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THE NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY'S ROLE IN SUPPORTING ECONOMIC COMPETITIVENESS IN THE 21ST CENTURY: THE FISCAL YEAR 2008 BUDGET REQUEST

HEARING

BEFORE THE

SUBCOMMITTEE ON TECHNOLOGY AND INNOVATION

COMMITTEE ON SCIENCE AND TECHNOLOGY

HOUSE OF REPRESENTATIVES

ONE HUNDRED TENTH CONGRESS

FIRST SESSION

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THE NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY'S ROLE IN SUPPORTING ECONOMIC COMPETITIVENESS IN THE 21ST CENTURY: THE FISCAL YEAR 2008 BUDGET REQUEST

THURSDAY, FEBRUARY 15, 2007

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON TECHNOLOGY AND INNOVATION,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
Washington, DC.

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

BART GORDON, TENNESSEE
CHAIRMAN

RALPH M. HALL, TEXAS
RANKING MEMBER

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Subcommittee on Technology and Innovation

Hearing on:

"The National Institute of Standards and Technology's Role in Supporting Economic Competitiveness in the 21st Century: the FY08 Budget Request"

2318 Rayburn House Office Building
Washington, D.C.

Thursday, February 15, 2007
10:00 AM – 12:00 PM

WITNESS LIST

Dr. William Jeffrey
Director
National Institute of Standards and Technology

Dr. Stan Williams
Senior HP Fellow in Quantum Science Research
Hewlett-Packard Corporation

Mr. Michael Borrus
General Partner
X/Seed Capital

Mr. Peter Murray
Vice President
Welch Allyn

Mr. Michael Ryan
President, CEO
TUG Technologies

HEARING CHARTER

SUBCOMMITTEE ON TECHNOLOGY AND INNOVATION
COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

The National Institute of Standards and Technology's Role in Supporting Economic Competitiveness in the 21st Century: The Fiscal Year 2008 Budget Request

THURSDAY, FEBRUARY 15, 2007
10:00 A.M.—12:00 P.M.
2318 RAYBURN HOUSE OFFICE BUILDING

1. Purpose

On Thursday, February 15, 2007, the Technology and Innovation Subcommittee of the House Committee on Science and Technology will hold a hearing to consider the President's fiscal year 2008 (FY08) budget request for the National Institute of Standards and Technology (NIST). An Administration witness will review the proposed budget in the context of the President's overall priorities for NIST. In addition, there will be four witnesses who will comment on the President's FY08 budget request and the future direction and requirements for NIST.

2. Witnesses

Dr. William Jeffrey, Director, National Institute of Standards and Technology

Dr. Stan Williams, Senior HP Fellow in Quantum Science Research, Hewlett-Packard Corp, Palo Alto, CA

Mr. Michael Borrus, General Partner, X/Seed Capital, Menlo Park, CA

Mr. Peter Murray, Vice President, Welch Allyn, Inc., Beaverton, OR

Mr. Michael Ryan, President and CEO, TUG Technologies Corporation, Marietta, GA

3. NIST Overview

Founded in 1901, the National Institute of Standards and Technology (NIST) has developed and promoted measurement, standards, and technology to enhance productivity, facilitate trade, and improve quality of life. NIST is a non-regulatory agency of the U.S. Commerce Department's Technology Administration.

NIST operates in two primary locations: Gaithersburg, MD and Boulder, CO. It also operates two institutes jointly with other organizations: the Center for Advanced Research in Biotechnology in Rockville, MD (with the University of Maryland) and JILA in Boulder, CO (with the University of Colorado).

NIST's staff includes approximately 2,700 scientist, engineers, technicians, and support personnel. In addition, 1,800 associates complement the staff, and NIST partners with about 1,500 manufacturing specialists and staff at affiliated centers around the country. Three NIST scientists have earned the Nobel Prize in the last 10 years.

NIST carries out its mission through four cooperative programs:

- **NIST laboratories—**conduct research supporting U.S. technology infrastructure by developing tools to measure, evaluate and standardize, enabling U.S. companies to innovate and remain competitive. NIST helps U.S. companies, workers, and consumers by ensuring that standards are used to create a level playing field—not a barrier to trade—in the global marketplace.
- **Baldridge National Quality Program—**promotes excellence among U.S. manufacturers, service companies, educational institutions, and health care

providers; conducts outreach programs and manages the annual Malcolm Baldridge National Quality Award recognizing performance excellence and quality.

- **Manufacturing Extension Partnership—**offers technical and business assistance services to improve the productivity and competitiveness of small manufacturers through a nationwide network of local centers. The centers are funded by a one-third equal match from federal, state, and fees charged for services.
- **Advanced Technology Program—**accelerates the development of high-risk, innovative technologies that promise broad benefits for the Nation by co-funding R&D partnerships with the private sector, including universities.

NIST laboratories are comprised of seven labs and a technical program, and are funded under the Scientific and Technical Research Services (STRS) account.

- **Building and Fire Research Laboratory (BFRL)—**works to improve quality and productivity in the U.S. construction. The lab also works to reduce human and economic loss due to fires, earthquakes, wind, and other hazards.
- **Chemical Science and Technology Laboratory (CSTL)—**conducts research in measurement science and develops the chemical, biochemical, and chemical engineering measurements, data, models, and reference standards that are required to enhance U.S. industrial competitiveness in the world market and to improve public health, safety and environmental quality.
- **Electronics and Electrical Engineering Laboratory (EEEL)—**provides the fundamental basis for all electrical measurements in the U.S. and advances standards for the electronics and electrical industries.
- **Information Technology Laboratory (ITL)—**conducts research and develops test methods and standards for emerging and rapidly changing information technologies. ITL focuses on technologies to improve the usability, reliability, and security of computers and computer networks for work and home.
- **Manufacturing Engineering Laboratory (MEL)—**develops measurement methods, standards, and technologies to improve U.S. manufacturing capabilities. MEL researchers work with industry to achieve greater efficiency and productivity with improved measurements and standards, both dimensional and mechanical. MEL also maintains the basic units for measuring mass and length in the United States.
- **Materials Science and Engineering Laboratory (MSEL)—**anticipates and responds to industry material-science needs in areas including microelectronics, automobiles, and health care. MSEL houses the Nation's only fully equipped cold neutron research facility.
- **Physics Laboratory (PL)—**provides measurement services and research for electronic, optical, and radiation technology. Research on atomic clocks at PL has led to the world's most accurate timing devices, critical for the Global Positioning System (GPS), financial markets, and electrical power grid testing. Over the last 10 years, three scientists from PL have won the Nobel Prize.
- **Technology Services—**provides technology products and services including support for NIST calibrations, Standard Reference Materials, Standard Reference Data, and Weights and Measures; coordination of documentary standards activities; training of foreign standards officials; laboratory accreditations; facilitating partnerships between NIST researchers and U.S. industry; and access to the NIST Research Library.

In addition, NIST has two national research facilities.

- **NIST Center for Neutron Research (NCNR)—**provides an intense source of neutrons used to probe the molecular and atomic structure and dynamics of a wide range of materials. This facility is used heavily by industry. In 2006, researchers from over 40 national labs, 140 U.S. universities, and 60 U.S. companies conducted research at the facility in collaboration with NIST scientists.
- **Center for Nanoscale Science and Technology (CNST)—**leverages the unique capabilities of the NIST Advanced Measurement Laboratory complex, providing state-of-the-art facilities for nanomanufacturing and nanometrology where industry, universities and other federal laboratories can collaborate in

solving critical measurement and fabrication issues necessary to convert nano-discoveries into products.

NIST also manages two programs that support small businesses.

- **Manufacturing Extension Program** (MEP) is a proven public/private partnership in all 50 states and Puerto Rico with the mission of improving the competitiveness of small and medium-sized manufacturers. In FY05, MEP, a network of 59 centers, assisted more than 16,000 small manufacturers, providing a ten to one return on federal investment. In a survey of approximately 25 percent of MEP clients, they reported over $1.3 billion in cost savings directly attributed to the program's assistance as well as creating $6.25 billion in new or retained sales. The program also helped create/retain more than 53,000 jobs and increased investment by $2.25 billion returned to the economy.
- The **Advanced Technology Program** (ATP) was created to foster economic growth through the development of innovative technologies. Through private/public partnerships, ATP's early stage investment is accelerating the development of high-risk, broadly enabling technologies and helping bridge the gap between the laboratory and the market place. Through May 2004, ATP cofunded 736 projects with 1,468 participants. Sixty-six percent of ATP projects are led by small businesses, while more than 160 different colleges and universities have participated in ATP projects. Benefit-cost studies from approximately 40 projects indicate an eight to one return on investment.

NIST Budget Summary

NIST's FY08 budget request is summarized in the table below.

Table 1. National Institute of Standards and Technology FY05 - FY08 Request.

Program	FY05 Approp	FY06 Approp	FY07 Request	FY07 H.J.Res. 20	FY08 Request	Change FY08R vs FY07 H.J.Res. 20	% Chg FY08R vs FY07 H.J.Res. 20
STRS	373.3	387.5	459.4	416.7	492.4	75.7	18.2%
Baldridge	5.5	7.3	7.6	7.6	8.1	0.5	6.6%
ITS							
ATP	140.4	79.0	0.0	79.0	0.0	-79.0	-100.0%
MEP	107.5	104.6	46.3	104.6	46.3	-58.3	-55.7%
Construction	72.5	173.6	68.0	58.6	93.9	35.3	60.2%
Total	699.2	752.0	580.3	665.9	640.7	-25.2	-3.8%

Figures may not add up due to rounding

STRS: Scientific Technical Research Services (includes NIST laboratories, technical services and National Research facilities).
Baldridge: Baldridge National Quality Program.
ITS: Industrial Technology Services
ATP: Advanced Technology Program
MEP: Manufacturing Extension Program

4. NIST Budget Highlights

NIST's Laboratory Programs

The FY08 budget requests $492 million for scientific research. The request is $68 million (17 percent) above the FY07 level of $417 million appropriated in the continuing resolution, H.J. Res. 20 (which passed the House on January 31, 2007) and is $41 million above the FY06 request. The request also includes $94 million for construction and renovation of NIST's scientific facilities, $35 million (60 percent) above the FY07 appropriated level and $80 million (46 percent) below the FY06 appropriation.

The increase in laboratory programs (STRS) for FY08 includes new research initiatives plus those requested in FY07 as summarized below.

- **Enabling Nanotechnology from Discovery to Manufacture** (requested increase of $26 million) aims to improve the basic scientific understanding of artificial materials on the nanoscale as well as aid US industry in developing

manufacturing technologies for these materials. (Includes $6 million in FY08 request and $20 million from FY07.)

- **Measurements and Standards for the Climate Change Science Program** (requested increase of $5 million) will expand the NIST component of the multi-agency U.S. Climate Change Science Program (CCSP) to study the impact of aerosols on global warming, and to carry out precise calibration of satellite light sensors to monitor the amount of sunlight striking the Earth.
- **Enabling Innovation through Quantum Science** (requested increase of $13 million) will pursue the development of devices governed by quantum physics to develop next-generation cryptography and computing technologies. (Includes $4 million in FY08 request and $9 million from FY07 "Quantum Information Science" initiative.)
- **Disaster Resilient Structures and Communities** (requested increase of $6 million) will improve the scientific basis for building codes and best practices that make buildings more resistant to damage during natural disasters such as hurricanes, fires, and tsunamis. (Includes $4 million in FY08 request and $2 million from FY07 "Structural Safety in Hurricanes, Fires, and Earthquakes" initiative.)
- **National Earthquake Hazards Reduction Program Initiative** (requested increase of $3.25 million) will fund research into technologies for retrofitting or otherwise protecting buildings against earthquake damage. NIST is the lead agency for this interagency initiative. (Combined $3.25M new initiative with $2M increase for similar FY07 initiative.)
- **NIST Center for Neutron Research Expansion and Reliability Improvements: A National Need** (requested increase of $10 million) will upgrade and expand the NCNR neutron source, which is used for research into superconductors, nanostructured materials, biomaterials, microelectronics, and hydrogen fuel cells. U.S. neutron research facilities are currently oversubscribed.
- **Enabling the Hydrogen Economy** (requested increase of $10 million) will fund research into fuel-cell design and high-volume manufacturing through development of measurement tools, material characterization, theory, and models allowing real-time diagnostics of hydrogen fuel cell performance, as well as hydrogen transportation and point-of-sale technical requirements.
- **Manufacturing Innovation through Supply Chain Integration** (requested increase of $2 million) to advance industry towards seamless global supply chains by developing manufacturing standards, measurements, and testing tools.
- **Synchrotron Measurement Science and Technology: Enabling Next Generation Materials Innovation** (requested increase of $5 million) will fund the creation of a Center for Synchrotron Measurement Science and Technology to provide state-of-the-art measurement tools for characterizing the chemical and structural state of materials and devices through close collaborations with researchers from industry, academia, and other government agencies.
- **International Standards and Innovation: Opening Markets for American Workers and Exporters** (requested increase of $2 million) will support NIST assuming a more proactive role as a convener, facilitator, and catalyst in ensuring that the necessary underpinnings for product and process standards are in place to support full U.S. participation in global markets.
- **Innovations in Measurement Science** (requested increase of $4 million) will be used to advance NIST's capabilities in the core measurement science areas underpinning technology innovation.
- **Bioimaging: A 21st-Century Toolbox for Medical Technology** (requested increase of $4 million) will fund NIST utilizing its expertise in the physical and information sciences to provide the necessary measurements and standards to pave the way for innovative diagnostics, in partnership with the National Institutes of Health (NIH) and the bioimaging industry.
- **Cyber Security: Innovative Technologies for National Security** (requested increase of $2 million) will fund NIST collaboration with industry and academia to develop metrics and measurement techniques for characterizing known and unknown vulnerabilities of computer systems.

- **Biometrics: Identifying Friend or Foe** (requested increase of $2 million) will fund NIST to develop measurements and standards to support testing and evaluation of enhanced biometric systems, in partnership with DHS, the FBI, and the State Department.

The FY08 construction and renovation (CRF) request includes two major new projects:

- **Boulder Building 1 Extension** (requesting $28 million) will begin construction of a new laboratory building on the Boulder campus with high-performance facilities. Total construction is estimated at $76.2 million with $28.0 budgeted in FY08.
- **Center for Neutron Research Expansion and Reliability Improvements** (requesting $31 million) will fund expansion and complete new construction at the neutron research facility on the Gaithersburg campus, which is used to probe the atomic and molecular structure of plastics, biological materials, and thin magnetic films. As a national user facility, researchers from academia, industry, and government conduct research at the center. (Includes $19 million in FY08 request and $12 million from FY07 "NIST Center for Neutron Research Expansion and Reliability Improvements: A National Need.")

Advanced Technology Program (ATP): The FY08 budget request proposes to eliminate ATP (funded at $79 million in FY07).

Manufacturing Extension Partnership (MEP) Program: The FY08 request for MEP is $46.3 million, which represents a 58 percent cut from the FY07 enacted level of $104.6 million.

5. Issues

- Does the FY08 budget request set the appropriate priorities to achieve the stated goals of improving U.S. competitiveness?
- What are the criteria used by the Administration in determining the priorities for NIST funding and activities?
- As a part of the American Competitiveness Initiative (ACI), the Administration proposes doubling NIST's Scientific & Technical Research Services and Construction budgets. What should NIST's mandate and activities include under this proposed funding scenario?
- Can the Manufacturing Extension Partnership (MEP) program function effectively with the Administration's proposed budget request of $46.3 million (56 percent reduction from H.J. Res. 20). What would be the impact of this funding amount on the level of MEP services provided to small manufacturers and what would be the impact on the small- and medium-sized manufacturing community?
- Given the current focus on developing programs and policies to support an innovation-based economy, should the Advanced Technology Program (ATP) be eliminated as proposed in the Administration's FY08 budget request?

Chairman WU. The Subcommittee now stands in order.

I want to welcome everybody to the first hearing of the Technology and Innovation Subcommittee. It is only fitting that with the Subcommittee's focus on technology, competitiveness, and innovation that our first hearing is on the National Institute of Standards and Technology, NIST. For over 100 years, NIST has done outstanding work to promote the public welfare and support industrial growth: from setting standards for uniform pipe threads on fire hydrants to the time measurements that make electronic financial transactions and the Global Positioning System, or GPS, work, NIST has always been responsive to industry's and the public's needs.

NIST's development of uniform pipe thread standards for fire hydrants was one of NIST's first success stories. Three years after NIST's creation, a fire in Baltimore largely destroyed the city, because when adjacent fire companies within a 100-mile radius came to the assistance of Baltimore, they found that their hoses and the fire hydrants in Baltimore didn't have a uniform standard and didn't work together. NIST solved the problem over time.

However, when I mention NIST to my colleagues, most don't recognize that name as a federal agency. Perhaps the Manufacturing Extension Program, or MEP, perhaps the Advanced Technology Program have a little visibility in the Congress and among my constituents. But when I meet with industry representatives, while their technical staff may know about NIST, frequently, the business executives and line folks do not.

During the next two years, I hope to educate my colleagues in Congress and the broader public about the great importance of NIST. I know that Dr. Jeffrey shares this goal as well.

Now, on to the issue at hand: the Administration's fiscal year 2008 budget request for NIST. I am glad that the Administration has recognized the importance of at least a portion of NIST's work as outlined in the American Competitiveness Initiative. Congress and the prior Administration have long been supportive of the NIST lab programs. During the past 15 years, NIST's lab budget has increased by 130 percent. When President Clinton took office, the NIST lab budget was $163 million. Eight years later, it was $313 million. In addition, Congress had also provided more than $310 million for the construction of new lab facilities. There are few federal agencies that have grown so rapidly over the past decade. The Science and Technology Committee has always been NIST's strongest supporter.

I am concerned that this Administration follows a strategy of paying for increases in the lab programs and construction by cutting funding for the MEP and proposing repeatedly to eliminate ATP. Both of these programs are successful public/private partnerships, which have contributed to American innovation and competitiveness. I hope that we can break this cycle where every year the Administration proposes either eliminating or cutting these two programs and then Congress has to restore the funding.

NIST has not had an authorization for all its programs since 1992, and I intend to break this cycle, also. I want to move a complete NIST authorization bill through Congress. I am hoping that the Administration will work with me on this effort. We need to

move an authorization bill which sets NIST on a path to broadly support innovation and competitiveness in the United States and with our friends and competitors around the world. We are in a global race for economic competitiveness and we can't afford to stand idly by and watch our economy burn to the ground as happened to Baltimore 100 years go.

Now, I would like to recognize the Ranking Member of the Subcommittee, the gentleman from Georgia, Dr. Gingrey, for his opening remarks.

[The prepared statement of Chairman Wu follows:]

PREPARED STATEMENT OF CHAIRMAN DAVID WU

I want to welcome everyone to the first hearing of the Technology and Innovation Subcommittee. It seems only fitting that with the Subcommittee's focus on technology, competitiveness, and innovation our first hearing is on the National Institute of Standards and Technology—NIST. For over 100 years, NIST has done outstanding work to promote the public welfare and support industrial growth: from setting standards for uniform pipe threads on fire hydrants to the time measurements that make electronic financial transactions and the Global Positioning System (GPS) functional. NIST has always been responsive to industry's and the public's needs.

NIST's development of uniform pipe thread standards for fire hydrants was one of NIST's first success stories. Three years after NIST's creation, a fire in Baltimore largely destroyed the city. Why? Because when the fire companies from within a 100 miles radius showed up, none of their hoses would fit Baltimore's fire hydrants because there was no uniform standard. NIST solved the problem.

Now, on to the issue at hand—the Administration's FY08 budget request for NIST. I am glad that the Administration has recognized the importance of at least a portion of NIST work as outlined in the American Competitiveness Initiative (ACI). Congress and the prior Administration have long been supportive of the NIST lab programs. During the past 15 years, NIST's lab budget has increased by 130 percent. When President Clinton took office the NIST lab budget was $163 million; eight years later it was $313 million. In addition, Congress had also provided more than $310 million for the construction of new lab facilities. There are few federal agencies that have grown so rapidly over the past decade. The Science and Technology Committee has always been one of NIST's strongest supporters.

I am concerned that the Bush Administration continues to follow a strategy of paying for increases in the lab programs and construction by cutting funding for the MEP and eliminating the ATP. Both of these programs are successful public/private partnerships which have contributed to American innovation and competitiveness. I hope that we can break this cycle where every year the Administration proposes either eliminating or cutting these two programs and then Congress restores the funding.

NIST has not had an authorization for all its programs since 1992 and I intend to break this drought. I want to move a complete NIST authorization bill through Congress. I'm hoping that the Administration will work with me on this effort. We need to move an authorization bill which sets NIST on a path to broadly support innovation and competitiveness in the United States. We are in a global race for economic competitiveness—we can't afford to stand idly by and watch our economy burn to the ground as happened in Baltimore, 100 years ago.

Now, I would like to recognize the Ranking Member of the Subcommittee, Dr. Gingrey, for his opening remarks.

Mr. GINGREY. And I thank you, Mr. Chairman.

Good morning. I am very excited for our subcommittee's first hearing of the 110th Congress, and I want to thank my friend from Oregon, Mr. Wu, for organizing this hearing. And I look forward to working with him over the next two years on technology and innovation, issues that are vital to our economic competitiveness.

It is quite important that this first hearing in the Technology and Innovation Subcommittee is about one of our nation's scientific stars, the National Institute of Standards and Technology, or NIST.

Almost every federal agency and United States industry sector uses the standards, measurements, and certification services that NIST laboratories provide. The breadth of NIST's applications stretches from guidelines on the accuracy and reliability of electronic voting machines to research into the causes of building and structural failures and to making health care information technology inter-operability a reality in a health care delivery system. A must-do, in my opinion, to deliver the kind of radical reforms needed to improve the quality and lower the cost of delivering health care in this country.

The future of many cutting-edge technologies also depends on the research and technical expertise of NIST laboratories. Emerging fields, such as nanotechnology and bioengineering, will not become mature industries and markets without the existence of scientifically-based industrial measurements and standards. Beginning last year, the President recognized the important role that NIST plays in our nation's economic security and started NIST on a path to double its core research and facilities budget by 2017. I fully support the President's American Competitiveness Initiative and the Office of Science at the Department of Energy. I look forward to hearing more details today about the role NIST will play in the President's American Competitiveness Initiative.

And I am interested to hear the Administration's rationale in requesting only $46 million for the Manufacturing Extension Partnership, the MEP program. The MEP program helps small and medium-sized United States manufacturers optimize their operations and remain competitive in the global economy. And it is a critical program that is worthy of taxpayer dollars. It deserves the $106 million that Congress had provided in recent years, and I intend to work with my colleagues to see that it once again receives an adequate appropriation for fiscal year 2008.

Chairman Wu, I am pleased to have Mike Ryan, President and CEO of TUG Technologies, a company that is located in my district, in Marietta, Georgia, with us today to discuss the importance of the MEP program. He has vast experience with a variety of MEP programs in different states of this great country and has some exciting success stories to share with this subcommittee.

I thank all of the witnesses for taking the time to be here today. I only wish that I could stay to hear what will be, I know, a fruitful and productive debate. However, as you know, a good friend and colleague, our own Dr. Charlie Norwood, passed away this week, and his funeral is this afternoon in Augusta, Georgia. And in order to offer my condolences to his wife and family, I will be joining many of my colleagues as we leave here in just a few minutes to fly back to his services. So please keep his family and friends in your thoughts and prayers.

And, Mr. Chairman, I yield back the balance of my time, and I thank you.

[The prepared statement of Mr. Gingrey follows:]

PREPARED STATEMENT OF REPRESENTATIVE PHIL GINGREY

Good morning. I am very excited for our subcommittee's first hearing of the 110th Congress. I thank my friend from Oregon, Mr. Wu, for organizing this hearing and look forward to working with him over the next two years on technology and innovation issues that are vital to our economic competitiveness.

