ability to create wealth and new jobs depends on innovative and agile manufacturing deployed at scale, and the USMCI seeks to achieve that vision."

Manufacturing has a great multiplier effect, McDougle explained. For every manufacturing job on the plant floor, five other jobs are supported elsewhere in the economy.[7] Because manufacturing enterprises have deeper supply chains than other business sectors, manufacturers also generate more output from other sectors of the economy than other types of businesses. In fact, every dollar in total manufacturing sales supports $1.40 in other parts of the economy.[8] "No other sector comes close to manufacturing as a multiplier," McDougle continued. Information technology is the next, while the financial services sector is similar to wholesalers and retailers in the 55 cent to 65 cent range.

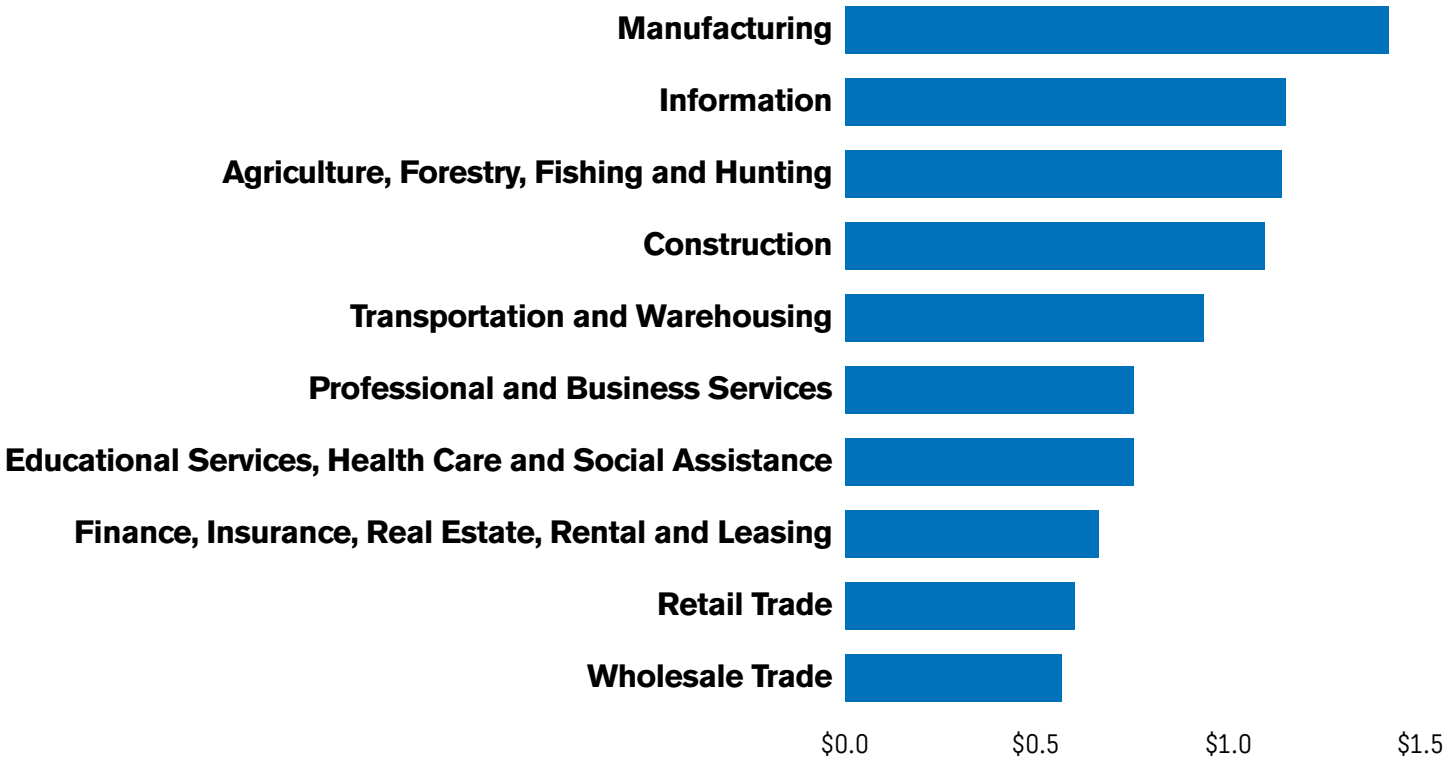
Although the economy has changed significantly, McDougle noted the lingering notion of manufacturing as being dumb, dirty and dangerous. The manufacturing ecosystem, however, includes cutting-edge science, technology, innovation, high performance computing, nanofabrication, highly talented workers, sustainable design, systems engineering, supply chain excellence and smart services. "And that's only part of the spectrum," he said, "but it offers an overview of just how complicated manufacturing can be and how many different factors are under consideration in the initiative."