It is quite appropriate that the first hearing of the Technology and Innovation Subcommittee is about one of our nation's scientific stars—the National Institute of Standards and Technology (NIST). Almost every federal agency and U.S. industry sector uses the standards, measurements, and certification services that NIST labs provide. The breadth of NIST's applications stretch from guidelines to the accuracy and reliability of electronic voting machines to research into the causes of building and structural failures, and to making health care information technology interoperability a reality in our health care delivery system. A must do, in my opinion, to deliver the kind of radical reforms needed to improve the quality and lower the cost of delivering health care in this country.

The future of many cutting-edge technologies also depends on the research and technical expertise of NIST's laboratories. Emerging fields such as nanotechnology and bio-engineering will not become mature industries and markets without the existence of scientifically-based industrial measurements and standards.

Beginning last year, the President recognized the important role NIST plays in our nation's economic security and started NIST on a path to double its core research and facilities budget by 2017. I fully support the President's American Competitiveness Initiative to double not only NIST's budget but also those of the National Science Foundation and the Office of Science at the Department of Energy. I look forward to hearing more details today about the role NIST will play in the President's American Competitiveness Initiative.

I am interested to hear the Administration's rationale in requesting only $46 million for the Manufacturing Extension Partnership (MEP) program. The MEP program helps small and medium-sized U.S. manufacturers optimize their operations and remain competitive in the global economy and it is a critical program that is worthy of taxpayer dollars. It deserves the $106 million Congress has provided in recent years and I intend to work with my colleagues to see that it once again receives an adequate appropriation for FY 2008.

Chairman Wu, I am pleased to have Mike Ryan, President and CEO of TUG Technologies, a company that is located in my district in Marietta, Georgia, with us today to discuss the importance of the MEP program. He has vast experience with a variety of MEP programs in different states of this great country and has some exciting success stories to share with this subcommittee.

I thank all the witnesses for taking the time to be here today and wish I could stay to hear what I know will be a fruitful and productive debate. However, a good friend and colleague, Dr. Charlie Norwood, passed away this week and his funeral is this afternoon in Augusta, GA. In order to offer my condolences to his wife and family, I need to leave to fly back for the services. Please keep his family and friends in your thoughts and prayers and I yield back the balance of my time.

Chairman WU. Thank you, Dr. Gingrey.

And it is my understanding that the timeline for meeting downstairs for our friend Charlie is in about 12 minutes. And I just want to recognize that, while many of us are going, many of us would like to be there. Charlie was a gentleman and a principled fellow. I enjoyed working with him on the Education Committee. And I also went toe-to-toe with him on occasion, and he did each of those equally well. And I think, as the President would say, he was a good man.

Mr. GINGREY. Thank you, Mr. Chairman.

Chairman WU. Thank you.

I ask unanimous consent that all additional statements be submitted by Committee Members to be included in the record. Without objection, so ordered.

[The prepared statement of Mr. Mitchell follows:]

PREPARED STATEMENT OF REPRESENTATIVE HARRY E. MITCHELL

Thank you, Mr. Chairman.

To compete in the global economy, America needs technological innovation. Innovation is often expensive, however, and not always immediately profitable. This can be especially problematic for small businesses. For me, the question isn't WHETHER we should help small businesses get the technology and training they need, it's HOW we should do so.

Today, we will hear about two such programs: the Manufacturing Extension Partnership and Advance Technology Program.

The President's budget proposes drastic cuts to these programs. I am eager to hear from today's witnesses about this. . . not only about whether they agree with these cuts, but also what kind of alternative ideas they have for assisting small businesses' technological innovation and training.

I yield back the balance of my time.

[The prepared statement of Mr. Ehlers follows:]

PREPARED STATEMENT OF REPRESENTATIVE VERNON J. EHLERS

NIST is extremely important to U.S. competitiveness. With three Nobel prizes awarded in less than a decade, I don't think anyone would disagree that the research environment fostered at NIST is enviable or that NIST's mastery of cultivating innovation is truly remarkable.

I am glad the witnesses today will highlight some of the outreach endeavors NIST is engaged in. I look forward to determining with my colleagues how programs like the Manufacturing Extension Partnership (MEP) and Advanced Technology Program (ATP) can be strengthened. I believe there are opportunities for improvement, though we must make sure we resist changes based purely on ideological grounds.

I am very pleased that the President's requests includes funding ($28 million) to begin much needed repairs and improvements to the NIST facilities in Boulder, CO. I've worked at these facilities and have seen first-hand some of their limitations. They were built more than 50 years ago and cannot provide the stable environment required for today's precision's measurements. For example, the scientists must use duct tape and plastic sheeting to protect their experiments from the unpredictable air flow in the buildings' ventilation systems. I applaud Dr. Jeffrey for undertaking a comprehensive review of the needs of the lab and assessing the most cost-effective way to upgrade the facilities.

Chairman WU. We have a very distinguished panel of witnesses, and I want to thank them for taking the time to travel the distance, whether it is 2,500 miles or a dangerous 12 miles to Capitol Hill. And in this subcommittee, at least, the dangerous part of the journey is over. You will find an inquiring, friendly environment.

Before we begin, I would like to make a short introduction of each of the panelists, other than Mr. Ryan, who has already been very well introduced by Dr. Gingrey.

First, Dr. Bill Jeffrey has been the Director of NIST for the past year and a half. Before that, he was at the White House Office of Science and Technology Policy, the Defense Advanced Research Projects Agency, and he started his career at the Defense Airborne Reconnaissance Office. Since coming to NIST, Dr. Jeffrey has been their strongest advocate within this Administration.

Dr. Stan Williams of the Hewlett-Packard Corporation is a senior HP fellow and founding Director of the Quantum Research Group. I have never been able to find anything there, and maybe you can tell me what I have been missing. Dr. Williams is an expert in nanotechnology and quantum computing. He has been awarded the Julius Springer Award for Applied Physics, the Feynman Prize in Nanotechnology, the Dreyfus Teacher-Scholar Award, a Sloan Foundation fellowship, and was named by Scientific American as one of the 50 top technology leaders.

Mr. Michael Borrus is the founding general partner of X/Seed Capital, a seed-focused, early-stage venture fund. That, plus your youth, must be where the "X" comes from. He has taught at UC–Berkeley and is the author of three books on high-tech issues.

Mr. Peter Murray is the Vice President of Welch Allyn, a prominent manufacturer of patient-monitoring equipment with a footprint across the world but with a location, importantly, in Bea-

verton, Oregon. His company has relied upon the services of the Oregon Manufacturing Extension Partnership, or the MEP, center in Oregon.

And Dr. Gingrey has already introduced Mr. Ryan.

And if I may have the envelope, please. No envelope.

Gentlemen, I understand that you all have submitted substantial materials in writing. We have a five-minute period for a statement, and if you could, please, summarize and point out the highlights or lowlights, or both, of your written testimony.

Dr. Jeffrey, let us begin with you.

STATEMENT OF DR. WILLIAM JEFFREY, DIRECTOR, NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY, TECHNOLOGY ADMINISTRATION, U.S. DEPARTMENT OF COMMERCE

Dr. JEFFREY. Thank you.

Chairman Wu, Ranking Member Gingrey, and Members of the Subcommittee, I am pleased to present the President's 2008 budget request for NIST. This is a strong budget that will further enhance our abilities to support the measurements and standards needs of U.S. industry and academia.

NIST has a long history of being at the forefront of new innovations through our measurements and standards. In 2003, the National Academy of Engineering identified the greatest engineering achievements of the 20th century. NIST measurements and standards were integral to the successful development and adoption of virtually every one.

Nineteen retrospective studies of economic impact show that, on average, NIST labs generated a benefit-to-cost ratio of 44:1 to the U.S. economy. The high rate of return results from the fact that new measurements or standards benefit entire industries or sectors of the economy as opposed to individual companies.

For example, NIST researchers recently developed new measurement techniques that cut up to 80 percent of the cost and time for industry to develop advanced materials. As one industry scientist put it, NIST's scientists are reawakening a major element of creativity that analytical science almost lost.

NIST also operates world-class user facilities. Last year, approximately 2,000 researchers from 60 different industries leveraged the NIST Center for Neutron Research, or the NCNR. A National Academy of Science's report describes the NCNR's capability to image and operate a fuel cell as "a considerable achievement and one of the most significant analytical advances in the membrane fuel cell realized in decades." Industry scientists have stated that the research performed at the NCNR has allowed them to jump five years ahead in fuel cell development.

To prepare for the future, NIST is working with industry to identify critical measurement barriers to innovation, evaluating its physical infrastructure, forming new and strengthening existing partnerships, and updating ways to stimulate the knowledge transfer from its labs to industry and academia.

The increased funding provided through the budget request will directly support innovative advances in broad sectors of the economy as well as improve the safety and quality of life for our citi-

zens. For example, the research initiatives will speed the development and foster the adoption of nanotechnology products and provide the physical measurements to ensure their safety, accelerate the revolutionary economic potential in exploiting the unique properties of the quantum world, provide confidence and reduce uncertainty in measurements supporting global climate change models, reduce the risk to communities as they encroach on hurricane-prone coasts and fire-prone wildland urban interface regions, and enhance the safety of new and existing structures from the catastrophic impact of earthquakes.

To meet the demands for measurements at ever-smaller scales, at faster rates, and with more accuracy, it requires excellent laboratory and user facilities. The budget request, therefore, includes capacity and capability improvements at both our Boulder campus and the NCNR.

The budget request for MEP is identical to last year's request and is a reduction of $58.3 million from the fiscal year 2006 enacted.

I recognize the difference in priority between the Administration and Congress regarding the federal funding level for the MEP program. One thing that you can be certain of, regardless of the final appropriations: NIST will execute the program in the most effective manner possible to support the Nation's small manufacturers.

No funds for ATP are requested in the President's 2008 budget. The 2006 enacted budget was consistent with the phase-out of the program. The 2007 Joint Resolution, however, included funding for ATP. And I understand it was approved by the Senate last night, and assuming it is signed by the President, NIST will initiate a new competition in 2007.

In summary, recent NIST measurements and standards research have enabled innovations now embedded in the iPod, body armor, saving the lives of domestic law enforcement officers and our service men and women overseas, and diagnostic screening devices for cancer patients making their treatment more targeted and accurate. The results of NIST research can be found in virtually every manufacturing and service industry.

For more than a century, NIST research has been critical to our nation's competitiveness. The increased funding requested for NIST will directly support innovations in broad sectors of the economy that will, quite literally, define the 21st century.

Thank you, and I would be happy to answer any questions.

[The prepared statement of Dr. Jeffrey follows:]

PREPARED STATEMENT OF WILLIAM JEFFREY

Chairman Wu, Ranking Member Gingrey and Members of the Subcommittee, I am pleased to appear before you today to present the President's FY 2008 Budget request for the National Institute of Standards and Technology (NIST). This is a strong budget for NIST and it will further enhance NIST's ability to support the measurement and standards needs of U.S. industry and universities. The FY 2008 request of $640.7 million includes $594.4 million for NIST's core (encompassing NIST's research and facilities) and $46.3 million for the Hollings Manufacturing Extension Partnership. The budget for the NIST core represents an 11 percent increase over the President's FY 2007 request and a 21 percent increase over the proposed FY 2007 joint resolution (H.J. Res. 20) recently passed by the House and sent to the Senate. This funding supports NIST's mission *to promote U.S. innovation and industrial competitiveness by advancing measurement science, standards and technology in ways that enhance economic security and improve our quality of life.*

NIST's Impact on Innovation and the Economy

NIST has a long history of being at the forefront of new innovations through our high-impact measurements and standards. In 2003, the National Academy of Engineering identified 20 of the greatest engineering achievements of the 20th century—including automobiles, aircraft, lasers, computers, and the Internet. NIST measurements and standards were integral to the successful development and adoption of virtually every one. Now NIST is paving the way for the greatest achievements of the 21st century which are still yet to be imagined.

NIST's measurement science and standards form part of the foundation upon which innovation is built. Just as the Nation's physical infrastructure (e.g., roads or power grid) define the Nation's capacity to build and transport goods—the Nation has an innovation infrastructure which defines the Nation's capacity to innovate. And investment in long-term basic research like that done at NIST is an integral component of the innovation infrastructure. As stated in the National Academy of Sciences' *Rising Above the Gathering Storm,* "The power of research is demonstrated not only by single innovations but by the ability to create entire new industries."

NIST researchers are world leaders in their fields. They frequently arrive at the "cutting edge" of science before anyone else. And once there, they partner with industry and academia to identify and overcome barriers that can slow or even halt the progress of new innovations. With the proposed FY 2008 budget, NIST will continue developing the measurement and standards tools that enable U.S. industry to maintain and enhance our global economic competitiveness.

NIST continues to meet the Nation's highest priorities by focusing on high impact research and investing in the capacity and capability of our user facilities and labs. This emphasis is validated by the high rate of return to the Nation that the NIST labs already have demonstrated. Nineteen retrospective studies of economic impact show that, on average, NIST labs generated a benefit-to-cost ratio of 44:1 to the U.S. economy. The high rate of return results from the fact that new measurements or standards benefit entire industries or sectors of the economy—as opposed to individual companies.

NIST supports U.S. innovation and economic competitiveness primarily through its measurements, standards, and national user facilities. Recent NIST successes highlight the importance of each of these critical components and illustrate how NIST's labs are able to return such a large benefit to the Nation:

Measurements—NIST researchers recently developed new measurement techniques that allow for rapid and cost-effective assessments of advanced materials that are used in a range of products from new detergents to improved adhesives for next-generation electronics. Previously, it could cost industry $20 million to develop and understand the characteristics of one new material. With this NIST measurement advance, the cost and time are estimated to have been cut by 80 percent. To facilitate the transfer of this technique to industry, NIST organized an open consortium now consisting of 23 members that are learning to use and adapt these new measurement techniques. As a scientist from Honeywell International put it, *". . .NIST offers an invaluable resource to show what can be done, and how to go about it. NIST Combinatorial Methods Center scientists are reawakening a major element of creativity that analytical science almost lost."*

Standards—Nanotechnology has the potential to revolutionize manufacturing. And one of the most promising nanomaterials is the carbon nanotube. Carbon nanotubes have unique electronic and mechanical properties that lend themselves to a variety of applications, ranging from the development of stronger and lighter materials to nanowires and transistors for miniature electronics. Regardless of the potential application, the quality of the materials is paramount. Unfortunately, current production techniques for carbon nanotubes result in products with high levels of uncertainty in their quality and uniformity. To address this concern, NIST is currently developing a carbon nanotube reference material. This reference material, when deployed, can be used by any nanotube manufacturer to validate their product's quality, purity, and consistency and accelerate the adoption of carbon nanotubes into more sophisticated devices.

National User Facilities—NIST operates world-class user facilities that benefit the entire U.S. research community. Last year, approximately 2000 researchers from 60 different industries across the country leveraged the NIST Center for Neutron Research (NCNR). One recently developed application of the NCNR was to image the interior of operating fuel cells to help improve the efficiency and durability of these devices. Large and small companies involved in the manufacture or use of hydrogen fuel cells, including General Motors, Daimler-Chrysler, Dupont, and PlugPower, have benefited from this new capability. The NCNR is the premier facility in the world providing this capability. A National

Academy of Sciences report describes the NIST efforts in regards to fuel cell technologies as *". . .a considerable achievement and one of the most significant analytical advances in the membrane fuel cell realized in decades. The NIST facility offers the entire fuel cell community unique research opportunities that previously eluded them."* Industry scientists have stated that the research performed at the NCNR has allowed them to jump five years ahead in terms of fuel cell development.

The President recognized NIST's critical role for the Nation as part of the American Competitiveness Initiative (ACI). The ACI describes NIST as: *". . .a high-leverage federal research agency that performs high-impact basic research and supports the successful technical translation and everyday use of economically significant innovations. . ."* Under the ACI, overall funding for NIST's core, the National Science Foundation, and the Department of Energy's Office of Science is together slated to double by 2016.

Preparing for the Future

The 21st century will be defined by technology innovations that fundamentally change the products and services available, the way they are manufactured and provided, and the impact on our quality of life. These advances will arise from basic research now beginning in, for example, nanotechnology, quantum science, and alternative energies—all areas in which NIST has a strong and increasing focus with its investments.

The goal of increasing physical sciences research at NIST (along with that supported by the National Science Foundation and the Department of Energy's Office of Science) provides a unique opportunity to strategically establish the programs, plans, and infrastructure that will more than double the impact that NIST has on the economy. To prepare for the future, NIST is working with industry to identify critical measurement barriers to innovation, evaluating the capacity and capability of NIST's physical infrastructure, forming new and strengthening existing partnerships, and updating the ways it stimulates the knowledge transfer from its labs to industry and academia.

For example, over the past year, NIST worked with over 1,000 experts from industry and universities to identify measurement barriers to innovation in a number of critical industry sectors. Over 700 technical barriers were identified, analyzed, and documented in a report. NIST is now in the process of working with industry, universities, and other government agencies to address many of these identified barriers over the coming years.

In terms of facilities, NIST has conducted a rigorous evaluation of its laboratory capacity and capabilities on its Boulder, Colorado, campus. This review found facilities' shortfalls in our ability to meet both current and projected industry and university needs in a number of important areas. Examples include the high-speed and high-frequency measurements required for electronics, defense, and homeland security; measurements and tests at the single atom level; and improved methods for measuring time, an area expected to vastly improve navigation and positioning systems. Each technical area was evaluated in terms of necessary laboratory conditions (to include stability of temperature, vibration, and humidity, as well as air cleanliness). As a result of this assessment, new laboratory space to meet the Nation's needs well into the 21st century is proposed in the FY 2008 budget (Boulder Building 1 Extension).

NIST also serves industry and academia by being a steward of world-class user facilities. As part of the ACI, NIST identified two important opportunities first called out in the FY 2007 budget and enhanced in the FY 2008 budget—increased capacity and capability of the NIST Center for Neutron Research and creation of the NIST Center for Nanoscale Science and Technology. Both of these facilities are designed to stimulate progress in support of our nation's economic competitiveness.

The ACI provides NIST the opportunity to further promote U.S. innovation and industrial competitiveness. With focused, world-class research and facilities, NIST will have a greater impact on the 21st century economy than it did even over the past century.

FY 2008 President's Budget

The increased funding provided through the FY 2008 request will directly support innovative advances in broad sectors of the economy as well as improve the safety and quality of life for our citizens. The following table summarizes the proposed FY 2008 budget. In this table we show both the FY 2007 President's budget and the FY 2007 joint resolution (H.J. Res. 20) for comparisons as different baselines.

Budget Summary ($ million) Showing Both FY 2007 President's Request and H.J. Res. 20 as Baselines

	FY 2007 President's Request	FY 2007 H.J. Res. 20[1]	FY 2008 President's Request		Change Between FY 2008 and FY 2007 Request	Change Between FY 2008 and H.J. Res. 20
STRS (Labs):	467.0	432.8	500.5		33.5	67.7
CRF (Facilities):	68.0	58.7	93.9		25.9	35.2
Core Subtotal:	535	491.4	594.4		59.4	102.9
ITS (MEP + ATP) Subtotal:	46.3	183.6	46.3		0	(137.3)
TOTAL:	581.3	675.1	640.7		59.4	(34.4)

[1] Totals for FY2007 do not include the 50% of the pay raise that was included in H.J.Res. 20.

The FY 2008 budget was formulated with the FY 2007 President's request as the baseline. Since H.J. Res. 20 provides a smaller budget for the NIST core (STRS and CRF) than the FY 2007 President's request by $43.6 million, some proposed initiatives in FY 2007 that will not receive full funding are implicitly contained within the President's FY 2008 request. New initiatives are described in more detail below:

Scientific and Technical Research Services (STRS)

Enabling Nanotechnology from Discovery to Manufacture (+$6 million)

The potential market for products containing nanomaterials is estimated at over $1 trillion by 2015. Because of their small size—a thousand times thinner than a human hair—nanoscale products require entirely novel ways to characterize their physical properties and fully exploit their unique characteristics in the manufacture of new products.

In FY 2007, NIST began a major initiative to address the measurement barriers hindering rapid development of nanotechnologies. A new NIST Center for Nanoscale Science and Technology (CNST) has been established that combines both research and a state-of-the-art nanofabrication and nanometrology user facility.

The research initiatives proposed in FY 2008 will build on recent NIST advances by:

- Developing ways to measure strength, stress, strain, optical, and electronic properties of nanostructures to improve processes and understanding of failure mechanisms;
- Creating three-dimensional, high-resolution imaging methods that reveal details of structure, chemical composition, and manufacturing defects and allow researchers to view nanostructures as they interact with their environment;
- Simulating nanoscale phenomena with computer models to allow economical development of production methods for complex nanodevices; and
- Producing the measurement techniques required to address the interagency efforts to characterize nanotechnology impacts to our health, safety, and environment.

Measurements and Standards for the Climate Change Science Program (+$5 million)

The climate is changing. Determining how fast it is changing, and understanding the complex relationships between all the environmental variables is a critical objective of the U.S. Climate Change Science Program. Many different climate monitoring systems in space, in the air, and on the ground are currently monitoring solar output as well as trapped and reflected heat by the Earth's atmosphere. These systems are operated by many countries and research groups. Establishment of absolute calibration and standard references will allow accurate inter-comparisons of these systems, will help identify small environmental changes occurring over many years, and will reduce uncertainties in the data input to global climate change models.

With the proposed FY 2008 funding, NIST will, working in coordination with other agencies, develop:

- An international irradiance measurement scale to be used in rigorously calibrating satellite light intensity instruments prior to launch to ensure sufficient accuracy to allow valid comparisons among results from different instruments or from data sets taken over different periods of time;

- New instrument design strategies and quality assurance programs to optimize accuracy and stability of satellite-based irradiance measurement systems;
- Techniques for generating specific types of aerosols in the laboratory, measuring aerosol optical and physical properties, and for simulating aerosol properties that cannot yet be measured in the laboratory; and
- A database of critically evaluated data on aerosol properties collected at NIST and elsewhere.

Enabling Innovation Through Quantum Science (+$4 million)

Unlike the laws of physics that govern our "every day" world, the laws of physics that govern the quantum world of atoms, electrons, and light particles are fundamentally different. These quantum particles are able to interact in ways that according to human experience would seem impossible. For example, a quantum particle can actually be in two different places simultaneously.

Conceptualizing these phenomena is difficult to say the least, but developing ways to exploit them for the development of technologically significant innovations is even more challenging. NIST, however, has world-class scientists who are leaders in the emerging field of quantum information science. Three NIST scientists have won Nobel Prizes in the last 10 years based on their work in this field. Many of the best minds in physics today believe that applications of quantum science will transform the 21st century just as integrated circuits and classical electronics revolutionized the 20th century.

The proposed FY 2008 initiative will build upon NIST's significant expertise in this area, and leverage the collaborations established in the recently created Joint Quantum Institute between the University of Maryland, NIST, and the National Security Agency. NIST proposes to accelerate the potential of the quantum world for enhancing our nation's competitiveness through research into:

- Quantum "wires" that use "teleportation" techniques to reliably transport information between the components of a simple quantum computer;
- Quantum memory analogous to the random access memory of today's computers to allow more complex logic operations;
- Quantum conversion processes that transfer information from one form of quantum information to another (for example, ways to transfer information about the quantum characteristics of an atom to a photon); and
- Quantum based measurement tools such as optical clocks and single electron counters.

Disaster Resilient Structures and Communities (+$4 million)

The past few years have reminded us that both natural hazards—including extreme winds, storm surge, wildland fires, earthquakes, and tsunamis—as well as terrorist actions, are a continuing and significant threat to U.S. communities. The disaster resilience of our physical infrastructure and communities today is determined in large measure by the building codes, standards, and practices used when they were built. Many of these legacy codes, standards, and practices—which have evolved over several decades—are oversimplified and inconsistent with current risk assessments. As construction and rebuilding costs continue to rise, there is increasing recognition of the need to move from response and recovery to proactively identifying and mitigating hazards that pose the greatest threats.