7 The Manufacturing Institute. *The Facts About Modern Manufacturing, 8th edition*. 2009.

8 ibid.

**Figure 9. Economic Activity Generated by $1 of Sector GDP**

Source: National Manufacturing Institute based on U.S. Bureau of Economic Analysis Data




The USMCI also hopes to change the perception that innovation and production cycles are linear or discreet. Policymakers frequently talk about increasing R&D, improving tech transfer and encouraging early stage commercialization, McDougle observed. "There is less attention paid to the production process in Washington. Council research in partnership with Deloitte found that once U.S.-developed technology gets through early stage commercialization and generates roughly $150 million in revenue, that technology typically cannot be produced cost effectively in the United States."

Many variables affect those decisions, McDougle said, and labor costs tend to be a lesser factor. "The main factor right now is taxes. The U.S. corporate tax rate is the second highest in the world, and tax rates on repatriated profits range in the 35-45 percent range." The Council is concerned that losing manufacturing will result in the loss of advanced workforce skills and the loss of innovation generated by knowledge of how products are made.

McDougle emphasized that manufacturing dynamics are constantly shifting, and that America's future is not likely to rest on commodity-based produc-

tion. "At the height of manufacturing jobs in 1979," McDougle said, the U.S. had about 30 million manufacturing workers. Today, we have 11 million, but our output has gone up significantly. Roughly 80 percent of the job losses have been due to productivity improvements and automaton rather than off-shoring. This year, America will produce roughly 20 percent of global manufacturing output with 11 million workers. China produces about 18 percent of global manufacturing output with a roughly 70-100 million workers," he stated. China will face productivity issues and is already losing jobs to off-shoring.

The Council believes that production at scale should be conceived as embedded in the innovation process. To maximize economic benefit to the U.S. economy, American leaders should consider how to expand innovation clusters into production clusters, McDougle argued. "The USMCI is focusing a lot of our efforts to understand production at scale. We're considering, for example, what a desirable full production ecosystem might look like in the future if you could start from scratch. What attributes would an ideal production facility have? How would it be energy efficient, low cost and carbon neutral? Would it have permanent learning laboratories and maximize value from its waste stream? We think there are many lessons learned by going through this process that could be applied broadly to manufacturing in the United States. Once we capture the vision, we can tie that to policy recommendations."

The USMCI is an outgrowth of other things the Council has done and is doing, including the TLSI. McDougle noted that the initiative also links to Council efforts on workforce, energy security and high performance computing, and thanked TLSI participants for their contributions.

## Discussion

Evans observed that the USMCI is moving on an aggressive time line. He asked McDougle to share information about the Council's December 2010 annual event and about of the process leading up to the event.

McDougle stated that the USMCI will issue a set of findings and recommendations at the event, drawn from the initiative's steering committee. "We also are conducting interviews in partnership with Deloitte with more than 70 U.S. CEOs of manufacturing firms," he said. "The interviews will be distilled and embedded in our recommendations that we will share with the administration and Congress."

The Council will go deeper into the issues in 2011 explained McDougle, exploring each of the drivers—talent, technology, infrastructure and investment. "Our CEO steering committee will remain engaged, including a meeting to be held at Ford hosted by Alan Mulally. The Council also will host a series of meetings across the country on various topics related to the drivers. I could definitely see a combined TLSI manufacturing meeting next year before the summit to look at the intersections."