The proposed FY 2008 initiative will, working in coordination with other agencies, develop:

- Standard methods to predict losses, evaluate disaster resilience, and estimate cost-to-benefit of risk management strategies at the community and regional scales that local officials can use to evaluate and mitigate risks via land-use planning and practices;
- Decision support tools to modernize codes, standards, and practices consistent with the risk;
- A validated "computational wind tunnel" for predicting extreme wind effects on structures; and
- Risk-based storm surge maps for the design of structures in coastal regions.

National Earthquake Hazards Reduction (+$3.25 million)

Many earthquakes strike without warning. Within the U.S., more than 75 million people are located in urban areas considered to be of moderate to high risk of earth-

quakes. Just the economic value of the physical structures within these regions—not including the potential loss of life and economic disruption—is valued at close to $8.6 trillion. To address this threat Congress (and this committee in particular) has provided longstanding support for the National Earthquake Hazards Reduction Program which NIST coordinates across the Federal Government.

This initiative will enhance the safety of:

- *New structures* by establishing and promoting performance-based standards for entire building designs and by accelerating the adoption of basic research into the model building codes, standards, and practices; and
- *Existing structures* through research on actual building performance in earthquakes; developing structural performance models and tools; and establishing cost-effective retrofit techniques for existing buildings.

Construction of Research Facilities (CRF)

Building 1 Extension (B1E)—Enabling Sustained Scientific Advancement and Innovation (+$28 million)

When President Eisenhower dedicated the NIST facilities in Colorado in 1954, no one imagined that half a century later scientists would be manipulating matter atom-by-atom. Such technological advances require increasingly complex and difficult measurements—to be able to observe, characterize, and create structures at ever smaller spatial scales. As the structures shrink in size, small fluctuations in temperature, humidity, air quality, and vibration begin to distort the results. We are now at the point where laboratory conditions are inhibiting further advances in some of the most promising areas of research for the 21st century.

The $28 million proposed in the FY 2008 budget will leverage previously proposed funds ($10.1 million) in the FY 2007 budget to construct state-of-the-art laboratory space that will meet the stringent environmental conditions required for 21st century scientific advances. An additional $38.1 million will be needed in FY 2009 to complete the project. With a total cost of $76.2 million, the Building 1 Extension is the most cost-effective approach to enabling world-class measurement science in support of some of the country's most important economic sectors.

NIST Center for Neutron Research (NCNR) Expansion and Reliability Improvements (+$19 million)

The NCNR is widely regarded as the most scientifically-productive and cost-effective neutron facility in the U.S., and serves more scientists and engineers than all other U.S. facilities combined. Neutron scattering techniques, in which beams of neutrons are used as probes to see the structure and movements of materials at the smallest scales are critical in a wide range of applications that will define the 21st century including nanotechnology, alternative energies, and understanding the structure of biological molecules. Because of the unique properties of neutrons for probing materials and their applications to some of the most advanced technologies, a significant shortage of neutron beam capacity and capability exists in the U.S. to satisfy the demands of industry and academia.

This initiative begun in FY 2007 is the second-year of a planned five-year program to expand significantly the capacity and capabilities of the NCNR. The program includes the development of a new neutron cold source together with a new hall to house the guide tube, modernization of the control system, and five new world-class neutron instruments. The specific FY 2008 funding will complete construction of the new guide hall.

Industrial Technology Services

Hollings Manufacturing Extension Partnership (MEP) ($46.3 million—no change from FY 2007 President's request; -$58.3 million from H.J. Res. 20)

The MEP program is a partnership between the Federal Government and local officials to provide assistance to small and medium-sized manufacturers around the country. Surveys taken of companies one year after receiving MEP assistance indicate a significant financial benefit accrued to the individual company.

The Federal Government is an important partner in the MEP program. Specifically, the Federal Government:

- Develops new services and programs in response to the evolving manufacturing environment and propagates them throughout the network;
- Evaluates and ensures high-quality performance of every member of the network; and

- Ensures that small manufacturers remain the focus of the effort.

The above federal role can be accomplished within the requested budget. The reduction of federal funds to the local centers may have to be compensated through a combination of increased fees derived from the benefits accrued by individual companies and cost-savings in the operations of the centers.

Advanced Technology Program (ATP) ($0—no change from FY 2007 President's request)

No funds for ATP are requested in the President's FY 2008 budget. The FY 2006 enacted budget and the 109th Congress' House mark and Senate Appropriations Committee mark were consistent with the phase-out of the ATP program. The last new awards were made in 2004 and sufficient funds were available in the carryover to complete all awards and provide government oversight.

The FY 2007 Joint Resolution (H.J. Res. 20) recently passed by the House included funding for the ATP program. If enacted, NIST will work with Congress to ensure the funds are executed in the most effective manner to promote U.S. industry's competitiveness.

Summary

Measurements and standards are the bedrock upon which any economy stands. Our founding fathers recognized this. The Constitution assigns the Federal Government responsibility to both issue money and to *"fix the standards of weights and measures."* The two are actually more similar than they might seem at first glance.

All economic transactions rest fundamentally on trust—trust between two parties that a given amount of something is worth a given amount of something else. Helping to create that trust for innovative new technologies is the common theme that runs through all of NIST's proposed FY 2008 research initiatives. Each helps build a missing or inadequate measurement base—a rigorous, accepted way of quantitatively describing something—that improves confidence in scientific results or improves the quality, reliability or safety of innovative products. Recent NIST measurements and standards research have enabled innovations now embedded in the iPod, body armor currently saving the lives of domestic law enforcement officers and our service men and women overseas, and in diagnostic screening devices for cancer patients making their treatment more targeted and accurate. The results of NIST research can be found in virtually every manufacturing and service industry.

For nearly 106 years, NIST research has been critical to our nation's current and future competitiveness. The increased funding in the President's FY 2008 budget for the NIST core will directly support technological advances in broad sectors of the economy that will quite literally *define* the 21st century—as well as improve the safety and quality of life for all our citizens.

BIOGRAPHY FOR WILLIAM JEFFREY

Dr. William Jeffrey is the 13th Director of the National Institute of Standards and Technology (NIST), sworn into the office on July 26, 2005. He was nominated by President Bush on May 25, 2005, and confirmed by the U.S. Senate on July 22, 2005.

As Director of NIST, Dr. Jeffrey oversees an array of programs that promote U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology in ways that enhance economic security and improve quality of life. Operating in fiscal year 2006 on a budget of about $930 million, NIST is headquartered in Gaithersburg, Md., and has additional laboratories in Boulder, Colo. NIST also jointly operates research organizations in four locations, which support world-class physics, cutting-edge biotechnology, and environmental research. NIST employs about 2,800 scientists, engineers, technicians, and support personnel and has extensive cooperative research programs with industry, academia, and other government agencies. Its staff is augmented by about 2,500 associates and visiting researchers from industry and universities.

Dr. Jeffrey has been involved in federal science and technology programs and policy since 1988. Previous to his appointment to NIST he served as Senior Director for Homeland and National Security and the Assistant Director for Space and Aeronautics at the Office of Science and Technology Policy (OSTP) within the Executive Office of the President. Earlier, he was the Deputy Director for the Advanced Technology Office and Chief Scientist for the Tactical Technology Office with the Defense Advanced Research Projects Agency (DARPA). While at DARPA, Dr. Jeffrey advanced research programs in communications, computer network security, novel sensor development, and space operations.

Prior to joining DARPA, Dr. Jeffrey was the Assistant Deputy for Technology at the Defense Airborne Reconnaissance Office, where he supervised sensor development for the Predator and Global Hawk Unmanned Aerial Vehicles and the development of common standards that allow for cross-service and cross-agency transfer of imagery and intelligence products. He also spent several years working at the Institute for Defense Analyses performing technical analyses in support of the Department of Defense.

Dr. Jeffrey received his Ph.D. in astronomy from Harvard University and his B.Sc. in physics from the Massachusetts Institute of Technology.

Chairman WU. Thank you, Dr. Jeffrey.

Dr. Williams.

STATEMENT OF DR. R. STANLEY WILLIAMS, SENIOR HP FELLOW IN QUANTUM SCIENCE RESEARCH, HEWLETT-PACKARD CORPORATION

Dr. WILLIAMS. Chairman Wu and Representative Gingrey, I thank you for this opportunity to testify before you today on behalf of ASTRA, the Alliance for Science and Technology Research in America.

Benjamin Franklin, often called the "first American," was also the first American scientist. He understood that science was not just a pastime to demonstrate wealth or satisfy curiosity, but rather a force that could generate wealth and be utilized for the public good. Franklin performed careful experiments to characterize electrical phenomena. He was the first to understand the nature of electrical conduction and he utilized his knowledge to invent the lightning rod, which was one of the most important technical advances of his day. Thus, Franklin created the distinctly American paradigm for technological innovation: If you measure something that has never been quantified before, you can discover something that has never been known before, which enables you to invent something, which has never existed before. He said, "An investment in knowledge always pays the best interest."

Over a period of nearly two centuries, American technological innovation has been the primary source of our wealth in this country. ASTRA was founded in 2000 to work on behalf of and provide a more effective voice for industry, academia, and professional associations involved in the technology enterprise. Our members represent an underlying constituency of more than 2.4 million scientists and engineers in the United States who work every day to build a stronger America.

The focus of today's testimony is NIST. And I gratefully acknowledge the extensive collaborations that Hewlett-Packard, in general, and my research group, in particular, have enjoyed with NIST scientists. ASTRA strongly endorses the doubling of the NIST budget because of its unique role and strategic importance to our country's research ecosystem.

The mission of NIST is to promote U.S. innovation and industrial competitiveness by advancing metrology, standards, and technology to enhance economic security and improve our quality of life. As a government agency, it does so objectively without favor or advantage to any preferred technology or enterprise. Unfortunately, the essential role NIST plays in enabling the competitiveness of American industry has often been under-recognized.

Among other activities, NIST develops and improves measurement technologies, supplies critical reference standards used across industries to calibrate their products and services, and from my point, most importantly, provides verified and reliable technical data to the scientific community. NIST scientists act as a critical check on the often conflicting and confusing claims coming out of various research labs. I consider these activities to be the core of the NIST mission and the keystone for technological innovation. Before we can discover and invent today, we must measure with extraordinary precision and trust the results.

I compliment NIST on the extent of its efforts to understand and respond to the needs of industry and on the quality of its oversight programs. However, it is my observation that the scientific staff at NIST are now overwhelmed by their responsibilities. The number of new program areas that have been added to the NIST portfolio has really exceeded their funding increases. This mission creep has stretched the staff and slowed their ability to respond. In some cases, it has taken several years to complete key measurements, which can make them less valuable in an era of rapid technological change.

In order to respond to new opportunities, NIST scientists often have to compete for grant funding from other federal agencies. While such activities can meet important governmental needs, the need for such activities should be an exception.

ASTRA strongly recommends that all current NIST missions and programs, including the newly-created NIST Center for Nanoscale Science and Technology, the ATP and the MEP should be adequately funded and supported by Congress and the Administration under the doubling initiative. These programs are sound investments with high potential returns for American taxpayers. We should resist the temptation of adding new responsibilities, especially unfunded ones in 2008 and the future until we can be certain that the current missions will be adequately served. An important issue to realize here is that during the next five years, the amount of scientific information that we will accumulate will double. In other words, we will learn as much about science over the next five years as we have over all of human history. So we somehow need to keep up with this information glut and make it something that we can internalize and understand and utilize.

NIST must attract and hire a continuous stream of world-class researchers in order to carry out its mission. The three Nobel Prizes awarded to NIST staff in the past years demonstrate the quality of the current staff and have brought overdue recognition to NIST. However, in my view, the current climate at NIST is strained with the technical staff having to work harder and longer to accomplish less. The budget doubling should be accomplished in a manner that the research, support, and infrastructure is improved to make the current staff more flexible and productive, which will, in turn, attract new scientific stars to the NIST staff.

In summary, ASTRA believes that NIST must maintain its world leadership in metrology and understanding the infrastructure of emerging technologies in order for the United States to remain technologically and economically competitive. Nanotechnology, I

think, is an ideal area of focus because of the tremendous potential of economic rewards and the acute demand it places on metrology.

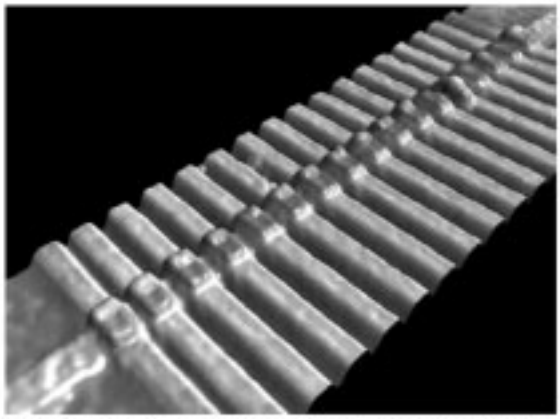
NIST holds the key to American technological innovation and competitiveness. Today, more than ever, exquisite measurement is necessary for discovery and invention.

I thank you for this opportunity to speak to you today on these important issues.

[The prepared statement of Dr. Williams follows:]

PREPARED STATEMENT OF R. STANLEY WILLIAMS

Chairman Wu, Representative Gingrey and distinguished Members of the House Subcommittee on Technology and Innovation; I thank you for this opportunity to testify before you today on behalf of ASTRA, the Alliance for Science and Technology Research in America. My name is Stan Williams, and I am a Hewlett-Packard Senior Fellow and the founding Director of H–P's Quantum Science Research Group in Palo Alto, California. Our laboratory was created in 1995 at the behest of David Packard to prepare HP for the major challenges and opportunities ahead in electronic device technology as feature sizes continue to shrink to the nanometer scale, where quantum mechanics dominates the behavior of matter.



An atomic force microscope image of a 'serial implication logic circuit'. Each switch in this circuit (orange) is about the size of the smallest known virus (i.e. ~25 nm). Image courtesy HP Labs.

I. Background

Benjamin Franklin has been called by many people the "first American." He was also the first American scientist of world renown. Franklin understood that science was not just a pastime to demonstrate wealth or satisfy curiosity, but rather a force that could generate wealth and be utilized for the public good. He performed careful experiments to characterize electrical phenomena: he was the first to understand the nature of electrical conduction and he utilized his knowledge to invent the lightning rod. Thus, Franklin created the distinctly American paradigm for technological innovation: If you measure something that has never been quantified before, you can discover something that has never been known before, which enables you to invent something that has never existed before. He was also prescient about the funding of research when he said "An investment in knowledge always pays the best interest."

Benjamin Franklin Tercentennary
$1 Commemorative Coin from U.S. Mint, 2006

Over a period of two centuries, technological innovation became the goose that laid the golden eggs for American society. Inventions such as the telephone, light bulb, radio, phonograph, vacuum tube, transistor, laser, and integrated circuit, among many others, have created huge industries that employ our citizens, improve our lives, and supply a large fraction of the tax dollars collected by the U.S. Government.

However, toward the end of the last century, we started to become complacent and neglectful. Our wonderful goose was slowly being starved, and the consequences of that were alarming indeed. This situation brought scientists like me to Washington in a new role—rather than trying to obtain a research grant, we had to learn to represent the entire scientific enterprise in the annual budgetary process so familiar to you but foreign to us.

ASTRA was founded in 2000 to work on behalf of, and provide a more effective voice for, industry, academe, and professional and trade associations involved in the technology enterprise. Our members, in turn, represent an underlying constituency of more than 2.4 million scientists and engineers in the United States. We have had the pleasure of working with many of you on bipartisan efforts over the years, and together we have accomplished a great deal. But as you know, this work is never done, and there have been a significant number of emergencies and distractions that have prevented us from reaching our goals.

We must succeed in revitalizing the math, physical science and engineering infrastructure of the United States. The cost of failure is too grim to contemplate. One necessary component of this revitalization is the doubling of the budgets of the National Science Foundation, the Department of Energy's Office of Basic Energy Sciences, Department of Defense 6.1 research and the National Institute of Standards and Technology, preferably on a five-year time frame. We must do this before we lose an entire generation of American scientists and engineers and become completely reliant on other countries for our technology. I have appended several graphs to my presentation to illustrate the situation we face today, especially in the context of global competition.

The primary focus of today's testimony is NIST. I gratefully acknowledge the extensive collaborations that HP in general, and my research group in particular, have enjoyed with NIST scientists over the years, and the crucial contributions they have made to American industry. ASTRA has paid special attention to NIST because of its unique role and strategic importance to our country's research "ecosystem."

II. NIST in Context

The mission of NIST is "To promote U.S. innovation and industrial competitiveness by advancing measurement science (or metrology), standards, and technology in ways that enhance economic security and improve our quality of life." As a government agency, it does so objectively, without favor or advantage to any preferred technology or enterprise. NIST has been described before this committee—by representatives of both Republican and Democratic Administrations—as the "crown

jewel of the federal laboratories," since it is recognized as the broadest and strongest national metrology institution in the world. Unfortunately, the essential role NIST plays in enabling the competitiveness of American industry has often been under-recognized.[1]

Among other activities, NIST develops and improves measurement technologies, supplies critical reference standards used across industries to calibrate their products and services, and provides verified and reliable technical data to the scientific community. NIST scientists act as a critical check on the often conflicting claims coming out of various research labs on the discovery of new phenomena. In our group at HP, we consider it to be the ultimate validation of our claims when NIST scientists reproduce our experimental results. We are eager to collaborate with NIST to ensure our measurements are as good as they can be. These activities are the keystone for technological innovation—before we can discover and invent today, we must measure with extraordinary precision and trust the results.

Metrology is also an essential enabler of standards, especially those standards that describe the properties and performance of products. A customer can make wise choices among competing products only when the specifications of those products are determined accurately, using the same or consistent methods.[2]

III. The Need for Additional Resources and Avoiding Mission Creep

I would like, first of all, to compliment NIST on the extent of its efforts to understand and respond to the needs of its industrial constituency and on the quality of its oversight programs. These efforts start at the highest levels of NIST management, with the statutory (15 U.S.C. 278) NIST Visiting Committee on Advanced Technology (VCAT). VCAT members are high level executives and managers, two-thirds of whom must, by law, represent U.S. industry. They advise the NIST Director on broad policy issues and report their views to the Secretary of Commerce and Congress.

For more detailed advice, NIST contracts with the National Research Council (NRC) to review, annually and in depth, the technical direction of its individual scientific programs. The results of this review are reported to NIST staff at all levels, and are publicly available through the NRC. And as in many large organizations, each organizational unit of NIST develops its own strategic and tactical plans.

Recently there has been a noteworthy effort at NIST to structure its knowledge of industrial measurement needs. The first result was a special report issued last year called "An Assessment of the United States Measurement System: Addressing Measurement Barriers to Accelerate Innovation." NIST should be commended for this proactive effort to understand measurement needs and to promote greater dialog with industry.

All this said, it is my observation that the scientific staff at NIST are now overwhelmed by the volume of work that they face. In the past, the number of new programs and responsibilities that have been added to the NIST portfolio has dramatically over-reached their funding increases. This mission creep has stretched the staff very thin, and has made their response time quite long.[3]

In some cases, it has taken several years to complete key measurements, which can make them ineffectual in an era in which a new technology can become obsolete in a single year. Some projects have taken so long they have not survived reorganizations or staff reassignments. In order to respond to new opportunities, NIST scientists often have to compete for grant funding from other government agencies, which creates even more demands on their time.

According to the NIST web site, in FY 2006, roughly 25 percent of the approximately $520 million NIST expended for Scientific and Technical Research and Services was from such contracts. While these activities can meet important governmental needs, they diminish the Institute's flexibility in responding to the industrial priorities it identifies. Dependence on such short-term funding also diminishes the opportunity to plan long term programs of broader benefit.

Thus, ASTRA strongly recommends that all *current* NIST missions and programs, including the newly created NIST Center for Nanoscale Science and Technology, the Advanced Technology Program and the Hollings Manufacturing Extension Partnership (MEP) Program, should be adequately funded and supported by Congress and the Administration under the "doubling" initiative. These programs are sound investments with high potential returns for American taxpayers, and should be seen in the context of managing a vital portfolio of assets and talents for the country's economic and security needs. We must resist the temptation of adding any new programs in 2008 to justify the increase in funding until we know that current missions are adequately served.

IV. Construction and Facilities

I am pleased to note that $94 million of the NIST budget proposal for FY 2008 is devoted to "Construction and Research Facilities," roughly half for maintenance and repairs and the remainder for new construction. Most of the facilities on the NIST Gaithersburg campus date from the 1960's and all of the facilities on the Boulder campus date from the 1950's.

All too often, maintenance and repairs are deferred year after year in difficult budget times, leading to buildings and facilities that are obsolete. When most of the current buildings were dedicated, nobody anticipated the manipulation of matter atom-by-atom or metering of light photon-by-photon. Such research requires facilities with extreme mechanical and thermal stability. The proposed state-of-the-art facilities will enable NIST to meet these and other emerging industrial needs.

V. NIST Involvement with Industry Must be Maintained and Expanded

Something that makes NIST exceptional among federal laboratories is the extent of involvement by NIST staff in industry activities and industrial researchers in NIST. Historically, NIST management has encouraged staff at all levels to participate in technical conferences and the activities of professional societies and trade associations, and through these activities to become well informed about industrial trends and measurement needs. Even more importantly, it empowers staff to act on what they learn, providing channels through which any professional staff member can propose and advocate new projects. This culture of gathering information and acting on it is effective, and it is essential that it be maintained.

An example of NIST collaboration with industry is its participation in the International Technology Roadmap for Semiconductors. The roadmap process brings together over 800 experts from around the world to identify technical barriers that would prevent continued advances in semiconductor technology. Almost three quarters of the roadmap participants are from industry, with the remainder from universities, research institutes and consortia, and from government. NIST co-chairs and has four scientists on the Metrology technical working group, and also has experts on the Emerging Research Devices and Materials, Assembly and Packaging, Factory Integration, and RF for Wireless working groups. Through this interaction, NIST is very familiar with the industry's needs and can direct internal NIST metrology research to address these challenges. NIST should continue to host user facilities for both academic researchers and industry. Areas like the neutron facility for materials testing and the new nano metrology laboratory should be user friendly without a lot of bureaucratic interference.

VI. Future NIST Staffing and Workforce Development

NIST must attract and hire a continuous stream of world-class researchers in order to carry out its mission and to maintain its position as the premier metrology institute in the world. The three Nobel prizes awarded to NIST staff in the past ten years demonstrate the quality of the current staff, and have brought overdue recognition to NIST. However, the current climate at NIST is strained, with the technical staff having to work harder and longer to accomplish less. The budget doubling should be accomplished in a manner that the research support and infrastructure is improved to make the staff more flexible and productive, rather than erecting barriers and increasing red tape.

VII. Conclusion

In summary, ASTRA would like to see NIST maintain its world leadership in researching and understanding the infrastructure of emerging technologies. Increased funding and proper planning executed now will give our country vital resources that it will need to remain a major competitive force in the world economy.

The range of activities at NIST is quite broad and it should remain so. The example of nanotechnology is an ideal area to focus on because of the tremendous potential it has for the U.S. to be very competitive in a new field and the extreme demands it places on metrology. However, we have to ensure that NIST can perform its current responsibilities before tacking on any more.

Finally, there will always be debate in the science and engineering community over the details of how NIST should best use additional resource. In any case, ASTRA recognizes the need for increased support at NIST and is pleased that Congress and the Administration have recognized the importance of metrology. And we fervently hope that Congress will be able to provide NIST with the funds requested as we embark upon this exciting journey.

NIST holds the key to American technological innovation and competitiveness—measurement is necessary discovery and invention.

I thank you for the opportunity to speak to you today on these important issues.

Footnotes

1. Example of How Advances in Metrology Boost U.S. Competitiveness

As conventional integrated electronics continue to shrink, our ability to continue to increase the performance of the circuits on each chip is on a collision course with the laws of physics. A good example of the importance of advances in the science of metrology is offered by the recent HP announcement of research that could lead to integrated circuits with eight times the logic density of current chips without having to shrink the transistors on the circuit. In a paper that I published with Greg Snider in the January 24 issue of *Nanotechnology,* a publication of the British Institute of Physics, we documented how a nanoscale crossbar switch structure could be layered on top of a conventional layer of transistors to create significantly more capable field programmable gate arrays (FPGAs). A FPGA is a type of semiconductor chip that can be adapted by end-users for specific applications, and is used in a wide range of industries, including communications, automotive and consumer electronics.

To actually produce this chip in the lab, and then to introduce it into the commercial marketplace requires numerous measurements, including the width and alignment of the crossbars, the electrical characteristics of the connection between the crossbar and the conventional semiconductor device, and the presence of defects in the crossbar and substrate material. In our paper, we presented a chip model using 15-nanometer-wide crossbar wires which could be technologically viable by 2010, and a model based on 4.5-nanometer-wide crossbar wires, which could be ready by 2020. To shrink the crossbars and connect them to the semiconductor devices will require improvements in the accuracy of all of the required measurements. NIST metrology research is absolutely essential if we are to continue to improve our electronic circuits at the traditional rates that have made America the leader in this technology.

2. Semiconductor Industry of Association Written Testimony for this Hearing

Written testimony submitted to this hearing by the Semiconductor Industry Association, an ASTRA Founding Member, discusses other measurements needed to continue to increase the circuit density on each semiconductor chip, the productivity and competitiveness effects resulting from these advances, the industry-university-government collaboration through the Nanoelectronics Research Initiative to find a new technology to replace our current semiconductor logic switch, and NIST's role in keeping U.S. leadership in this area.

3. Concern About NIST Workforce Preparedness and New Missions

In my capacity representing ASTRA (and not H–P), I would like to express concern about NIST moving into fields in which they have no history or prior expertise (e.g., climate science and geophysics), and which are arguably outside of NIST's mission in support of American industry. The fact that current NIST staff are stretched too thin might exacerbate the problem. NIST reliance on contract workers and guest researchers can be a two-edged sword. Such reliance may enable "scalability" for project needs, but also create an impermanence and *ad hoc* nature to NIST as an institution. Currently, contract worker and guest researcher numbers are almost as large as the permanent S&T staff.

According to public reports, NIST currently has a staff of about 2,800—roughly half of whom are professionals in science and technology. In addition, about 1,200 guest researchers and contractors work at NIST. Though the guests and contractors are professionals who bring creativity and energy to the Institute, *they are unable to participate in inherently governmental functions,* such as measurement services performed for the public.

Neither can they participate in research under Cooperative R&D Agreements (CRADAs) with private sector collaborators, an important vehicle by which NIST research is transferred to industry.

In terms of our concern about "mission creep," all of which are laudable goals, ASTRA cites the agency's own Web Site which identifies five new initiatives which have been added to the Fiscal Year 2008 Budget Request as well as 12 Initiatives described in the FY 2007 Budget. They are:

Major components of the '08 budget request include five new initiatives in the following areas:

Enabling Nanotechnology from Discovery to Manufacture (+$6 million)

Measurements and Standards for the Climate Change Science Program (+$5 million)

Enabling Innovation Through Quantum Science (+$4 million)

Disaster Resilient Structures and Communities (+$4 million)

National Earthquake Hazards Reduction Program (+$3.25 million)

Plus continuation of 12 initiatives previously described in the FY 2007 budget:

Enabling Nanotechnology from Discovery to Manufacture

NIST Center for Neutron Research Expansion and Reliability Improvements: A National Need

Enabling the Hydrogen Economy

Manufacturing Innovation through Supply Chain Integration

Quantum Information Science: Infrastructure for 21st-Century Innovation

Structural Safety in Hurricanes, Fires, and Earthquakes

Synchrotron Measurement Science and Technology: Enabling Next Generation Materials Innovation

International Standards and Innovation: Opening Markets for American Workers and Exporters

Innovations in Measurement Science

Bioimaging: A 21st-Century Toolbox for Medical Technology

Cyber Security: Innovative Technologies for National Security

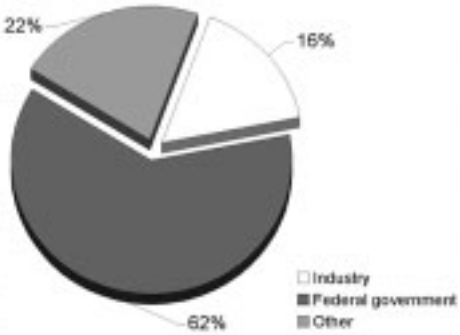
Biometrics: Identifying Friend or Foe

Facts About R&D Funding in the U.S.

Source: Unless otherwise indicated, all data in the following chart series is sourced to either the National Science Foundation's (NSF) *Science & Engineering Indicators 2006* or ASTRA.

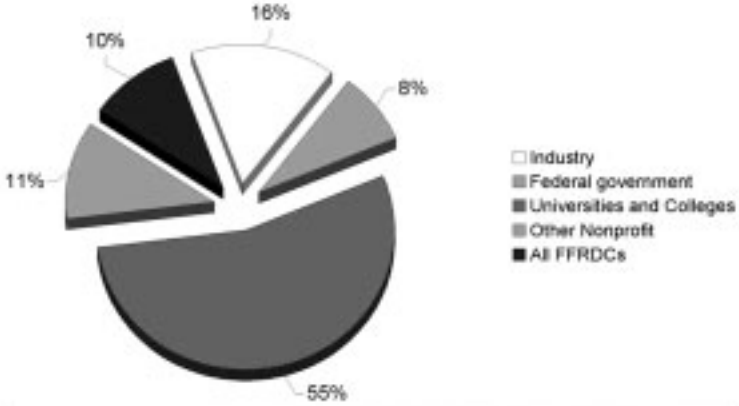
U.S. R&D Funding System Trend 1980-2005

The Federal share of total U.S. R&D has plateaued over the past generation, while industry share has increased. Most industry R&D is in applied research, not basic or "frontier" research. For 2003, the Federal share of basic research was approximately 62% of total funding. With the exception of the pharmaceutical sector, Wall Street and the investment community overall provide industry little incentive to perform frontier research. Institutional investors tend to focus on short-term profitability and quick shareholder "return of value."



Who performs Federal R&D in the U.S.?

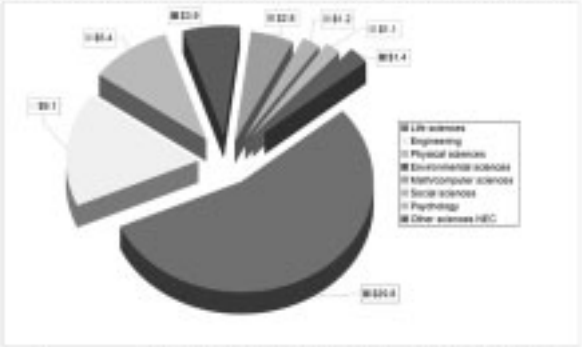
The bulk of Federal R&D funds go to universities and colleges — about 55%. Industry share is only 16%. This is one reason that the capability of universities to provide access to intellectual property discovered in the academic setting is a critical topic. Congress is expected to hold hearings during 2007 on the effectiveness of the *Bayh-Dole Act*, which governs many aspects of this strategic intersection of private and public scientific research funding.



Appendix to ASTRA Testimony of Dr. Stan Williams, February 15, 2007

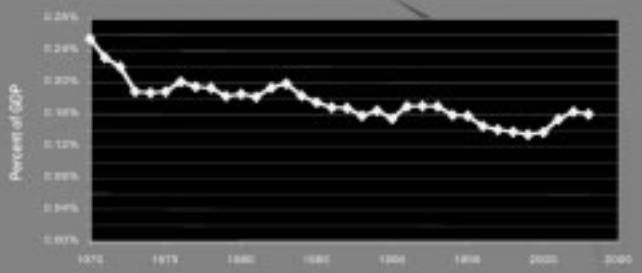
Facts About R&D Funding in the U.S.

Federal Obligations for Research by Agency and Major S&E Discipline: FY 2005 in Current Dollars (Billions)



	Total	HHS	DOE	DOD	NASA	NSF	USDA	EDC	Other
Life sciences	29.7	25.5	0.3	0.7	0.3	0.8	1.4	0.1	0.5
Engineering	9.1	0.3	2.0	3.9	2.4	0.7	0.1	0.2	0.6
Physical sciences	9.4	0.5	3.3	0.5	1.1	0.7	0.1	0.2	0.1
Environmental sciences	3.9	0.5	0.3	0.3	1.2	0.7	0.8	0.4	0.8
Math/computer sciences	2.5	0.1	0.9	0.8	0.1	0.8	0.8	0.1	0.0
Social sciences	1.2	1.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1
Psychology	1.1	0.3	0.0	0.0	0.0	0.1	0.2	0.0	0.4
Other sciences NEC	1.4	0.6	0.0	0.3	0.2	0.2	0.0	0.0	0.1

Ratio of Federal Funding for Physical, Mathematical & Engineering Sciences as % of GDP

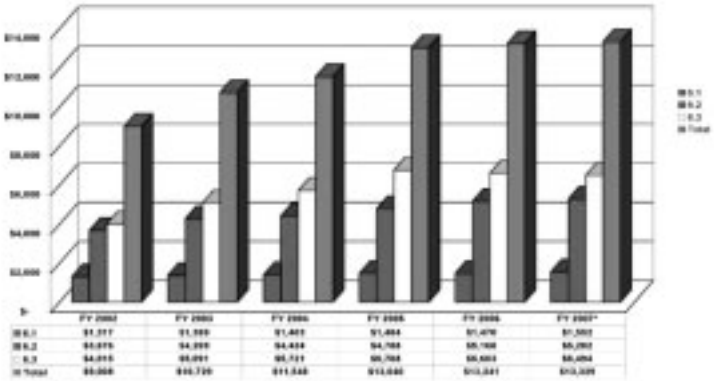


2007 ASTRA, The Alliance for Science & Technology Research in America

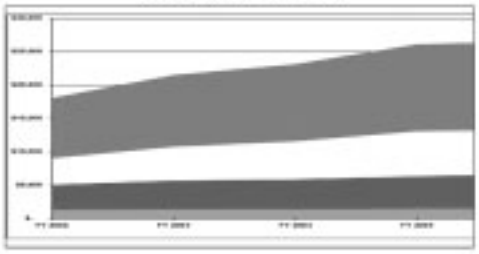
Budget Focus: DOD R&D Trends 2002 - 2007

With final passage of FY 2007 Department of Defense (DOD) funding legislation in late September 2006, ASTRA has created a five-year trend chart. It characterizes DOD's R&D spending by the type of research being performed. DOD Basic Research (so-called "6.1" research) continues to languish. Long term under-funding of 6.1 research is a source of concern within the S&T community because of the disproportionate role DOD funding plays in engineering and physical sciences basic research ...

Department of Defense Science & Technology 6.1 — 6.3
Research & Development Expenditures FY 2002 - 2007*



Overview of 6-year Trend



Notes:

* FY 2007 data includes final Congressional appropriations for FY 2007.

Medical Research Programs are not included in "6.2" Programs.

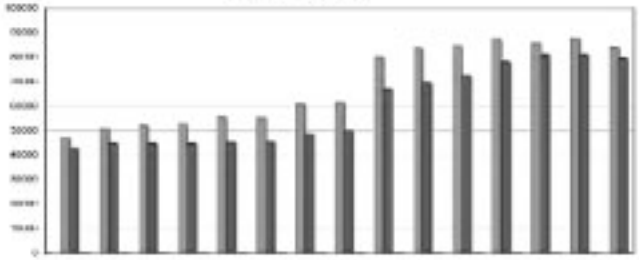
Source: U.S. Office of Management & Budget, Budget of the United States

Compiled by ASTRA, The Alliance for Science & Technology Research in America 2007 • www.aboutastra.org

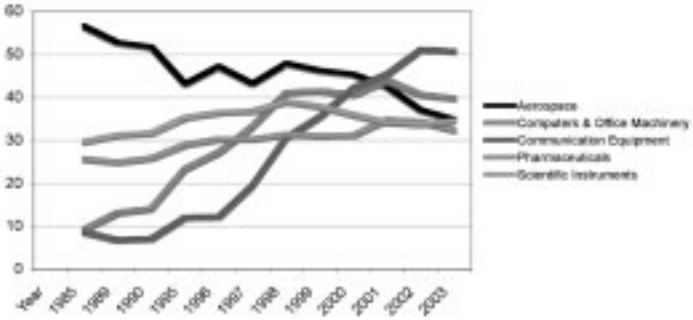
Appendix to ASTRA Testimony of Dr. Stan Williams, February 15, 2007

Consequences of R&D Funding in the U.S.

U.S. Patents and Intellectual Property Creation 1990 - 2004



Global Trade: U.S. Share Of Selected High Tech Market Sectors 1985 - 2003



What is Happening to U.S. High Tech Exports? With the exception of communications equipment, export markets for key high tech sectors of the U.S. economy continue a decline begun in the late 1990's. **Global outsourcing** and **highly competitive foreign entities** may explain these trends, but **trade protectionism, currency manipulation, standards "gaming" by foreign governments and other non-tariff barriers to trade** are also thought to be causative factors ...

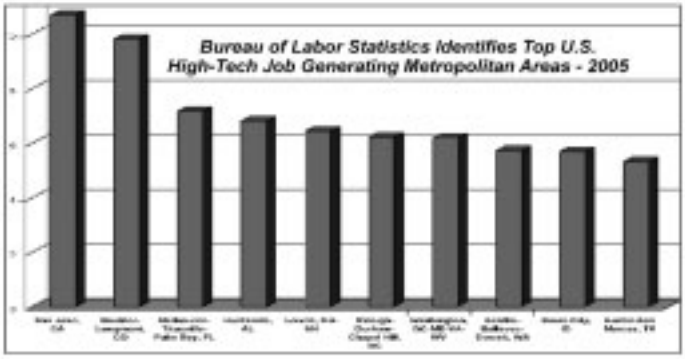
R&D Spending and R&D Gross State Product (GSP) Ratios by State 2003
Evidence of a Growing "Knowledge Divide" and Economic Gap

Only a handful of U.S. states benefit from the lion's share of technology-based development. What consequences will this have on future income distribution and economic opportunity for all Americans in an increasingly dynamic, competitive world market place?

State Rank	Name of State	R&D (current $ millions)	GSP (current $ millions)	R&D/GSP(%)
1	California	50,884	1,439,154	4.14
2	Michigan	16,884	389,660	4.69
3	Massachusetts	15,609	297,715	5.26
4	Texas	14,788	831,840	1.79
5	New York	13,831	644,606	1.86
6	New Jersey	12,788	384,240	3.34
7	Washington	11,489	246,140	4.67
8	Illinois	11,348	499,731	2.27
9	Maryland	10,163	213,073	4.76
10	Pennsylvania	9,844	443,799	2.24
11	Ohio	8,883	386,819	2.15
12	Virginia	7,865	384,774	2.49
13	Connecticut	6,848	174,849	3.78
14	North Carolina	6,841	315,486	2.01
15	Minnesota	6,842	210,184	3.77
16	Florida	6,170	663,789	0.93
17	Colorado	5,812	188,287	3.09
18	New Mexico	4,877	67,976	6.72
19	Indiana	4,487	213,240	2.10
20	Georgia	3,823	224,189	1.32
21	Wisconsin	3,847	199,886	1.93
22	Arizona	3,679	163,273	1.96
23	Oregon	3,679	119,915	3.07
24	Tennessee	2,888	203,271	1.47
25	Missouri	2,791	199,828	1.40
26	District of Columbia	2,688	70,888	3.80
27	Alabama	2,643	160,792	1.64
28	Kansas	2,634	90,283	2.77
29	Rhode Island	1,787	38,263	4.66
30	New Hampshire	1,684	46,292	3.46
31	South Carolina	1,618	127,363	1.26
32	Mississippi	1,618	71,912	2.11
33	Utah	1,588	78,874	1.96
34	Iowa	1,481	102,488	1.41
35	Delaware	1,414	60,488	2.30
36	Idaho	1,288	46,368	2.78
37	Kentucky	1,214	153,219	0.79
38	Oklahoma	963	101,168	0.95
39	Louisiana	884	144,321	0.61
40	Nebraska	710	68,289	1.05
41	Nevada	679	69,715	0.94
42	West Virginia	633	46,728	1.13
43	Arkansas	609	74,848	0.81
44	Vermont	492	30,844	1.59
45	Hawaii	448	46,871	0.95
46	North Dakota	382	21,887	1.75
47	Maine	372	40,829	0.91
48	Alaska	321	31,794	1.01
49	Montana	241	25,844	0.93
50	South Dakota	140	27,237	0.51
51	Wyoming	111	22,279	0.50

Appendix to ASTRA Testimony of Dr. Stan Williams, February 15, 2007

How R&D Funding Affects Local Economies and the Work Force



Bureau of Labor Statistics
Occupation Projections
2002 - 2012

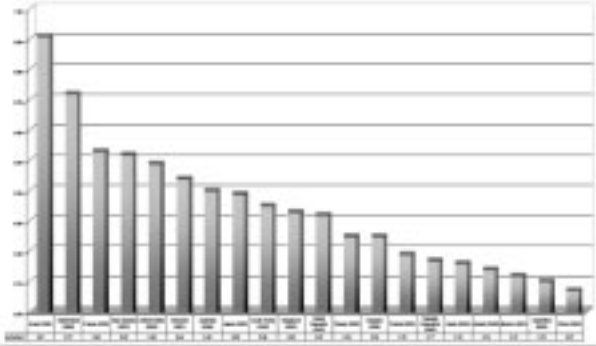
Why NIST Funding is Critical to Future U.S. Economic Health

Without expansion of NIST funding, U.S. industry and the innovation ecosystem which underpins U.S. competitiveness are at risk. ASTRA has compiled a variety of expert studies which link "technological progress" as a primary driver of economic growth. Without metrology leadership in promising new sciences, and the innovation occurring within existing cornerstone sectors of the U.S. economy, other players will command world markets and the advance of knowledge.

Experts: "Technological Progress" is the Primary Driver of Economic Growth.

Author (Year)	Time Period	% of Economic Growth Due to		
		Capital	Labor	Tech. Progress
Abramovitz (1956)	1869-1953	22	33	48
Solow (1957)	1909-1949	21	24	51
Kendrick (1961)	1889-1953	21	34	44
Denison (1962)	1909-1929	26	32	43
	1929-1957	19	16	58
Denison (1967)	1960-1962	20	19	47
Kendrick (1973)	1948-1966	29	19	46
	1929-1957	8	14	78
	1889-1929	34	32	34
Jorgenson (1973)	1958-1962	40	8	51
Kendrick (1973)	1948-1966	21	24	56
Denison (1979)	1929-1976	19	26	55
Denison (1985)	1929-1982	19	26	46
Jorgenson (1987)	1948-1979	12	20	69

International Comparison of R&D Spending to GDP (latest year)

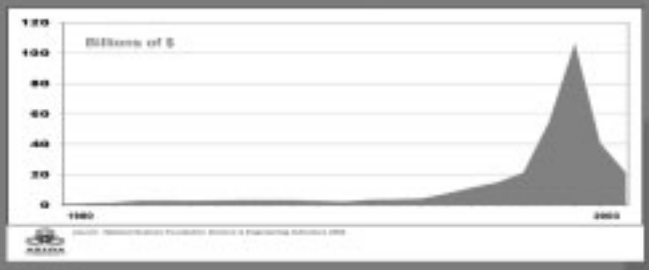


Appendix to ASTRA Testimony of Dr. Stan Williams, February 15, 2007

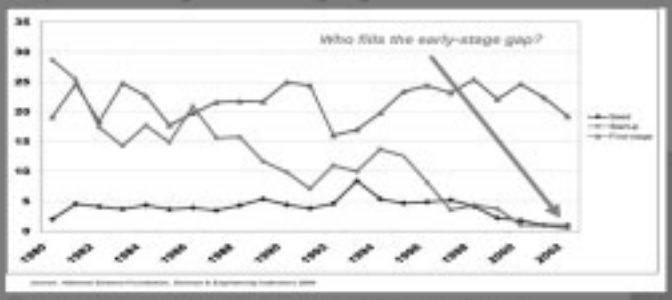
Why NIST Funding is Critical to Future U.S. Economic Health

Market failure — in this case, the plight of U.S. venture capital after the Year 2000 bubble — puts the U.S. innovation ecosystem at severe risk. Global predation on U.S. intellectual accomplishments is a likely result of inadequate funding of such NIST activities as the **Advanced Technology Proegram (ATP)** and the **Hollings Manufacturing Extension Partnership Program (MEP)**. It may take years to discover what damage was done to U.S. economic interests while our entrepreneurial private sector languished following year 2000. Recent revival of the sector cannot re-capture lost opportunities ...

Market Failure? U.S. Venture Capital Disbursements 1980 - 2003. Note Post "Bubble" Collapse After Year 2000 ...



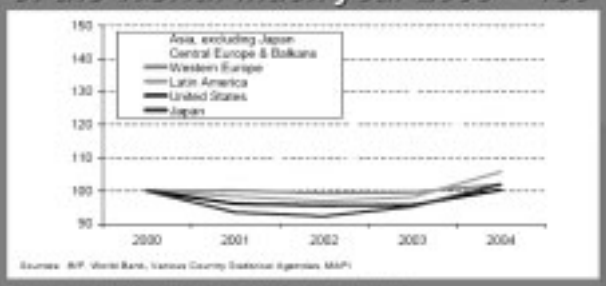
The Collapse of U.S. Seed and First-Stage Venture Capital Funding – dwindling high risk investments ...



Appendix to ASTRA Testimony of Dr. Stan Williams, February 15, 2007

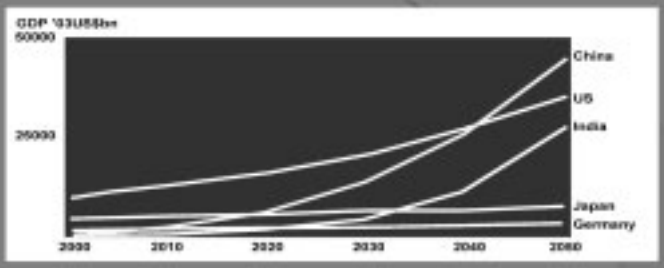
NIST Metrology is Essential to Advanced Manufacturing and World Competitiveness of New and Emerging Enterprises in the U.S.

Manufacturing Production by Region of the World: Index year 2000 = 100



High Stakes Game: U.S. loss of world economic leadership is at stake with momentous consequences for the U.S. economy, national security and the well being of our citizens. NIST plays critical if unappreciated role in our future ...

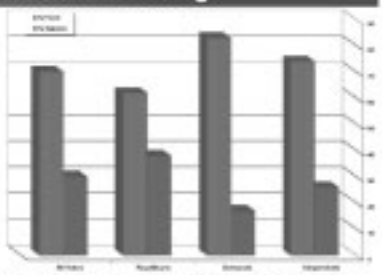
GDP Race: U.S. Falls Behind China by 2040, India Closing in ...



Appendix to ASTRA Testimony of Dr. Stan Williams, February 15, 2007

Who Supports NIST Doubling?

70% of all voters favor a "doubling" of Federal science spending ...



Who supports "Doubling?" By party affiliation, Republicans favor doubling by 63-30%, Democrats by 83-17%, and Independents by 74 - 26%.