The Council continues to do analytical work, too, McDougle stated. "We're talking with Lawrence Livermore about building a system-wide manufacturing model so we can better understand the impacts and potentially unintended consequences of different policy solutions on the manufacturing sector," he

*Jack McDougle, Council on Competitiveness.*

said. "We're also developing a number of case studies, particularly around re-shoring and manufacturing at scale in the United States."

Hallacher suggested that part of the USMCI work be tied to how to increase U.S. manufacturing exports to deal with the country's trade deficit. McDougle replied that exports will be part of the work. He noted that emerging technologies in life sciences and alternative energies should offer export opportunities. "How do we make sure we maintain that market share? We've already seen a lot of alternative energy manufacturing going to China. We are working to tie in the dynamics of the current account balance and the value of the dollar. As the dollar plummets (due to our public debt, fed policy and other factors), exports rise. On the other side, our energy resources become more expensive. So we're exploring how that nets out." McDougle also stated that manufacturing jobs that produce goods for export pay significantly higher wages than manufacturing jobs for domestic consumption.

Phillips added that currency manipulation by China is an important topic that harms U.S. exports and competitiveness. McDougle agreed, but noted an emerging phenomenon where some companies are beginning to recalculate the cost of manufacturing and choosing to locate in the United States. "We are doing a case study with GE on their decision to open a $400 million U.S. manufacturing facility to produce refrigerators. The Council is examining the phenomena driving that decision, and what we're learning is that as companies get more sophisticated in understanding the fully burdened cost of manufacturing in different locations, they're finding advantages in the United States they didn't previously realize—things such as lower employee turnover and better health, training and development, product quality, and intellectual property protection. There are a host of different things coming into play and shifting some of the perceptions on where to manufacture."

Evans thanked the TLSI working groups and added they will help make the USMCI even more robust. He also noted that Tomas De la Rubia from Lawrence Livermore National Laboratory has volunteered to begin a TLSI working group on high performance computing that will contribute to the USMCI on issues like modeling and simulation.

Johnson concluded by thanking the working group members and dialogue participants. He complimented the progress made on the recommendations and their quality in reflecting the TLSI discussions.

PART 2: FINDINGS FROM TLSI DIALOGUE 4

# Conclusion

The Council is grateful to the many TLSI participants engaged in the working groups and encouraged by the body of work emerging from the initiative. Dialogue 4 and this report are designed to invite the larger TLSI community to review the work underway and to share their insights.

Please contact Chad Evans (cevans@compete.org or 202 969 3380) or Chris Mustain (cmustain@compete.org or 202 969 3398) at the Council for information about contacting or participating in a working group. The working group chairs are:

| | |
|---|---|
| **Accelerating Innovation:** | Steven Ashby, Keith Blakely and Spiros Dimolitsas |
| **Regulation-Policy:** | Pradeep Khosla |
| **Talent:** | Mel Bernstein |
| **Outreach:** | Hank Foley |

# TLSI Dialogue 4 Participants

Dr. Ray Johnson, *Co-Chair*
Senior Vice President and Chief Technology Officer
Lockheed Martin Corporation

Mr. Thomas Ballard
Director of Partnerships Directorate
Oak Ridge National Laboratory

Dr. Melvin Bernstein
Vice Provost for Research
Northeastern University

Mr. Keith Blakely
Chief Executive Officer
NanoMech

Dr. Michael Blaustein
Technology and Ventures Director
DuPont Central Research and Development

Ms. Rochelle Blaustein
Senior Advisor for Technology Transfer
Department of Energy

Mr. Frank (Ted) B. Campbell
Vice President
Lockheed Martin Corporation

Ms. Nancy Conrad
Council Member
Chairman and Chief Executive Officer
Conrad Foundation

Mr. Chad Evans
Senior Vice President
Council on Competitiveness

Dr. Paul Hallacher
Director, Research Program Development
Pennsylvania State University

Ms. Merle McKenzie
Senior Advisor to the Associate Administrator
National Aeronautics and Space Administration

Dr. Mark Peters
Deputy Laboratory Director for Programs
Argonne National Laboratory

Mr. James Phillips
Council Executive Committee Member
Chairman
NanoMech

Dr. James Woodard
Deputy CTO and Director, ST&E Innovations and Partnerships
Sandia National Laboratories