A 2005 national survey conducted by Public Opinion Strategies for the ASTRA-supported **Task Force on the Future of American Innovation** found overwhelming support for increasing federal funding by ten percent a year for the next seven years for university research for all sciences and engineering. A Summary of the Survey, completed on November 17, 2005 shows:

1 - Voters increasingly think America's ability to compete economically in the world has gotten worse since 1991.

2 - There is overwhelming support for federal funding of scientific research at universities.

ASTRA States Then and Now ... Where our Members are Headquartered

2007 ASTRA, The Alliance for Science & Technology Research in America

ASTRA's Board of Directors *and* Current & Founding Organizations *as of February 2007*

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American Chemical Society
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American Institute of Chemical Engineers
American Physical Society
American Society of Engineering Educators (ASEE)
Applied Materials
Athena Alliance
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CASI, Inc.
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Kent State University
Lutia Innovations
Materials Research Society
Nanotechnology Business Alliance
National Association of Manufacturers
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National Center for Manufacturing Sciences (NCMS)
National Science Teachers Association
National Semiconductor Corporation
National Venture Capital Association
Northern Illinois University
Orbital Research, Inc.
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Optoelectronic Industry Development Association (OIDA)
Purdue University
Rensselaer Polytechnic Institute
Rohm & Haas
Sandia National Laboratories
Semiconductor Equipment & Materials International (SEMI)
Semiconductor Industry Association (SIA)
Semiconductor Research Corporation (SRC)
Southeastern Universities Research Association (SURA)
SPIE – The International Society for Optical Engineering
Stanford University
TechVision 21
Texas Instruments
The Minerals, Metals and Materials Society (TMS)
University Corporation for Atmospheric Research (UCAR)
University of Arkansas, Fayetteville
University of Arkansas, Little Rock
University of California, Los Angeles
University of California, Office of the President
University of California, Santa Barbara
University of Central Florida
University of Florida
University of Illinois, Chicago
University of Illinois, Springfield
University of Illinois, Urbana-Champaign
University of Massachusetts
University of Missouri
University of New Mexico
University of South Carolina
US Car

Founding ASTRA Organizations

Alfred P. Sloan Foundation
American Association for the Advancement of Science
American Association of Engineering Societies
American Chemical Society
American Institute of Chemical Engineers
American Institute of Physics
American Physical Society
American Mathematical Society
Association of American Universities
Battelle
California State University System
David & Lucille Packard Foundation
Federation of Materials Societies
Florida State University
Golden Family Foundation
IBM Corporation
Lucent Technologies
Materials Research Society
National Association of Manufacturers
Optical Society of America
Rensselaer Polytechnic Institute
Sandia National Laboratories
The Science Coalition
Semiconductor Industry Association
The Minerals, Metals and Materials Society (TMS)
University Corporation for Atmospheric Research (UCAR)
University of Arkansas, Fayetteville
University of Arkansas, Little Rock
Worcester Polytechnic Institute

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BIOGRAPHY FOR R. STANLEY WILLIAMS

R. Stanley Williams is an HP Senior Fellow at Hewlett-Packard Laboratories and founding Director (since 1995) of the HP Quantum Science Research (QSR) group, which currently has over 50 scientists and engineers working in areas of fundamental physical sciences. There are five active HP Senior Fellows out of a total technical staff of ~40,000 at Hewlett-Packard. The QSR was established to prepare HP for the major challenges and opportunities ahead in electronic, photonic and mechanical device technology as features continue to shrink to the nanometer size scale, where quantum mechanics becomes important.

He received a B.A. degree in Chemical Physics in 1974 from Rice University and his Ph.D. in Physical Chemistry from U. C. Berkeley in 1978. He was a Member of Technical Staff at AT&T Bell Labs from 1978–80 and a faculty member (Assistant, Associate and Full Professor) of the Chemistry Department at UCLA from 1980–1995. His primary scientific research during the past thirty years has been in the areas of solid-state chemistry and physics, and their applications to technology. This has evolved into the areas of nanostructures and chemically-assembled materials, with an emphasis on the thermodynamics of size and shape.

Most recently, he has examined the fundamental limits of information and computing, which has led to his current research in nano-electronics and nanophotonics. He has received awards for business, scientific and academic achievement, including the 2004 Joel Birnbaum Prize (the highest internal HP award for research), the 2003 Herman Bloch Medal for Industrial Research, the 2000 Julius Springer Award for Applied Physics, the 2000 Feynman Prize in Nanotechnology, the Dreyfus Teacher-Scholar Award and the Sloan Foundation Fellowship.

He was named to the inaugural Scientific American 50 Top Technology leaders in 2002 and then again in 2005 (the first to be so named twice), and the molecular electronics program he leads was named the Technology of the Year for 2002 by *Industry Week* magazine.

In 2005, the U.S. patent collection that he has assembled at HP was named the world's top nanotechnology intellectual property portfolio by *Small Times* magazine, and the Chinese Academy of Science voted the crossbar latch as the number three scientific breakthrough of the year (behind the Cassini and Deep Impact space missions). He was a co-organizer and co-editor of the workshop and book *"Vision for Nanotechnology in the 21st Century,"* respectively, that led to the establishment of the U.S. National Nanotechnology Initiative in 2000.

He has been awarded fifty-two U.S. patents with more than forty more pending, he has published over 280 papers in reviewed scientific journals, and he has written several general articles for technical, business and general interest publications (including an article in the Nov. 2005 issue of *Scientific American*). One of his patents was named as one of five that will "transform business and technology" by MIT's *Technology Review* in 2000.

Williams has presented hundreds of invited plenary, keynote and named lectures at international scientific, technical and business events, including the 2003 Joseph Franklin Lecture at Rice University, the 2004 Debye Lectures at Cornell University, the 2004 Herman Bloch Lecture at the University of Chicago, and the 2005 Carreker Engineering Lecture at Georgia Tech.

Chairman WU. Thank you, Dr. Williams.

Mr. Borrus.

STATEMENT OF MR. MICHAEL BORRUS, GENERAL PARTNER, X/SEED CAPITAL

Mr. BORRUS. Mr. Chairman, distinguished Members of the Congress, and staff members, for reasons I will describe in a moment, I created X/Seed to focus on a sorely-neglected part of early-stage capital markets, the so-called seed stage, which is typically the first money raised by entrepreneurs to start a new business to begin to transition an idea, a rudimentary technology, out of the laboratory toward the commercial marketplace. My typical investment involves two entrepreneurs and ten PowerPoint slides, and not much else.

I also want to call the Committee's attention to several other parts of my background, because they are relevant to my testimony today.

Prior to entering the venture capital industry, I spent a little over half a decade as a start-up entrepreneur. And for over a decade before that, I was at UC–Berkeley on the engineering faculty where my work focused on emerging new technologies, the commercialization of innovation, and related policy.

My testimony is based on my experience in all of those domains: studying, doing, and now investing in high-risk, early technological innovation.

As I have been asked to comment on the ATP program, I would also call the Committee's attention to the fact that I currently serve on the external industry Advisory Committee to ATP, and I previously served on the National Academy's Steering Committee on Government and Industry Partnerships, which issued two very detailed analysis reports on the ATP program in 1999 and then again in 2001.

I have three simple points to make. I will make them briefly, and they all lead to one conclusion.

First, significant changes over the last 15 years in early-stage capital markets in the United States create, in my view, an urgent need for the ATP to be continued and for it to be substantially funded so that it can run new competitions.

The most significant change in those markets is this: as the venture capital has grown and matured, the bulk of that industry has moved away from seed-stage investing to invest later in the life cycle of a start-up. When large amounts of capital can be efficiently deployed to permit companies to expand later on, at the point in which companies already have products developed typically may actually have initial sales. That drift-away from early-stage funding has created a paradox. There is plenty of capital available to expand company operations, but there is too little capital available at the riskiest moment in a start-up's life, at the very beginning when only an idea, a concept, or a rudimentary technology exists and needs to be transitioned out of the lab, across the so-called "valley of death," and toward the commercial marketplace. Very few organized financing mechanisms of sufficient scale exist to address that problem. That, frankly, is why X/Seed Capital exists. And that, frankly, is also ATP's historical sweet spot, and there is plenty of room for both of us.

That leads to my next point: why ATP?

ATP is, quite likely, the most intensively studied, rigorously scrutinized, and carefully assessed U.S. technology program of the last 50 years at least. As the National Academy's reviews concluded, "ATP is an extremely well-run program that works and works well." Several of its program features, notably its rigorous peer-reviewed, pork-free, merit-based competitions, its emphasis on cost sharing, its rigorous self-assessment, and its measured return on investment set the standard to which other federal technology programs ought to aspire, which leads to my third point.

As the Committee knows, as a nation, we face a series of major challenges to which continued innovation is the best response. These include the need to move to carbon-neutral alternative en-

ergy technologies to maintain energy security for this country; escalating health care costs driven by an aging population, one increasingly prone to chronic long-term illnesses, like diabetes; the competitive rise as technological challengers of China, India, and other advanced economies; and not least, the concomitant erosion of U.S. technological leadership in a number of significant areas. In addressing these challenges why reinvent the wheel? Leverage a program that historically has helped to produce significant innovation and that works and works well. Use ATP.

That leads to my conclusion.

As a result of those arguments, I recommend that Congress should reauthorize the ATP program, provide sufficient funding for ATP to run several competitions, both general and specific competitions focused in areas of acute need, like the search for carbon-neutral alternative energy technologies, and picking up on your opening remarks, Mr. Chairman, I believe the Committee should consider ways that ATP might be stably and predictably funded over a long enough timeframe, perhaps a decade, to have a significant impact over time.

Thank you very much.

[The prepared statement of Mr. Borrus follows:]

PREPARED STATEMENT OF MICHAEL BORRUS

Distinguished Members of Congress:

I am Michael Borrus, founding General Partner of X/Seed Capital, a seed-focused early stage venture fund based in California's Silicon Valley. I have been asked to give my views on the Advanced Technology Program (ATP) at NIST, a program that, since its inception, I have studied closely—first as a UC–Berkeley faculty member focused on emerging technologies, technology markets and policy, then as an entrepreneur at an innovative start-up, and now as a very early-stage (so-called "seed-stage") venture capital investor focused on breakthrough innovation. Those experiences provide an informed perspective on ATP and color this testimony. You should also note that I currently serve on the external industry Advisory Committee to ATP and that I previously served on the National Academies' steering Committee on Government-Industry Partnerships, chaired by Intel founder Gordon Moore, which issued two detailed evaluations of the ATP program in 1999 and 2001.[1]

Summary Conclusions

- Significant changes over the last 15 years in early stage capital markets in the U.S.—in particular, an institutional drift away from very risky, seed stage funding by private venture capital investors—create an urgent need for the ATP to be continued, for substantial funding to be restored so that ATP can run new competitions, and for it to be *stably* funded for the foreseeable future.
- The ATP is quite likely the most intensively studied, rigorously scrutinized and carefully assessed U.S. technology program of the past 50 years. The overwhelming consensus of such painstaking analysis, as of the prior NRC reviews, is easily summarized: ATP is an extremely well run program that works and works very well.[2] Indeed, ATP boosts several unique features that permit it to set the standard among federal technology programs. It is, for example, the only federal technology program that actually measures its economic return to the Nation.[3]

[1] National Research Council, Committee on Government-Industry Partnerships *Review of ATP,* Washington, D.C.: National Academy Press, 2001. In addition to the papers and proceedings in that volume, the Committee issued National Research Council, *The Advanced Technology Program: Challenges and Opportunities,* Washington, D.C.: National Academy Press, 1999.

[2] In addition to the NRC studies, *Ibid.,* see the numerous evaluations referenced therein.

[3] See the discussion at *http://www.atp.nist.gov/factsheets/1-a-1.htm* and the source cited there, suggesting at least $18 billion in present value social benefits from 40 ATP projects (over 8X ATP's total investment over the full life of the program).

- As an especially well-run federal technology program targeted at areas of market failure and long-term national needs, a restored ATP has a vital role to play and can be an essential element in the broader American response to global changes in technology markets, in climate, in energy security, and in the U.S. competitive position in the global economy. Indeed, given the stakes, a restored ATP with increased, stable funding is in fact the most prudent, cautious and conservative approach for it risks the least: By contrast, failing to fund ATP risks sacrificing American opportunities for technical advance and the long-term economic growth and productivity gains it produces.
- For all of these reasons, I believe that Congress should re-authorize the ATP program, provide sufficient funding for ATP to run several competitions focused around areas of acute need or promise in such areas as carbon-neutral alternative energies and energy storage, and consider ways that ATP might be stably and predictably funded over the next several years to maximize its contribution to the Nation.

Let me now touch on key aspects of these summary points.

Seed financing

There is a paradox in today's venture capital markets: There is simultaneously too much venture capital and too little. There is too much venture capital available once early stage risk has been reduced and start-ups seek capital for expansion. However, there is too little venture capital available for the riskiest, de novo start-up phase of a new venture's life. That 'seed' stage—when an entrepreneur may have a good idea, some scientific validation and at best only a rudimentary technology—is typically when potential innovations are transitioned out of the lab and toward the commercial marketplace. It is when they must navigate the gap in seed-stage funding dubbed by many analysts as the 'valley of death'—a classic market failure in early stage innovation.[4]

The two parts of this paradox are actually halves of a single explanation: In the last 15 years, as the venture capital industry has grown in size, venture firms have put more capital under management. *Managing* more capital typically requires *deploying* more capital in each investment, that is, in far larger increments than can be consumed at the seed stage by start-ups. The bulk of the venture capital industry has consequently drifted away from seed and very early stage financing to invest later in more mature stages of a start-up's life when more capital is required to expand operations. Data compiled for the National Venture Capital Association confirm all of these trends.[5]

The consequence of these trends is a need for additional sources of capital at the seed stage. That is why my fund exists. And that is one of the reasons there is a greater need than ever before for ATP, which has always focused on filling the seed-stage gap, helping to cross the 'valley of death.' The need is sufficiently large that there is plenty of room for both government and private money—crowding out is just not an issue.

Unique ATP features

One of the reasons ATP works well is that it boosts several unique features that ought to be more widely adopted across the broad ecosystem of federal technology programs. ATP competitions are peer-reviewed, pork-free and merit based. The program's public-private cost-sharing, its demonstrated ability to run multiple competitions, both general and focused in areas of acute need, and to run them fast and on budget, its detailed, economically sound self-assessment, its measured return on investment, its explicit mission to enhance U.S. competitiveness through innovation—all set it quite apart from almost every other federal technology program.

So effective are these attributes, that at the same time the Bush Administration has sought to kill ATP, it has been widely taken as an ideal model and copied by foreign governments from Asia to Eastern Europe. These same attributes are one

[4] See, e.g., NIST head and IBM chief scientist, now Harvard Professor, Lewis M. Branscomb and Philip E. Auerswald, "Valleys of Death and Darwinian Seas: Financing the Invention to Innovation Transition in the United States," *The Journal of Technology Transfer,* Volume 28, Numbers 3–4/August, 2003, and sources cited there.

[5] See the last five years of the annual PricewaterhouseCoopers/National Venture Capital Association MoneyTree™ *Report;* in addition, the testimony by Jonathan Cohen, founder and CEO of 20/20 GeneSystems, at the House Science Committee Hearing on "Small Business Innovation Research: What is the Optimal Role of Venture Capital," July 28, 2005; Generally, the last 10 years has seen a decline in the percentage of venture investments going to seed and early stage and a concomitant shift away from higher-risk early-stage funding. See the discussion in the introduction in National Research Council, *SBIR and the Phase III Commercialization Challenge,* Charles W. Wessner, Ed., Washington, D.C.: The National Academies Press, 2007.

of the reasons the program has so effectively played a key role in providing early capital to the companies like Affymetrix and SunPower responsible for a wealth of valuable new innovation from gene chips, rapid DNA sequencers and cheap digital mammography to fuel cells, high-efficiency solar photovoltaic cells and novel engineered materials.[6]

ATP is sometimes labeled with the profoundly misleading and profoundly misinformed characterization of 'picking winners and losers': That is, frankly, flat wrong. No investor, private or public, picks winners and losers in technology innovation. Rather, it is the market (customers) that does the picking. By contrast, with ATP and other federal technology programs, the government is really helping to plant long-term technology seeds in areas of private market failure or acute public need. Some of those technology seeds will sprout, others will not. But the planting, the activity as a whole, must go forward if long-term economic gains are to be effectively harvested.

Global challenges and U.S. innovation

The U.S. faces numerous competitive challenges globally—among then, the rapid technological rise of China, India, and parts of Eastern Europe and Latin America, the need to respond to global climate change and the concomitant shift to carbon neutral energy sources, declining competitive position in certain technologically intensive industries.[7] The only enduring answer to all of these challenges that can sustain U.S. leadership and a growing standard of living for future Americans, is increased long-term innovation leading to wholly new industries and to the transformation of existing industries.[8] In turn, substantial domestic U.S. investment in research and development—both public and private—is the prerequisite for that kind of innovation.[9]

For a variety of reasons—enormous uncertainty, the impossibility of accurate risk assessment, extreme volatility, appropriability problems, among others, very early stage technology capital markets are especially prone to numerous market imperfections including herd behavior, strategic gaming, information asymmetries, institutional structures focused on early liquidity, and the exercise of market power. These problems are especially severe for especially risky new technical approaches, when intensive collaboration across multiple technical disciplines may be essential for technical progress (therefore requiring the coordination of disparate technical and market actors), and wherever a clear, reasonably short-term path is lacking for private market actors to reap sufficient returns from their private investment. In those cases, federal technology funding mechanisms have historically played an essential role in fostering technical innovation to the point where private capital markets can then sustain development.

That is the sweet spot that ATP very effectively addresses. Indeed, for reasons described earlier, ATP is uniquely positioned to respond to the competitive challenges identified above. It is my strong recommendation that Congress re-authorize the ATP program and provide sufficient funding for ATP to run several competitions, both general competitions and focused competitions in areas of acute need or promise such as carbon-neutral alternative energies and energy storage. Given the importance of funding stability and predictability to technological progress, Congress should also seriously consider ways that ATP might be stably and predictably funded over the next decade to maximize its contribution to the Nation.

BIOGRAPHY FOR MICHAEL BORRUS

Michael Borrus is the founding general partner of X/Seed Capital, a seed-focused early stage venture fund focused on breakthrough innovation. Prior to founding X/

[6] For more detail see the descriptions on the ATP web site at *http://www.atp.nist.gov/gems/listgems.htm*

[7] On some of these and other challenges see, the National Research Council, *Rising Above the Gathering Storm,* Washington DC: National Academies Press, 2006.

[8] See Michael Borrus and Jay Stowsky, "Technology Policy and Economic Growth," in Lewis Branscomb and James Keller, Editors, *Investing in Innovation: Creating a Research and Innovation Policy,* Cambridge, MA: MIT Press, 1998. The contribution of technology to economic growth is now well recognized. See P. Romer, "Endogenous Technological Change," *Journal of Political Economy,* 98(5):71–102, 1990. See also G. Grossman and E. Helpman, *Innovation and Growth in the Global Economy,* Cambridge, MA: MIT Press, 1993.

[9] P. Romer, "Endogenous Technological Change," *op. cit.;* Borrus and Stowsky, "Technology Policy and Economic Growth," *op. cit.* See also National Research Council, *Allocating Federal Funds for Science and Technology,* Washington, D.C.: National Academy Press, 1995. The report notes that federal investments in R&D have produced enormous benefits for the Nation's economy, national defense, health, and social well-being. *Ibid,* p. 3.

Seed, he was an Executive in Residence (EIR) at Mohr Davidow Ventures (MDV) in Silicon Valley.

Michael left his faculty position at UC–Berkeley in 1999 to do a financial services start-up for the five years prior to joining MDV. He was Managing Director of the start-up, The Petkevich Group (TPG), a merchant bank providing financial advisory services and investment capital to growth companies in life sciences and technology. He led the technology banking group at Petkevich & Partners, TPG's broker-dealer subsidiary, executing a variety of financial transactions from M&A and capital raising to spinouts and bankruptcy reorganization.

Before TPG, Michael was Adjunct Professor in UC–Berkeley's College of Engineering, Co-founder and Co-Director of the Berkeley Roundtable on the International Economy (BRIE) at the University of California, Berkeley, and a partner in Industry and Trade Strategies, a business consultancy. Much of his academic and consulting work has focused on how business models need to adjust to successfully commercialize new technologies, to exploit new market opportunities or to adapt to new competitors.

He is the author of three books and over 70 chapters, articles and monographs on a variety of topics including management of technology, high technology competition, international trade and investment, and financial strategies for technology companies. He is a frequent speaker before corporate and public audiences, and has appeared in numerous media outlets from CNN and NPR to *Business Week* and the *New York Times.*

Industry Associations: Michael serves on the Advisory Committee to the U.S. Government's Advanced Technology Program (ATP), several National Academy of Science/National Research Council Steering Committees, the Board of Trustees of the National Center for Women and Information Technology, and is a Director of HMicro Inc. and Geniisis Agents (privately held companies).

Education: Michael is an honors graduate of Harvard Law School, the University of California, Berkeley and Princeton University. He is a member of the California State Bar.

Chairman WU. Thank you very much, Mr. Borrus.

And I would like to thank all of the panelists to this point for both your excellent testimony and for your timeliness.

I would like to announce just a little bit in advance that, as is typical of this institution, we are not quite as entertaining as a three-ring circus, but we keep at least three rings going at any given time, so we do have Floor action going on. I have another committee in which, I understand, there will be a vote sometime in the next five or ten minutes, so if you notice a little shuffling up here, it is not out of disrespect for you, but out of a concern for adequately discharging our different duties.

And with that, Mr. Murray.

STATEMENT OF MR. PETER MURRAY, VICE PRESIDENT, WELCH ALLYN, INCORPORATED

Mr. MURRAY. Thank you, Mr. Chairman.

I want to thank, also, the Committee Members and staff for inviting me here to testify on behalf of MEP. I can see my presentation is up, so we are off to a good start.

[Slide.]

What I want to talk to you about is the success we have had with our local MEP in Oregon, and I will use the term OMEP, because that is the acronym, and then briefly go through some of the details of the implementation, the success story, a very good success story, and then conclude with some observations of the funding and what I think it will do to our local chapter and project and what I think it will do nationally.

Again, that is my agenda.

[Slide.]

We don't need to see that.

[Slide.]

We started with OMEP in 2004. The company was facing some serious competitive pressures, and we knew we needed to make some changes, and we began casting about to select a partner. And we clearly found OMEP to be the group that met our needs. And I will speak a little bit more about that later, but briefly, that is the timeline.

[Slide.]

What I would like to show you now in a few minutes is just examples of the engagement work. It is a lot of detail. I just want to give you an example of the quality of the work that the organization provides. Again, these consultants are very tactical and also very strategic. They gave us a lot of customized solutions, and I am just going to roll through these.

[Slide.]

There is a lot of generalized training that is shared among all of the clients of OMEP. They develop customized tools. I am just going to kind of flip through these a little bit. There are examples that are also in the written testimony.

[Slide.]

Again, the examples here really are to convey the point that they were teaching us how to fish as opposed to giving us the fish. These tools are broadly adopted now within our site in Oregon as well as spreading into some of our other sites in the company.

[Slide.]

Again, they gave us tools so that folks in the production area or anyone in the company that were using these productivity enhancements could use them.

[Slide.]

Finally, some of the results that we achieved, as you can see up here, these details may not mean much, but they were extremely significant to our company. That represents about half of the company being trained in two years. Again, part of what OMEP brought to us was the ability to develop people with ongoing skills and raise their capabilities so that we could continue to make these improvements long after our engagement with OMEP was completed.

[Slide.]

Some of the results that we experienced, as you can see up here, a significant labor savings, plenty of reductions, and these are very typical results you will see from an MEP engagement. Additionally, the company was facing some pressures to consolidate a wide variety of sites, and we ended up choosing Oregon as one of the sites to consolidate into as a result of these competitive improvements that the site had made. So not only are we more competitive externally, but we are competitive internally.

I want to make a couple of closing comments.

When I say, "Why choose an OMEP?", why did we decide to select an organization such as OMEP, one of the key differences between OMEP and some other providers that would give us similar kinds of services, I think, are the way the MEPs are measured on the clients' results gives them a focus that is very much in the in-

terest of the client. I don't know how else to say that any more simply.

Again, this is what is summarized in my testimony: they are both hands-on. They are both strategic.

Finally, let me just wrap up with where I think the funding proposal would go. I am also on the board of our OMEP affiliate. And I can tell you from personal experience if they were faced with this funding reduction that is in the proposal from the Administration, it would lead to a drastic reduction in services. I think it would reduce the ability to market to new clients. It will have a direct impact on the industry. Any company facing a significant loss of revenue that this would represent would take similar action. And I firmly believe that the funding levels should be restored, and hopefully, with reason, expanded.

Thank you very much. I will take any questions.

[The prepared statement of Mr. Murray follows:]

PREPARED STATEMENT OF PETER MURRAY

Who we are

Welch Allyn Monitoring, a division of Welch Allyn, Inc., is located in Beaverton, Oregon. The site currently employs approximately 420 people, up from 270 two years ago. Welch Allyn designs, manufactures, and markets mission critical flexible monitoring solutions that improve patient care and lower health care operating costs. Welch Allyn is a key player in the biomedical device industry in Oregon, nationally, and worldwide.

Our company faces increased and ongoing pressures from domestic and foreign competition. Our company was confronted with a critical need to increase profitability, quality, and shorten delivery lead times. The company also wanted to incorporate additional manufacturing capacity from another manufacturing location

How OMEP assisted our company

Welch Allyn felt they needed outside expertise to achieve these objectives and conducted a search of local firms. Welch Allyn decided to work with the Oregon Manufacturing Extension Partnership (OMEP), a NIST MEP network affiliate, to help us achieve a major operational goal of continued improvement of manufacturing processes, systems and capacity building. The company views this goal as essential to long-term financial growth and success. As a corporation, Welch Allyn was faced with difficult decisions regarding consolidation of manufacturing operations from four different U.S. sites. The Beaverton operation, while operating at a high level of quality and capability, sought to strengthen the likelihood of not only maintaining but increasing the amount of manufacturing at their facility. Welch Allyn needed assistance to transforming its entire operation to a culture of continuous improvement.

The overall goal was to create a culture of continuous improvement. This was done by starting with Lean manufacturing to obtain a larger and more immediate payback. The training and implementation was initially focused at the operator level and then expanded throughout the organization. OMEP was selected to work closely with Welch Allyn to provide classroom training, implementation and support, and guidance to help them transform into a Lean enterprise.

Because of Welch Allyn's size and numerous needs, several processes were created to implement their vision of becoming a Lean enterprise.

1. A steering committee was created to evaluate opportunities, select Lean projects and Kaizen events, assign resources, and ensure continued focus, and direction. Business needs are clearly established and used to prioritize Lean activities.
2. OMEP provided numerous classes to teach the Lean principles and concepts. Principles of Lean, 5S, and Value Stream Mapping were taught as foundation classes. More advanced Lean and leadership classes have helped support the ongoing transformation.
3. Specific Lean projects and Kaizen events used Value Stream Mapping to implement "Future States" with less waste, increased visibility, better flow, less Work in Process (WIP), higher quality, and increased productivity. Team

leaders stayed on track by reporting progress at a weekly accountability meeting where they also obtained help in overcoming roadblocks. OMEP helped Team Leaders learn valuable skills as they prepared and presented their results to company and corporate executives at celebratory "close-out" meetings.

4. OMEP worked closely with Welch Allyn to establish standards, audits, and a significant metrics program to sustain the gains and to create a continuous improvement environment.
5. Throughout the entire process OMEP has been key in developing people within Welch Allyn who can internally drive and support Lean. OMEP has provided significant coaching and mentoring in one-on-one situations. Together, they have developed custom training materials and have shared in providing Lean training.

Results

- Corporate has moved a significant manufacturing operation to Beaverton resulting over 50 new jobs plus an additional 50 jobs from organic growth created in Oregon.
- Operations have expanded into a new facility to accommodate the increased growth. There has been over $600,000 invested in the new facilities.
- Welch Allyn has saved nearly $1 million in direct expenses as a result of implementing Lean.
- Inventory has been reduced by more than $500,000.
- Sales of over $120 mil/year have been retained at the Beaverton location.
- Over 250 employees have received Lean training in a total of 750 training occurrences (most completed numerous classes).
- More than 20 Lean projects and 10 Kaizen events have successfully been completed.
- 10 to 15 Lean "Stars" have emerged and are driving daily continuous improvement activities.
- Lean methods have been shared and implementation has expanded and is being used throughout the corporate organization.
- Employee morale and daily improvement involvement has significantly increased.
- Workforce training and skills investment: Over $300,000.

Why we support MEP

We have had experience with purely private consulting firms and we are convinced that, based on our experience with OMEP, there are key differences between MEP (a public/private partnership) and private providers;

- What distinguishes OMEP from similar groups who claim to provide the same services is OMEP's unique focus on their client's success and less so on selling future services.
- They provided core training and implementation experience to get us started and were able then to adjust their approach as we progressed through our Lean journey.
- Their consultants are both hands on and strategic.
- OMEP has been key to our success in making our Lean transformation.
- We are continuing to expand our Lean Enterprise and we look forward to continuing to work with OMEP.

The Administration's reduced funding of the program

I understand that the Administration wants to cut by 56 percent the funding for the MEP program to $46.332 million for FY08. I am on the Board of OMEP and from a purely local perspective the impact to the Oregon affiliate would be disastrous. If the board were faced with such a funding cut we would likely be forced to dramatically reduce costs (primarily staff) and thereby services. I would expect many of the clients could not afford to make up the difference and OMEP's ability to market to new clients would also be reduced. The loss to the local economy from a withdrawal of OMEP would lead, in my opinion, to a loss of growth for many of the small companies in the area.

I view the federal funding as an efficient use of federal dollars. From my perspective as a board member for OMEP, I view the administration of the organization as a model. I have served on the boards of several profit and non-profit organizations and I view OMEP as one of the best run organizations.

Appendix: Copy of Oral Presentation

Pete Murray
V.P. Operations
February 15, 2007

Oral Presentation

The National Institute of Standards and Technology's Role in Supporting Economic Competitiveness in the 21st Century: the FY08 Budget Request

Welch Allyn

Agenda

- Welch Allyn's Experience Implementing Lean Manufacturing with OMEP
- Why choose an OMEP?
- The Administration's FY08 funding proposal

Welch Allyn

Getting Started – Finding The Right Partner

- August '04 – Launched company wide CI initiative
- November '04 – Site Management organizes to pursue program
- December '04 – Applied for State Grant through WSI to fund initial efforts
- January '04 – Grant approved, OMEP first meeting
- February '04 – OMEP contract signed, assessment begun
- April '04 – After 3 weeks delay for FDA inspection, training began

Welch Allyn

Examples of OMEP Engagement work

Welch Allyn

Custom Program Deployment Model

WelchAllyn Advancing Frontline Care™

Generalized Lean Classes

Everyone receives Basic Lean training

- Principle of Lean Manufacturing
- 5S and Visual Factory
- Value Stream Mapping

Advanced Lean training for key personnel

- Leadership and Workshop Facilitation
- Performance Measures
- Teams
- Problem Solving

WelchAllyn Advancing Frontline Care™

Project Selection Tools

Razorbacks select projects, team members and schedule durations

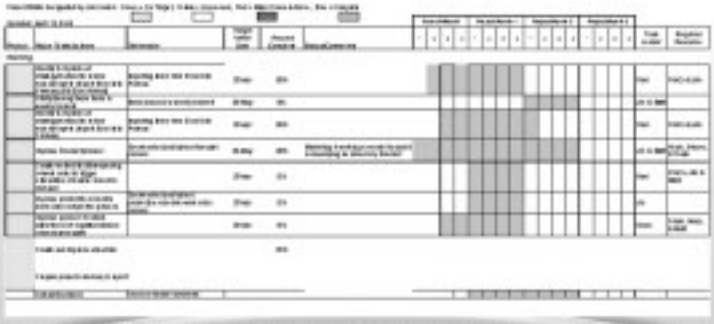
WelchAllyn Advancing Frontline Care™

Program Administration Tools: Scheduling

Managers responsible for selecting/notifying attendees

WelchAllyn Advancing Frontline Care™

Customized Project Summary Plans



These are select key milestones reported each week from the detail implementation plan

WelchAllyn Advancing Frontline Care™

Customized Project Management tools

Standard Forms for each team/project

WelchAllyn Advancing Frontline Care™

Standardize PowerPoint Summary Presentation

- Project Name and Team Members
- Current & Future State Value Stream Maps
- Before & After Layout
- Before & After Photos
- Delivery Improvements
- Quality Improvements
- Cost Reductions
- "What's Next"

Welch Allyn

Training & Implementation Accomplishments in First Year

- ✓ Over 250 have completed the Lean course,
- ✓ Over 100 have implemented their training on projects,
- ✓ Over 20 Lean projects and 10 Kaizen events have been completed,
- ✓ Pleasure of seeing 10 – 15 CI "Stars" emerge!

Welch Allyn

Results, Results, Results!

- ✓ Reduced labor expenses >$1 Million
- ✓ Reduced WIP >$500k
- ✓ Saved ~2500 ft2 of manufacturing space
- ✓ Added over 100 jobs in the past year (450 FTE in FY06 up from 270 FY04)
- ✓ Great improvement in Morale

Welch Allyn

Why Choose an OMEP?

- What distinguishes OMEP from similar groups who claim to provide the same services is OMEP's unique focus on their client's success and less so on selling future services
- They provided core training and implementation experience to get us started and were able then to adjust their approach as we progressed through our Lean journey.
- Their consultants are both hands on and strategic
- OMEP has been key to our success in making our Lean transformation
- We are continuing to expand our Lean Enterprise and we look forward to continuing to work with OMEP.

Welch Allyn

The Administration's FY08 funding proposal

- The Administration 56% cut to the funding for the MEP program to $46.332 Million for FY08 I feel would be a serious blow for the affiliates to overcome
- I sit on the Board of OMEP and I would expect the following to occur if the budget reduction went through;
  - Staff reductions
  - Reduced ability to attract new clients
  - Client base unable to make up revenue shortfall
- The funding model of MEP is a very efficient use of federal dollars and the funding level should be restored.

WelchAllyn Advancing Frontline Care™

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WelchAllyn Advancing Frontline Care™

BIOGRAPHY FOR PETER MURRAY

Peter Murray worked in the semiconductor and disk drive industries prior to spending the last 12 years in the medical device industry. He has worked at Welch Allyn in Engineering and Manufacturing roles.

He holds a M.S. and M.B.A. from Boston University and a B.S. from the University of California.

Chairman WU. Thank you very much, Mr. Murray.

Mr. Ryan.

STATEMENT OF MR. MICHAEL J. RYAN, PRESIDENT AND CEO, TUG TECHNOLOGIES CORPORATION

Mr. RYAN. It is, indeed, a pleasure to have the opportunity to address the House Science Subcommittee.

[Slide.]

Relative to my comments I will share with you, I am going to focus on the MEP and the role it plays in helping American companies to describe and to deploy lean methods.

[Slide.]

I am currently the CEO and President of TUG Technologies in Marietta, Georgia, as Dr. Gingrey mentioned. TUG, as such, manufactures ground support equipment for domestic and international airlines as well as the U.S. armed forces. If you look out the window the next time your plane stops at the gate, you will likely see a TUG baggage tractor, and you will certainly see belt loaders that are also manufactured by TUG Technologies.

I have had the unique opportunity over the last several years to work with five of the state MEPs, inclusive, of course, of the State of Georgia. But after spending 38 years in automotive and industrial companies, I would say to you I have learned how to learn. It is about people, and it is about learning. So today, my thoughts to share with you specifically focus on the last 13 years, and as an American, I believe that we, in this country, can be globally competitive by deploying lean methods to our manufacturing base. The MEP has played an important supporting role to enhance American productivity, now on record for 18 years.

[Slide.]

Back in 1982, I presented at a conference in Brazil as a member of TRW's senior management team. At that time, I used the flag to designate and talk to the point that order comes before progress. The written words on the flag in Brazil actually say "Ordem e progresso." And I think that it is significant to understand what that means as the associated task of the MEP continues to ramp up.

[Slide.]

In 1991, the result of a U.S. Government-supported productivity study of Japan was done, and the book that came from that was called *"The Machine that Changed the World."* The machine is the Toyota Production System in this designation in the book written by Womack and Jones, and it captures the Japanese work on productivity in the automotive industry primarily.

[Slide.]

I had the opportunity to work with Jim Womack during the time I worked for United Technologies, and he, subsequently, in 1996,

published a book, *"Lean Thinking."* And in his book, he talks about a five-step process, which I show you on the slides.

[Slide.]

Define the value of what you do, align it into a value screen, create flow from balancing process steps, create a pull process where the customers' needs are defined, associate it to your demand support, and ultimately perfection can happen. And perfection is the perfect balance of the value, value stream, flow, pull, and perfection.

[Slide.]

They do, however, list some actions that are important to consider, and what I have done here is try to align those actions from that book in line with the steps they have identified, as shown on this slide. And I show you the MEP interface that is appropriate to helping companies convert themselves through lean policy deployment processes.

[Slide.]

Though significantly, the MEP has a role in these process steps to success in any company. The basis of learning from Womack and some additional actions. The basic learning from Womack and Jones, when they looked at the Toyota Production System, is that we understood man, material, and machine, but we, in America, didn't have the entire puzzle put together. And this is a depiction of the Toyota Production System in one slide, one picture. And what they have done here is identify puzzle pieces that, frankly, I believe, we hadn't yet put together in this country.

[Slide.]

So how did we take the learning from this to deploy change in this country? There is an important quote from the ultimate scientist, in my mind, Albert Einstein. I have been referring to this for many years. And the questions I ask from this quote are: Can we learn to change our minds? Can we understand the differences we face? Can we be globally competitive? Can we stay at the same level of thinking we were at when we created the significant problems we are trying to fix? And it is said that the definition of a fool is one who expects different results while doing the same things. So, indeed, the challenge of lean and the challenge of the MEP profile is to make people understand and learn.

[Slide.]

In order to deploy lean, we have an implementation standard that optimizes the efforts of independent companies and is supported by an education process that understands the fundamental tools.

[Slide.]

What I am showing you here is the depiction of the profile of implementation for any lean activities. And the support of MEP is critical here as well. The depiction is an umbrella with leadership. And I would submit to you that the national MEP is that leadership profile that allows us to succeed. But more importantly, the umbrella is this Congress as well. The Members of the U.S. Congress represent the support needed by the MEP to truly lead the transformation process to change.

[Slide.]

On the next slides, I have just identified some of my experiences relative to those five different state MEPs. And in fact, I started my understanding of the MEP from having played a part on the board of the Michigan MEP, notably the MMTC, Michigan Manufacturers' Technical Center. The North Dakota MEP was engaged in our transformation when I worked as President and CEO of Bobcat Company.

[Slide.]

The teachers in Japan we call senseis. If you look back at the study that was originally done by Womack and Jones, the opportunity to coordinate and learn is a two-part process, if you would. The opportunity to create success has a significant amount of benefits, as I show on this slide. But truly, the MEP plays a role of support that would not have a high enough level of understanding to deploy the change processes required by that six-step picture with the umbrella supporting it.

[Slide.]

But what are the benefits? Here are some of the benefits achieved from doing a lean transformation supported by MEP consultants. Significant improvements in revenue at one company of 86 percent while operating income increased 128 percent. Again, a North American company competing globally. Improving inventory significantly. And improving the operational income of the companies by 400, 500, and 550 basis points of improved operational income. They reduced customer lead times and developed flawless launches, as well.

[Slide.]

So now, I ask you to think about a process. Consider that it has three versions, at least: what you think it is; secondly, what it actually is; and then third here is what it should be, proper value stream, mapping, and understand. And you can imagine the efficiency improvements from that step one, two, and three.

[Slide.]

Consider a moment that Henry Ford, at the Rouge Complex in Detroit, delivered a car to each customer in a four-day cycle from raw material to finished vehicle. And he did that in 1914. Most people don't know that he wrote a book called "Today and Tomorrow" in 1936 that described his lean process from some 22 years earlier. Taiichi Ohno developed the Toyota Production System from his studies of Henry Ford's methods.

Another important point, Toyota never had to change their bad habits since after the war they could start from the basics in 1947.

The challenge in America, still today, is that we have to change people from their habits of the past to the global changes and challenges we will need to have in the future. People do make the difference. In Japan, they call it, this body, the JUSE, the union of Japanese scientists and engineers. So they talk about people. We talk about, basically, the focus of NIST as science and technology, as subject matter very importantly.

[Slide.]

And here, a quote from Jack Welch of General Electric, who challenges us all to go for the quantum leap. Can we do it by reducing MEP funding? I don't think so.

[Slide.]

We pause to look at this picture. The worker is on the left talking to the engineer. We need to help the worker here so he can understand and also be empowered. Today, he is not.

[Slide.]

The salesmen in this picture are on the left. The two employees on the right are wearing safety glasses, so obviously, they must be production workers. They need, though, a different set of tools, not just better pails, but the right tools so they can avoid the dilemma they are in in the first place.

[Slide.]

In summary, MEP has been a strong contributor to the need in this country to stimulate change. They have been and need to continue as a catalyst for that change. They provide a countrywide network. Our government must continue to support enterprise. Small and medium-sized businesses need this kind of help even more. We must remember that the market is global, and other countries are getting better, too. MEP provides education, not just training. And not all good ideas originate in America.

Our Congress has a responsibility to provide solutions, not just observe. I have found the MEP five times in five states. They are the solution. We should expand, not retract, our support of the MEP. MEP is that synergy. If the 2007 budget is reduced from $109 million to $49 million, not only are past efforts of the MEP compromised, but it would show that the leadership umbrella I showed you, referring to it earlier, has been closed by our own Congress. Your constituents need your support. Your challenges as our representatives to this Congress, are to find synergies that allow Americans to prosper in an ongoing, expanding global market. I submit that MEP is that synergy.

Thank you.

[The prepared statement of Mr. Ryan follows:]

PREPARED STATEMENT OF MICHAEL J. RYAN

[Slide #1]

It is, indeed, a pleasure and an honor to have the opportunity to address the House Science Committee's Subcommittee for Science and Innovation. My comments today will focus on Lean Policy Deployment and the very necessary role that the NIST Manufacturing Extension Partnership plays in helping American companies deploy lean methods.

[Slide #2]

I am here at the invitation of Representative Phil Gingrey of Georgia. I am Michael John Ryan, currently the President and CEO of TUG Technologies based in Marietta, Georgia. TUG manufactures ground support equipment for domestic and international airlines and the United States Armed Forces. If you look out the window the next time your plane stops at the gate, you'll likely see a TUG baggage tractor and belt loader. I have had the pleasure of working with NIST MEP's in five states across our country. After spending 38 years in Automotive and Industrial product companies, I have learned how to learn. Today, as a witness to the Subcommittee, I will share my thoughts from those experiences, specifically over the past 13 years. I am an American who believes that we can be globally competitive by deploying lean methods to our manufacturing base in this country. MEP has played an important supporting role to enhance American Productivity now for 18 years.

[Slide #3]

Back in 1982 when I was Director of Quality for TRW, I spoke at a global conference in Brazil about the need to establish structure before improvements can be expected in any change process. After spending 11 years working for Ford Motor Company, I had learned that Henry Ford's successes were built on very structured methods.

[Slide #4]

Since I was in Brazil at a global conference, I used the flag of Brazil to make my point. Their flag says "order and progress." Our approach to change too requires order before progress is possible.

[Slide #5]

In 1991, the results of a U.S. Government-sponsored study on the productivity of Japan was published by Womack, Jones, and Roos in their book entitled *"The Machine That Changed the World."* Here is where they first described their findings at Toyota as "Lean Manufacturing." In this book they captured the reasons that Japanese productivity in the automotive industry was improving faster than in the USA. I had the opportunity to meet Jim Womack in 1995 at United Technologies, just before their next book, *Lean Thinking,* was published. In this new book they provided case studies showing how several American and European companies were deploying lean methods.

[Slide #6]

They describe five steps in a transformation as you see here (value, value stream, flow, pull, and perfection). But no where is it written; how to implement the "lean process."

[Slide #7]

They do, however, list some actions that are important to consider. Here, I show you their action steps and also identify, from my experience, the responsibility for each action. Here is where the MEP is extremely important to the process of change.

[Slide #8]

Here they continue to identify the steps. (pause) Here again I have identified the critical role MEP plays in these process steps.

[Slide #9]

The basis of learning that Womack and Jones discovered is best depicted by the Toyota Production System as described here. We already understood the alignment of Man, Material, and Machine, but they helped us fit the other pieces of the puzzle together as shown here as a "Global Production System." How did we use this learning to deploy change?

[Slide #10]

Here is an important quote from Albert Einstein that I have been referring to for many years. (pause) Can we learn to change our minds? Can we understand the differences we face? Can we be globally competitive? Can we stay at the same level of thinking we were at when we created significant problems? It is said that the definition of a fool is one who expect different results while doing the same things.

[Slide #11]

In order to deploy a Lean Policy we have to have an implementation standard that optimizes the efforts of independent companies and is supported by an education process that understands the fundamental tools of a lean system. Back in 1994 I was Vice President Quality and Continuous Improvement at UT Automotive. I had the opportunity to work with United Technologies' other companies like Pratt and Whitney, Otis, Carrier, Hamilton Standard and Sikorsky. I have used this depiction of the deployment process ever since. The Leadership umbrella represents the role of company leaders to support and protect a six-step sequential process to transform a company as it accepts the changes needed to become "world class." It is these six steps of transformation that need the supporting structure of the National MEP. We have tried to empower our employees through Quality Circles. We have taught SPC statistics to address TQM. But neither has worked. Why not? Because we must create product cells first, and then the sequence can follow. The MEP knows this! Most consultants do not.

[Slide #12]

Here I am sharing my own experiences with the application of MEP capabilities. I've listed the companies I have worked for over the past 13 years and then I am showing the five different state-supported MEP organizations where I have had an affiliation. Back in 2000, I was a board member of MMTC, a Michigan MEP. In 2003, I was President and CEO for the Bobcat Company, a division of Ingersoll Rand. The North Dakota MEP was engaged in our transformation there. In 2005, Bobcat Company joined a WMEP consortium with Harley Davidson, Oshkosh Truck and Trane to develop a supplier assessment tool. This coordination between OEM's and their supply base can be uniquely filled by the MEP. To the right I am showing the times I have also used the expertise of Shingijutsu. This is a teaching organization, based in Japan, that is made up of former students of Taichi Ohno. Ohno san is the "father" of the Toyota Production System. These teachers, called Sensei in Japanese, provide the ultimate level of expertise to refine the application of a lean system. In fact, this week we are conducting kaizen at TUG's Marietta and Kennesaw facilities in Georgia, supported by Shingijutsu. Without the support of MEP,

we would not have a high enough level of understanding to deploy the change processes required.

[Slide #13]

So, what are the benefits from these activities. I have listed several for you here from my own experiences. Significant improvement in revenue growth of 86 percent and operating income of 128 percent are examples. Large reductions in warranty expenses and improved customer satisfaction. Improved inventory turns; from five to 25 and from two to 16 in two examples. Operating income improvements of 400, 500, and 550 basis points over a two-year period at three different companies.