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Mr. Aaron Fuchs
Manager, Global Initiatives
Council on Competitiveness

Mr. Jack McDougle
Senior Vice President
Council on Competitiveness

Mr. Chris Mustain
Senior Advisor
Council on Competitiveness

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Vice President, Advanced Technology and Engineering
Deere & Company

Ray Johnson
Senior Vice President and Chief Technology Officer
Lockheed Martin Corporation

Mark Little
Senior Vice President and
Chief Technology Officer of GE Global Research
General Electric Company

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Constellation Energy Group

Mr. Montgomery Alger
Vice President and Chief Technology Officer
Air Products and Chemicals, Inc.

Dr. Amy Alving
Chief Technology Officer adn Senior Vice President
SAIC

Mr. Tilak Agerwala
Vice President, Systems
IBM

Mr. Leo Annab
Corporate Senior Vice President
CA, Inc.

Dr. Steven Ashby
Deputy Director for Science and Technology
Pacific Northwest National Laboratory

Dr. Francine Berman
Vice President for Research
Rensselear Polytechnic Institute

Dr. Melvin Bernstein
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Northeastern University

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Senior Vice Provost for Research
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Conrad Foundation

Dr. Walter Copan
Managing Director of Technology Commercialization and Partnerships
Brookhaven National Laboratory

Dr. Jim Davis
Vice Provost, IT & Chief Academic Technology Officer
University of California, Los Angeles

Dr. Wayne Delker
Vice President—Research and Development
The Clorox Company

Dr. Tomás Díaz de la Rubia
Deputy Director for Science and Technology
Lawrence Livermore National Laboratory

Dr. Spiros Dimolitsas
Senior Vice President & Chief Technology Officer
Georgetown University

Dr. Steven Fluharty
Vice Provost for Research
University of Pennsylvania

Dr. Hank Foley
Vice President for Research
Pennsylvania State University

Mr. Andrew Garman
Founder and Managing Partner
New Venture Partners LLC

Dr. J. Ian Gray
Vice President for Research & Graduate Studies
Michigan State University

Mr. Thomas Halbouty
CTO and CIO
Pioneer Natural Resources Company

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Vice President for Strategy, Marketing, Communications and Admissions & Special Asst. to the President
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CEO, Global Nutrition Group and Chief Scientific Officer
PepsiCo., Inc.

Dr. Pradeep Khosla
Dean, College of Engineering and Dowd University Professor
Carnegie Mellon University

Mr. Timothy Lyons
Senior Vice President
Bank of America

Dr. Ajay Malshe
Founder, Executive Vice President, and Chief Technology Officer
NanoMech

Dr. Merle McKenzie
Senior Advisor to the Associate Administrator
National Aeronautics and Space Administration

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Dr. Thomas Zacharia
Deputy Director for Science and Technology
Oak Ridge National Laboratory

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Acting Director, STEM Development Office
U.S. Department of Defense

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Office of the Under Secretary of Defense for Acquisition, Technology & Logistics
U.S. Department of Defense

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University of Pittsburgh

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Citigroup Inc.

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SMC3

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University Economic Development Association

Harrison A. Page
Oak Ridge Associated Universities

Hunter R. Rawlings
Association of American Universities

Peter M. Robinson
United States Council for International Business

Carol G. Schneider
Association of American Colleges & Universities

Steven G. Zylstra
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Chad Evans
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Jack McDougle
Senior Vice President

Cynthia R. McIntyre
Senior Vice President

Lisa Hanna
Vice President

Mohamed N. Khan
Vice President

Walt Kirchner
Chief Technologist

Deborah Koolbeck
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**Council on Competitiveness**

1500 K Street, NW
Suite 850
Washington, DC 20005
T 202-682-4292
Compete.org

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- Identifying and understanding emerging challenges to competitiveness
- Generating new policy ideas and concepts to shape the competitiveness debate
- Forging public and private partnerships to drive consensus
- Galvanizing stakeholders to translate policy into action and change

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1500 K Street, NW, Suite 850, Washington, D.C. 20005 T 202 682 4292
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