[Slide #14]

Reduced customer lead times. Flawless product launches, continuous kaizen, and an expanded use of employee intellectual capital were achieved. Through the Georgia Tech MEP in the past four months we have trained 79 staff associates in VSM, Office kaizen, and Lean methods at TUG Technologies.

[Slide #15]

So, now, think of a process. Consider that it has at least three versions. First; what you think it is.

[Slide #16]

Second; what it actually is.

[Slide #17]

And then third; what it should be.

[Slide #18]

Consider a moment that Henry Ford at the Rouge Complex near Detroit delivered a car to a customer in just four days from raw material to finished car. That was in 1914. Most people don't know that he wrote a book, *"Today and Tomorrow,"* in 1936 that describes his lean process from some 22 years earlier. Taichi Ohno, indeed, developed the Toyota Production System from his studies of Henry Ford. One other important point; Toyota never had to change "bad habits" since, after the war they could start from the basics in 1947. The challenge in America still today is that we have to change people from their habits of the past to the global challenges in our future.

[Slide #19]

People do make the difference! In Japan they have the JUSE body focused on people. It may be subtle, but they talk about scientists and engineers while we look at science and technology. Sometimes we seem too focused on issues and material things. MEP provides NIST with an opportunity to focus on the people. We must get more globally competitive.

[Slide #20]

A quote from Jack Welch of General Electric, who challenges us all to go for the Quantum Leap. Do we accept his challenge? Can we do it by reducing MEP funding? I don't think so!

[Slide #21]

(pause) The worker on the left is talking to the engineer. We need to help the worker here, so he can understand and also be empowered. Today he is not.

[Slide #22]

(pause) The salesmen are on the left. The two employees on the right are wearing safety glasses, so they must be production workers. They need a different set of tools, not just better pails, but the right tools so they can avoid their dilemma in the first place.

[Slide #23]

In summary, MEP has been a strong contributor to the need in our country to stimulate change. They have been, and need to continue as a catalyst for change. They provide a country wide network. Our government must continue to support enterprise. Small and medium-sized companies need this kind of help; even more. We must remember that the market is global and other countries are getting better too. MEP provides education; not training. Not all good ideas originate in America.

Our Congress has a responsibility to provide solutions, not just observe. I have found the MEP five times, in five states. They are the solution. We should expand, not retract our support for the MEP budget needs. MEP is that synergy. If the 2007 budget is reduced from $109M to $47M, not only are past efforts of the MEP compromised, but it would show that the leadership umbrella I referred to earlier has been closed by our own Congress. Your constituents need your support. Your challenges as our Representatives to this Congress are to find synergies that allow Americans to prosper in a global market.

MEP is synergy!!!!!!!!

TUG TECHNOLOGIES CORPORATION

LEAN POLICY DEPLOYMENT AND THE MANUFACTURING EXTENSION PARTNERSHIP

TUG TECHNOLOGIES CORPORATION

Introduction

- Michael J. Ryan
  President and CEO
  TUG Technologies Corporation
- Witness to the Science Committee, Subcommittee on Technology and Innovation
- Importance of MEP role to support American Manufacturing Productivity

2

TUG TECHNOLOGIES CORPORATION

World Class Manufacturing

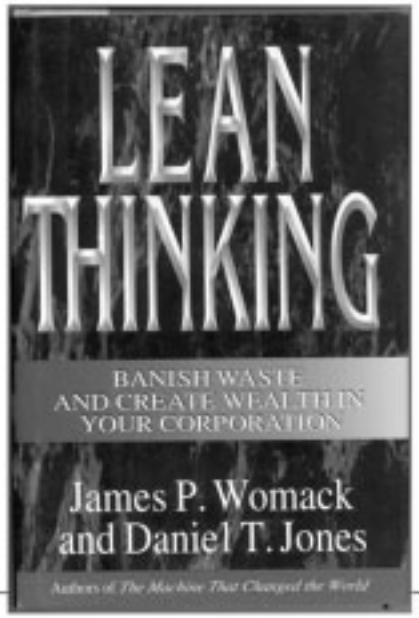
"Order and Progress" – structure, and then improvement

3

TUG TECHNOLOGIES CORPORATION

World Class Manufacturing

4



5

TUG TECHNOLOGIES CORPORATION

Global Gemba Kaizen

- **Value**
  - Focal Plane – Gemba
    - Design
    - Order Release
    - Plants (parts)
  - Look at the "parts"
- **Value Stream**
  - Supplier – Plant – Customer
    - Concept to launch
    - Order to delivery
    - Raw material to customer
  - Eliminate "Muda"
- **Flow**
  - No detours
  - No backflows
  - No scrap
  - No waiting
- **Pull**
  - Make only what is wanted when it is needed
- **Perfection**
  - Perfection is the complete elimination of Muda; every action and asset creates value, through revolution (kaikaku) and evolution (kaizen).

6

TUG TECHNOLOGIES CORPORATION

Global Gemba Kaizen

Action

- Find a change agent.....Leadership
- Get the knowledge.....MEP
- Seize (or create) the crisis.....Leadership
- Map value streams.....MEP
- Begin with something important..Leadership
- Demand immediate results.....MEP
- Expand your scope.....MEP

7

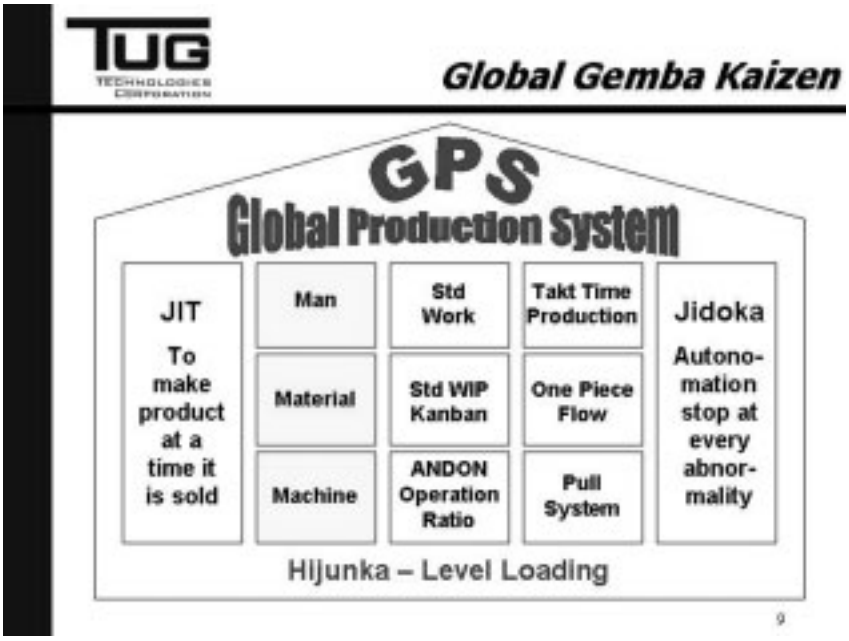
TUG TECHNOLOGIES CORPORATION

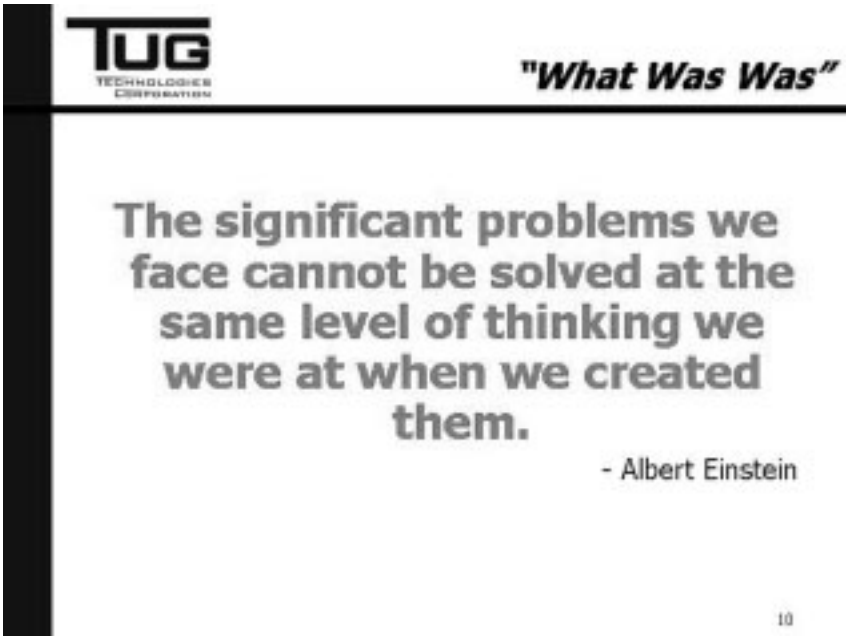
Global Gemba Kaizen

Action

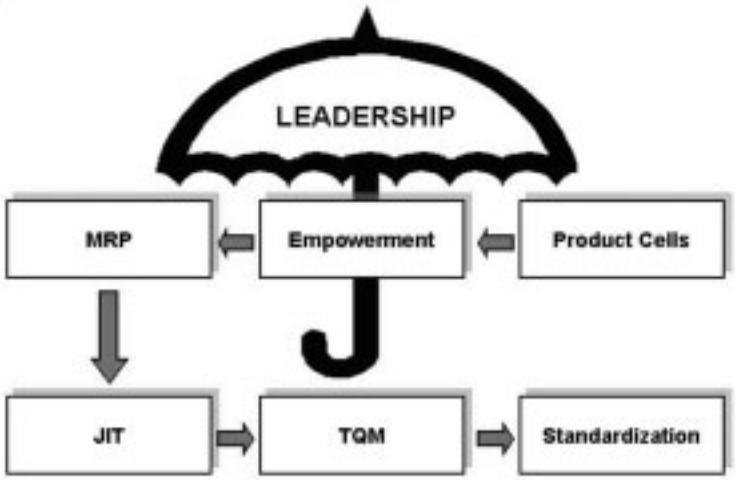
- Reorganize by product families and value streams.....MEP
- Create a lean promotion function.....MEP
- Deal with people at the outset...Leadership
- Devise a growth strategy.....Leadership
- Remove the anchor-draggers....Leadership
- When you have kaikakued and kaizened, do it again.....MEP

8


TUG
TECHNOLOGIES CORPORATION
Global Gemba Kaizen
GPS
Global Production System
JIT
To make product at a time it is sold
Man
Material
Machine
Std Work
Std WIP Kanban
ANDON Operation Ratio
Takt Time Production
One Piece Flow
Pull System
Jidoka
Autono-mation stop at every abnor-mality
Hijunka – Level Loading
9


TUG
TECHNOLOGIES CORPORATION
"What Was Was"
The significant problems we face cannot be solved at the same level of thinking we were at when we created them.
- Albert Einstein
10

Lean Policy Deployment



11

Application of MEP Capabilities

Year	Company	MEP Affiliation	Shingijutsu
1994	United Technologies	none	√
1998	Lucas-Varity/TRW	MMTC – MEP ♯	√
2000	Intermet Corporation	MMTC – MEP ♯	---
2003	Bobcat Company; IR	North Dakota MEP	√
2005	w/Harley Davidson,	Wisconsin MEP	---
	Oshkosh, Trane	Wisconsin MEP	---
2005	Ingersoll Rand	North Carolina MEP	√
2006/07	TUG Technologies	Georgia Tech MEP	√

♯ Board Member MMTC 2000/2001

12

TUG TECHNOLOGIES CORPORATION

Some of the Benefits from Lean Transformation

- Increased Revenues by 83% and Operating Income by 128% with same factory floor space over a three-year span, creating more jobs.
- Reduced warranty expenses by 64%, and 67%
- Improved, inventory turns from 5 turns to 25 turns and from 2 turns to 16 turns
- Improved operating income by 400 basis points, 500 and 550.

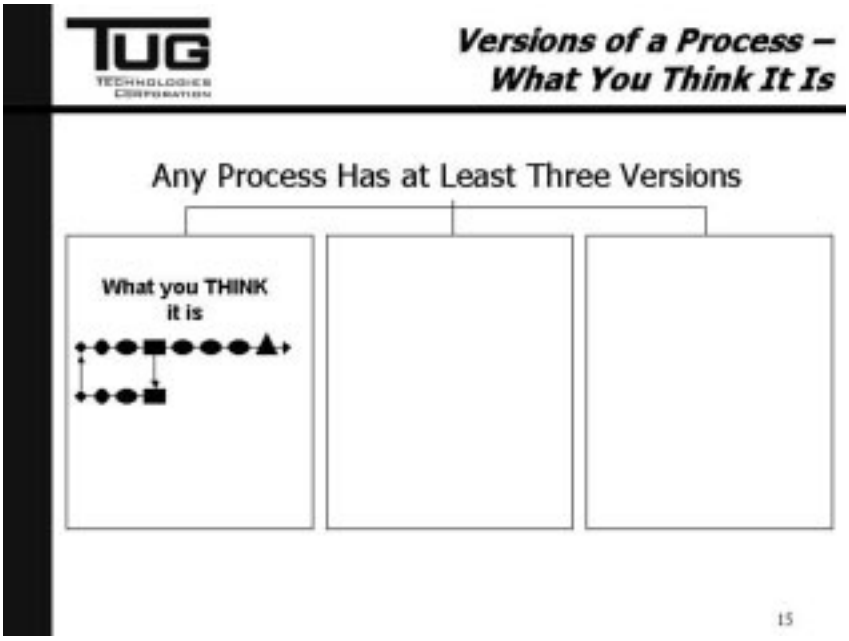
13

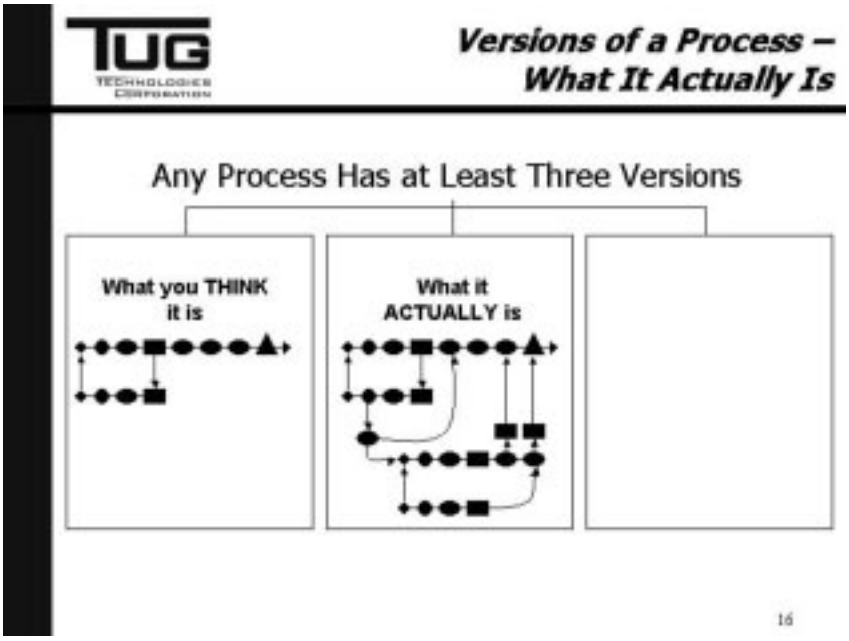
TUG TECHNOLOGIES CORPORATION

Additional Benefits of Lean

- Reduced customer lead times by 80% and 72%
- Used 3P process to allow flawless new product launches
- Conducted continuous Kaizen process with expert support
- Allowed for continual use of employee intellectual capital
- Georgia MEP trained 79 staff; teaching VSM, office Kaizen & Lean

14

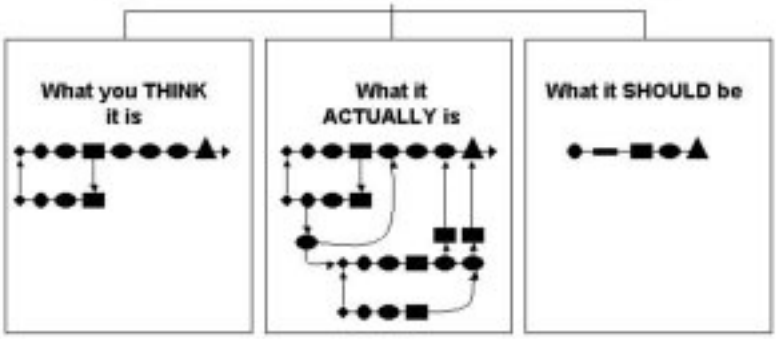

TUG
TECHNOLOGIES CORPORATION
Versions of a Process –
What You Think It Is
Any Process Has at Least Three Versions
What you THINK it is
15


TUG
TECHNOLOGIES CORPORATION
Versions of a Process –
What It Actually Is
Any Process Has at Least Three Versions
What you THINK it is
What it ACTUALLY is
16

TUG TECHNOLOGIES CORPORATION

Versions of a Process – What It Should Be

Any Process Has at Least Three Versions



17

TUG TECHNOLOGIES CORPORATION

Origins of Just-In-Time

Process described in 1936 by Henry Ford

- *Today* and *Tomorrow*
- Raw material to finished product in *4 DAYS (1914)*

Japan's Expansion of JIT

- Ford's book reprinted in Japanese
- U.S. Supermarket – model for Kanban
- Deming & Juran (SPC)
- Refined to science (1947 – today)

18

TUG TECHNOLOGIES CORPORATION

People Make The Difference!

- Union of Japanese Scientists and Engineers
- National Institute of Science and Technology

19

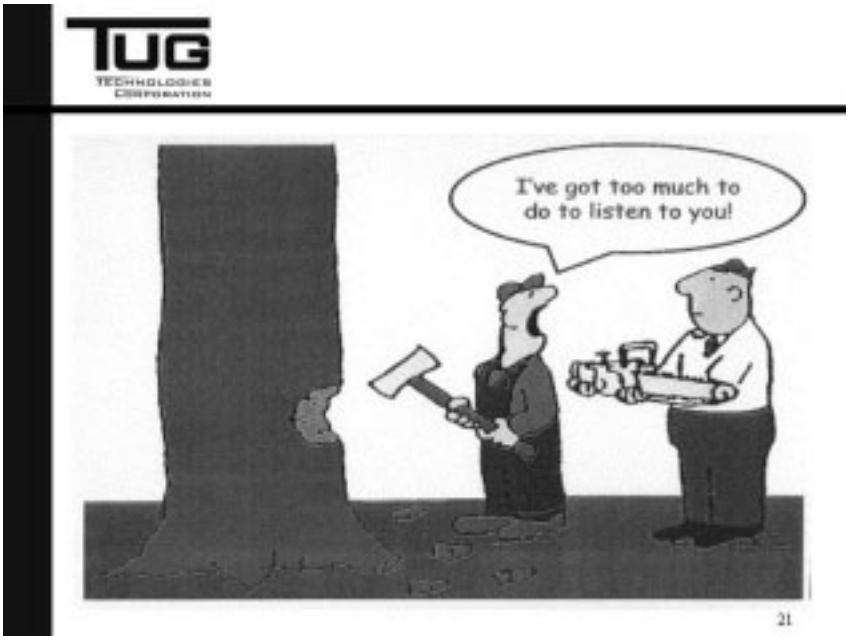
TUG TECHNOLOGIES CORPORATION

World Class Manufacturing

"Shun the incremental and go for the quantum leap."

Jack Welch

20


TUG
TECHNOLOGIES CORPORATION
I've got too much to do to listen to you!
21

TUG
TECHNOLOGIES CORPORATION
I'm glad the hole isn't in our end...
22

BIOGRAPHY FOR MICHAEL J. RYAN

Summary of Experience

An industrial professional with unique and exemplary global lean business process experience as a General Manager and Operations executive. A diversified corporate background with proven leadership and P&L success in both favorable and challenging economic conditions. Areas of expertise include: Lean Policy Deployment, Global Consulting/Sourcing, Operations Management, Operating System Design, New Product Development, Financial Reporting, Lean Manufacturing/6 Sigma, Strategic Planning, Productivity/Process Improvement, Business Development, Kaizen/Shingijutsu Projects, Talent Assessment and Team Building, Sales/Marketing Strategy, Competitive Analyses, Budget Development/Management.

2006 to 2007: JACOBSON PARTNERS, New York, New York (Private). A mid-cap private equity fund specializing in corporate divestitures and other middle market companies in the early stages of turnaround.

2006 to 2007: Managing General Partner—Operations; President and CEO, TUG Technologies Corporation

A market leader providing ground support equipment to the global airline industry.

- Leading major business turnaround
- Utilizing Lean Policy deployment
- Reorganized structures to bring efficiencies
- Developing and implementing pricing strategies with suppliers
- Coordinating customer market needs and pricing

2003 to present: INGERSOLL RAND COMPANY, Montvale, New Jersey (NYSE). An $11 billion diversified industrial company with 44,000 associates, 90 plants, and 150 service and distribution centers. Brand Name Products include: Thermo-King, Hussman, Bobcat, Club Car, Schlage, LCN, Von Duprin, ABG, Blau Knox, and Ingersoll Rand (IR).

2005 to present: Corporate Vice President, Global Operations. Promoted into a new corporate role directing a staff of 200 in the operation/management of In-

gersoll Rand BOS, Quality, Global Sourcing, Global Consulting, Supply Chain/ Logistics, and the IR India Engineering Center.

- Led the development of Operational Excellence thru a common Business Operating System.
- Aligned cross-sector projects in India, China, and Eastern Europe.
- Achieved continual quarter over quarter improvement for key operating metrics.
- Oversight of Sector Operations Executives to coordinate synergies and drive Lean Policy Deployment through Hoshin Planning, Application Modules, and Lean Conversion.
- Developed Lean and 6 Sigma education through the Ingersoll Rand University.
- Served as a Corporate Officer and an active member of the Enterprise Leadership Team.

2003 to 2005: President/CEO, Bobcat Company. Responsible for leading all corporate functions of the largest Ingersoll Rand Division.

- Moved revenues from $1.1 billion in 2002 to $2.1 billion in 2005 while launching 40 new products into strong channels in North American and Europe.
- Reduced warranty from 3.3 percent of sales to 1.2 percent saving $35,000,000 annually.
- Introduced Lean systems, taught Lean Policy Deployment and 6 Sigma tools to top 400 managers and supplier executives.
- Improved operating income by 400 basis points.
- Developed dealer network to expand product offerings in channel.
- Developed new leadership team and added employees at 1/3 ratio to baseline labor standards.
- Improved inventory turns while improving field inventories for dealers.
- Developed the Bobcat Production System.

2000 to 2002: INTERMET CORPORATION, Troy, Michigan (NASDAQ). A $1 billion publicly traded, casting supplier.

Executive Vice President, Operations. Responsible for operations oversight of 23 iron, aluminum and magnesium casting facilities and 8,400 employees.

- Aligned acquisitions by deploying lean manufacturing principles and a common Business Operating System.
- Reduced break-even by $200,000,000 and working capital to meet debt covenants.

1998 to 2000: TRW, Cleveland, Ohio (NYSE). One of the world's largest and most diversified suppliers of automotive safety systems, modules and components to global vehicle manufacturers and their related aftermarket. $17 billion in sales with $11 billion in sales to the automotive sector.

TRW AUTOMOTIVE, Livonia, Michigan.

1999 to 2000: Vice-President, Chassis Systems, North America. Responsible for the combined North America Braking, Steering, and Chassis Operations of the combined TRW and Lucas Varity generating $2.7 billion sales annually.

- Led 7,500 associates in 27 plants organized into five business units.
- Installed lean manufacturing principles that reduced both cost and PPM.
- Implemented a Business Operating System that significantly improved product delivery, quality, and warranty claims costs.

1998 to 1999: Vice-President, Braking Systems, North America. (Formerly Lucas Varity Automotive with $7 billion in sales including $1.7 billion N.A. Braking Systems.) Responsible for all Operations, Manufacturing Engineering, Service, Quality, Finance, Information Technology and Human Resources in 14 plants with 4,000 associates.

- Implemented lean manufacturing methods including 40 weeks of Shingijutsu projects.
- Improved quality and delivery by over 25 percent.

- Increased OI by 550 basis points for Braking Systems.
- Improved cash flow by $150,000,000 and exceeded all balanced scorecard metrics for 1999.

1994 to 1998: UNITED TECHNOLOGIES CORPORATION, Hartford, Connecticut (NYSE). Global company providing technology products to the aerospace, automotive and building industries.

UNITED TECHNOLOGIES AUTOMOTIVE, Dearborn, Michigan. $18 billion sales including $3 billion in wiring, motors, switches, and interiors.

1996 to 1998: Vice-President, Interior Operations. Responsible for $650 million in sales from 16 plant locations with 3,000 associates. Products included door panels, instrument panels, headliners, etc.

- Implemented Lean methods including 90 weeks of Shingijutsu projects.
- Rationalized product lines, optimized APQP and greatly improve ROS by 500 basis points.

1994 to 1996: Vice-President, Quality and Continuous Improvement. Responsible for Quality and Business Process Re-engineering (BPR) for interior trim, electrical, and electronic automotive products.

- Implemented BPR plan revising Financial Reporting and New Product Development.
- Initiated QS–9000 and introduced lean manufacturing methods.
- Moved U.T.A. from "worst" commodity supplier at Ford in 1994 to "best-in-class" in 1996.

1993 to 1994: HOLMAN ENTERPRISES, Pennsauken, New Jersey (Private). A $1.5 billion automotive corporation of retail, service, and lease businesses.

President, RMP. Responsible for all aspects of this re-manufacturing company generating $80 million in sales at three plants and five distribution centers providing engines, transmissions, and subsystems to 900 Ford Dealers.

- Implemented cost control, revised core values, regained Q1 for Ford, and returned to profit.

1991 to 1993: MASCOTECH, Detroit, Michigan (NASDAQ). A $1.5 billion automotive supplier operating 20 plants.

Vice-President, Operations, Braun Engineering. Managed operations of two Braun forging and machining plants with $70 million in sales annually. Initiated self-directed work teams and placed QCD focus through kaizen methods. Reorganized by flow and TPM focus to improve throughput.

1981 to 1991: TRW AUTOMOTIVE, Solon, Ohio (NYSE).

1988 to 1991: General Manager, APR. Generated $20 million sales with 450 associates and four reman plants. Consolidated operations with PIP into Maquiladora with headquarters in South Texas.

1984 to 1988: Director, TRW Electronic Controleld Steering. Directed product and process development of "ECS" managing an $11 million annual budget with 110 associates over five divisions. Applied Aerospace Technologies to Automotive steering systems.

1981 to 1984: Director, Quality, TRW Automotive Worldwide. Managed a worldwide Quality initiative across 96 plants in 16 countries. Chaired U.S. and Europe Councils and taught Quality College. Directed European class 8 heavy truck steering move from England to Spain.

1970 to 1981: FORD MOTOR COMPANY, Dearborn, Michigan (NYSE); FORD TRACTOR OPERATIONS, Troy, Michigan.

Inspection Superintendent

Staff Quality Auditor

Staff Quality Engineer

Production Analyst

Cooperative Education Trainee

EDUCATION:
MBA, Wayne State University, Detroit, Michigan
BS, Automotive Engineering, Western Michigan University, Kalamazoo, Michigan

ADDITIONAL TRAINING:
Lean Manufacturing Institute—1996
Columbia University Executive Management Program—1986 and 1987
Deming Seminar, Ford Motor Company—1985
Manufacturing Excellence, University of Michigan—1983

PROFESSIONAL MEMBERSHIPS:
SAE, 1982 to present
ASQ, Senior Member, 1978 to present

BOARD MEMBERSHIPS:
Manufacturer's Alliance/MAPI, Quality Council Director—2005
Board Member, Michigan Manufacturer's Technical Center—2001
Director, Lucas-Sumitomo Joint Venture Board of Directors—1998
Board Member, American Suppliers Institute (ASI)—1994

INSTRUCTOR/FACILITATOR:
Taught *Lean Policy Deployment* to 400 Bobcat employees and suppliers—2003
Taught *Lean Policy Deployment* to Lucas Varity N.A.—1998
Taught *Statistical Process Control,* Ford Motor Company—1979

PRESENTATIONS:
Lead Speaker, Lean System Training, University of Kentucky—2006
Lead Speaker, Ingersoll Rand Annual Worldwide Leadership Conference—2005
Panel Speaker, Virtus International Symposium, Montreal Quebec—2005
Speaker, ESGR Fargo Air Museum Recognition Ceremony—2004
Featured Speaker at ASAE ceremony honoring Bobcat's Keller brothers—2004
Lead Speaker at ceremony for U.S. Army Bobcat's Delivery for Use in Iraq.
Featured Speaker: U.S. Senator Byron Dorgan, Chair of Armed Services Committee—2003

RECOGNITION & AWARDS:
North Dakota MEP Award for Lean Training—2005
Recognized at North Dakota Governor's State of the State Address—2005
Elected to Fargo Chamber of Commerce—2004

DISCUSSION

Chairman WU. Well, thank you, Mr. Ryan.

And now we will have some discussion here.

I recognize the Chair for five minutes.

MANUFACTURING EXTENTION PARTNERSHIPS

Dr. Jeffrey, we have had eloquent, effective testimony about the need for MEP. Let us just declare the 50-some-odd-percent cut in MEP dead on arrival for now, and we will set that issue aside, and we will move on to some other things and maybe circle back to that.

I understand that NIST intends to re-compete all the MEP centers this spring, because you anticipate some reduction in funding from Congress. I would like to understand as best as possible, how much this re-competition will cost NIST and the MEP centers. I, quite frankly, think that Congress is more likely to relatively fully

fund MEP again this year. And I am a little bit concerned about a waste of not only money but, you know, when you wave an axe in front of a whole flock of turkeys, it gets everybody upset, and nobody gets back to feeding and growing more turkey for a while.

So I would really like to understand why you are doing this, what the estimated cost is, and get a sense for how much this is going to upset the whole flock of very hardworking folks.

Dr. JEFFREY. Well, the intent is certainly not to upset the flock.

In terms of the actual costs, I will have to take that for the record. I don't have the numbers in front of me, and so I would be happy to answer in writing to you on the costs.

In terms of the rationale as to why do this at this point, to do an effective re-competition, it would take about five to six months. If the budget reduction did occur, and we were to start that after the final appropriations, by the time we completed that competition, we would be out of money if we had all of the centers at the same spend rate. So what the re-competition allows, one, is a more efficient way of trying to get through to try to extract where there may be some savings in the program, where there may be slightly different business models to attract additional fee extraction, and where there may be efficiencies in consolidation that would allow for the maximum amount of service.

If the budget cut did occur and we waited until the end to then try to address that, we would actually have to be in a position of just cutting every single center by the same percentage, which would probably create much more of a disruption, and a——

Chairman WU. Well——

Dr. JEFFREY.—weaker system at that point.

Chairman WU. Thank you, Dr. Jeffrey. But given that Congress is opposed to the MEP re-competition and, in fact, in fiscal year 2005, NIST was specifically prohibited from doing the re-competition, I think there is some room to inquire as to why this path is being pursued, because if we need to, I suspect that we might put that prohibition back in the appropriations bill.

And I would like to get a sense from Mr. Murray and Mr. Ryan about what you think the effect of a re-competition across the country would have on MEP centers.

Mr. MURRAY. Can we reply?

Chairman WU. Yes, I am asking both of you about——

Mr. MURRAY. I will go first.

Chairman WU.—your take on the effect of a re-competition.

Mr. MURRAY. Okay. I think it would be disastrous, to use a word. Again, I am speaking as a board member of the affiliate in Oregon. The organization, as it is now, is extremely lean. I have been to their offices. They camp out in a—kind of a—it is anything but plush. The staff is incredibly efficient and very lean. I really don't know where they would find additional savings. I think it would be a distraction for that business, take away already limited resources, to look for new business or to market to other clients. I really think it would be a disaster. I can't say it strongly enough.

Chairman WU. Thank you, Mr. Murray.

Mr. Ryan, do you have anything to add?

Mr. RYAN. As I mentioned earlier in my talk that the MEP represents synergy. One of the things that I don't believe we do well

enough in our country in the manufacturing sector is identify the cost relationship between the supply chain steps. The OEM manufacturer of a finished product, the supplier of subsystems, the supplier of parts to the subsystems, et cetera, is the supply chain. Knotting that together, as well as by state representation, allows for some common methodology across the country to accept the challenge to be cost-reducing our products and to accept the opportunity to be more competitive globally.

Chairman WU. Thank you, Mr. Ryan.

I see that my time is actually 24 seconds over.

You know, if I do not have an opportunity to return to this particular topic, I would like the witnesses, especially you, Dr. Jeffrey and Mr. Murray and Mr. Ryan, to comment upon what Dr. Jeffrey alluded to earlier, which is to compensate for the Administration's proposed cuts, which, in my view, are, one hopes, unlikely at this point by having them be absorbed by increasing charges to small and medium-sized manufacturers and what the effect of this would be on services and uptake of services from the current client base, or customer base, if you will. So the makeup of government funds through additional charges in fees.

First of all, it was a shame to lose Dr. Gingrey for a very necessary trip for our friend, Mr. Norwood, and Dr. Gingrey is the Ranking Member of the Subcommittee. I would like to welcome Mr. Hall, the Ranking Member of the Full Science and Technology Committee. Thank you, Mr. Hall, for being here. I wanted to welcome Mr. Hall, but my understanding is that Mr. Smith had some time constraints.

Mr. Hall, a southern gentleman from morning to night.

Mr. Smith, you are recognized for five minutes.

Mr. SMITH. Thank you. I, obviously, am not a Ranking Member, but I appreciate the opportunity to be here.

Mr. Ryan, I believe you talked about empowering workers and affording workers the tools. Do you feel that our existing channels of empowering workers are sufficient? What suggestions might you have for, perhaps, a change in paradigm, or whatever the case might be, to empower workers?

Mr. RYAN. In my testimony, I make comments about 20 years ago when the country was focused on quality circles on SBC. Statistics, if you would, Dr. Deming methodologies. That is some 20-plus years ago. What I showed in my presentation is an umbrella chart, as I call it, with six significant steps in sequence. And the second step in that sequence is empowerment of the people. But the first step is product sales structure. You have to be in an appropriate structural physical manner in a manufacturing facility in order for people to be empowered. Otherwise, management just pushes the problem at the employee and frustrates them even more.

So my point is that the discipline for that six-step sequence, starting with the product sales structure to the six-step standardization, the distinction of that is the people get empowered once you create the structure that they can be and add, what I call, "intellectual capital" to the process. It is a huge opportunity that comes from a lean transformation. And again, the opportunity for productivity in this country amongst the people in small- and me-

dium-sized business is what will make us better as production management of large subsystems and vehicles and products for the associated markets served.

So the people empowerment needs that first step, and the MEP understands that sequence. And frankly, if you just go hire a consultant in the local state and not the MEP support, what you will find is unique opinions of what the proper process is. And again, as I said earlier that Jim Womack, who is the expert in lean concepts from back in 1991 on this survey work back at MIT, the learning is there, but the absolute application of that learning is still missing, and the linkage of the MEP—and my experience with five states, not all 50 yet, maybe I will live long enough to do that, but in those five states, that linkage is common. And so I am sharing with you that it isn't just the consulting activity at MEP. It is a common linkage of how things are done and the philosophy will get us there. If we take it down a notch or two or three or in half, as the proposal says, we lose what we have built up over 18 years, unfortunately. And that would be a travesty. And I do believe that Congress needs to support the people, and the people need to understand the profile of lean.

Thank you.

Mr. SMITH. Thank you.

R&D AT NIST

And also, Dr. Jeffrey, how does NIST evaluate new projects and novel fields of research, and are potential economic benefits explicitly considered when determining research priorities? And do you perform a formal needs assessment with involvement from the external community?

Dr. JEFFREY. Thank you, sir.

Our mission statement is to support the economic security and quality of life of Americans, and so every new initiative we put forward goes through a rigorous internal process that includes inputs, generally, from industry. It includes looking at what the kinds of impacts will be. Prospective studies have large errors to them, so often use best technical judgments involved.

Nanotechnology is a great example of where there have been a number of studies that have indicated that nanotechnology in the next 10 years may be anywhere from a $1 to $2.5 trillion global enterprise. And a lot of the issues there have to do with the measurements characterizations which Dr. Williams very eloquently described in his testimony.

In addition, we reach out to the private sector, probably more than any other part of the federal S&T enterprise to really try to get an idea of what the potential measurement barriers to innovation are. And in fact, we just completed our first assessment of what we call the U.S. measurement system, which actually looked at over 160 industry technical roadmaps, had over 1,000 people from the private sector participating with the NIST scientists to try to identify where there are current measurement barriers to innovation. And so we just catalogued that, just literally, released a report, and now using that as part of our strategic planning to identify and prioritize our investments.

Mr. SMITH. Thank you.

I yield back.

Chairman WU. Thank you.

The gentleman from Kentucky, Mr. Chandler.

ADVANCED TECHNOLOGY PROGRAM

Mr. CHANDLER. Thank you, Chairman Wu.

And I thank all of the witnesses for coming today. I appreciate you shedding some light on some of these topics.

I would like to, Dr. Jeffrey, ask you a little bit about the Advanced Technology Program, if I may. I understand, from Mr. Borrus, that he feels that that is an important program, and I understand that the Administration feels otherwise, that the Administration sees no need for it. Is there a particular need now, as Mr. Borrus claims, for seed stage investing? Please illuminate that a little bit for me.

Dr. JEFFREY. Thank you, sir.

The Administration recognizes the benefits that the ATP program has generated. It is an effectively-run program, and actually, I would have to say, I am actually very proud, as NIST's Director, to be hearing about success stories from all of the programs, because we do execute and run the programs as efficiently and effectively as possible.

Mr. CHANDLER. And therefore, we need to get rid of——

Dr. JEFFREY. Well, the issue isn't whether the program is effectively managed. The issue is, in the Administration's viewpoint, whether or not it is the appropriate role for the Federal Government to be playing. And it gets down to whether there are other policy mechanisms that may be able to help turn the tide that Mr. Borrus described of the private-sector investing in the early seed or whether a direct federal investment is necessary, and that basically gets down to a philosophical issue. But there really isn't so much an issue as to the effectiveness.

Mr. CHANDLER. Well, my understanding of what you are saying is if it is not broken, break it? I mean, you are saying that the program is working well, but now you are saying that somehow it is not the role of government to be a part of a program that is working well?

Dr. JEFFREY. Yes. There are a lot of effective programs that have different levels of priority for the Federal Government. And clearly, we are in a position where there are tight federal budgets. And, we have to prioritize what our investments are going to be based upon not just merit but also where we can make the biggest difference as the Federal Government. And that is what gets folded into the calculus.

Mr. CHANDLER. Well, let me give Mr. Borrus a chance, if you would like to add something.

Mr. BORRUS. I would only say that not only is it an appropriate role for the Federal Government, it is a historically-consistent, well-established role for the Federal Government over at least the last century and a half, if not longer, since the Morrill Act creation of land-grant colleges and the Agricultural Extension Service, which similarly, for the technologies of its time, sought to move innovation out of the colleges and out of the research institutes into agriculture. You know, it is not a departure for the U.S. Govern-

ment. It is not something new. This is a historically-consistent and well-received tradition. And it ought to be continued.

Mr. CHANDLER. Thank you.

I yield back, Mr. Chairman.

Chairman WU. Thank you very much.

The gentleman from Texas, Mr. Hall.

MEASUREMENT BARRIERS TO INNOVATION

Mr. HALL. Thank you, Mr. Chairman.

I want to try to get two questions in.

But first—and I would like a fairly direct and maybe a yes or no answer to one of the questions.

Dr. Jeffrey and Dr. Williams, both of you referred to the NIST report that identifies over 700 measurement barriers to innovation in critical industries. Give me not 700 but a few of the concrete examples of some of these barriers, first, and then just tell me whether or not there is a consensus on which barriers ought to be a priority for NIST to address. That last one, you can say yes or no and—without naming them. But give me just some examples, so we will have it in the record.

Dr. Williams, do you want to start?

Dr. WILLIAMS. Yes, thank you.

Specifically, in this area of nanotechnology, we are now getting into the realm of where electronic devices on circuits are just a few atoms thick, and they are starting to get tens of atoms wide. And in the not-too-distant future, literally, a single electronic device will be made up of a handful of atoms. The metrology requirements for, first of all, measuring the size of the device and then identifying which atoms are in the device and where they are within the device are absolutely daunting, and yet they are absolutely crucial for being able to understand the operation and being able to design future types of devices.

So it is this issue of literally counting and identifying individual atoms in a three-dimensional structure: when we can get to that point, the amount of progress that we are going to be able to make will really be stunning. So I would say that that, for me, is a key and critical issue.

Also, another one is literally metering light particles, photons, one at a time. We are now at the stage where we are generating and detecting single photons, and we are using those single photons to carry important information. And that is another issue, which is key and critical to the issue of metrology.

Mr. HALL. Dr. Jeffrey, do you want to——

Dr. JEFFREY. Actually, Dr. Williams did an excellent job. And thank you for allowing a plug. And here is a copy of the report that I will leave for you——

Mr. HALL. Okay.

Dr. JEFFREY.—afterwards. I will just add that——

Mr. HALL. Does that have all 700 of them in there?

Dr. JEFFREY. Actually, it does. There is a CD in the back with all of the data.

Mr. HALL. All right.

Dr. JEFFREY. Believe me. It is a fascinating read.

Mr. HALL. With pictures or——

Dr. JEFFREY. Not too many pictures, sorry. But one of the things I will just add is that what we concentrated on was 11 different industry sectors in this as a beginning, and so it runs the gamut from several of the measurements that Dr. Williams described down to some of the near-term needs of today's auto industry, information technology, and others. And I will leave a copy behind for you, sir.

Mr. HALL. All right. I thank you for it.

You should have given me one the other day, and I would have been studying it, and I could have taken a test on it or something.

Dr. JEFFREY. We just released it on Monday, sir.

Mr. HALL. And I was going to ask you if there is a consensus on which barriers should be a priority for NIST to address, but they are prioritized in your article there, are they not?

Dr. JEFFREY. Well, one of the things that we are doing, sir, is that we are taking these, and we are now doing what I will call a "deep dive", trying to identify whether or not there are some systemic issues, as opposed to 723 separate ones, that would be the ones to really focus on.

And one of the unique aspects of what this study did was it identified measurement barriers to innovation that may not fall just within the NIST purview, and so we are reaching out to industry, to universities, and to other government agencies so that we can get a more comprehensive attack on these issues. But we are at the point now where we are starting to look at the systemic issues, to see if there are systemic issues, which would then lead to that prioritization.

Mr. HALL. I lost a bet. I bet that I could get a yes or no. And——

Dr. JEFFREY. Yes.

Mr. HALL. There was a President who didn't speak very much, and a young journalist said, "Mr. President, I have a bet that I can get you to say at least three words." His answer was, "You lose."

Thank you for that.

But Dr. Jeffrey, while I am talking to you. Over the past several years, this committee, we have been active in promoting the nationwide transition to electronic health records that we think hold a great promise for reducing medical errors and lowering the cost of medical care. Can you summarize the efforts that NIST has made to help the Department of Health and Human Services promote EHR and the adoption of information technology solutions generally within the health care industry?

Dr. JEFFREY. Yes, thank you, sir.

NIST has been working very closely as a partner, supporting HHS, which has the lead on this. And we are working in several different areas. One is working with the private sector and standards development organizations to try to get some coherence and compatibility on some of the standards for interoperability of systems. We are also working and supporting some of the contracts that HHS has out, providing technical underpinning to them, and also looking at some of the validation mechanisms that will come into play. So we sort of tied in with HHS throughout the full end-to-end gamut.

Mr. HALL. I thank you. My time is out, and I understand we can write letters, make inquiries, and they will answer them.

I have a follow-up to that, but my time is up, and I yield back. Thank you, sir.

Chairman WU. Thank you, Mr. Hall. And you are absolutely correct, as always.

Mr. HALL. About what?

Chairman WU. That time was up and you can make written inquiry.

Mr. HALL. All right.

Chairman WU. All right. Mr. Matheson, the gentleman from Utah.

MANUFACTURING EXTENSION PARTNERSHIP; ADVANCED TECHNOLOGY PROGRAM

Mr. MATHESON. Well, thank you, Mr. Chairman.

I apologize. I had another meeting and didn't get to be here to hear all of the testimony, and I want to cover something that, I think, has been discussed a little bit before.

But Dr. Jeffrey, I wanted to ask you a couple questions, again, related to the MEP program.

This is a program, as we all know, that is a state/federal partnership. And I am curious, since there has been this continued annual process where the Administration has advocated reductions in the MEP budget, if the Administration has ever consulted with the states and their funding agencies about your intent and how the program would operate under the budget cut. It is my understanding that, at least in my State of Utah, the MEP center has not been consulted on this budget proposal. And I think that many state agencies would likely simply reduce their share of matching funds if the federal share is cut. But do you have an understanding of how states would react to these proposed cuts?

Dr. JEFFREY. In terms of the outreach, obviously, one of the issues is discussing the budget before it is actually submitted. Since the budget proposal has come up to the Hill, I know that the Director of the MEP program has been talking with the centers, having them understand what the implications would be, and having them start thinking about what the right approach would be to be moving forward. But as you point out, this, I believe, is the fifth year of this see-saw, and so I wouldn't say that it is a complete shock to the centers, but we are working with them now and before any kind of re-competition would occur to make sure that everybody understands what the ground rules are, what we are looking for, and how to maintain the most effective process for the small manufacturers that are out there.

Mr. MATHESON. Let me ask. As I understand it, one of the justifications from OMB for the budget cut in the MEP program is that almost 20 percent of the MEP clients are manufacturing firms that have more than 250 employees and that these firms would be able to make up the funding difference due to their size. Is this an indication that the Administration now considers manufacturers with more than 250 employees as outside the traditional federal definition of a "small business," the point being that the SBA defines small businesses as having less than 500 employees?

Dr. JEFFREY. I am not sure about the specific OMB reference that you are making, but we adopted the SBA definition for what

a "small manufacturer" is, so that we are consistent with that. So it would be 500 people under the MEP program.

Mr. MATHESON. Okay. Well, then we do have a disagreement here, and we will follow-up in written form and show you the OMB document that shows that they define it as if you are over 250, you don't need MEP anymore. And I would be happy to share that with you, because I am curious what evidence the Administration is using to say that clients with more than 250 employees suddenly don't need MEP. I think that would be a helpful exchange to have, because, quite frankly, I think you know this, the average manufacturing size in this country is about 33 employees.

One more question on MEP.

Is there a sense, under the proposed budget, how NIST is going to decide which centers will remain operational, assuming there would be a smaller system overall?

Dr. JEFFREY. Yes, sir. One of the things that we discussed was that there would be a re-competition that would basically have the centers come back with the plan for how they would be able to keep their effective services with the lower federal budget. And that could fall under a number of things from cost savings within the centers to consolidation to future action to whatever business model they want to have.

One of the things that I think is very important to maintain is that there is an important role for the Federal Government in the MEP program. And, I think it is very important that we understand that. There are really three absolutely critical core missions that the Federal Government needs to maintain. One is there has to be a driver for producing the new kinds of products and services that can then get propagated throughout the network, things like lean manufacturing and some of the other concepts that were talked about by two witnesses.

Second, it has to maintain the quality of each of the centers. There needs to be, essentially, that umbrella organization to ensure that an absolute standard of quality is maintained.

And third, it basically has to have enough skin in the game so that the focus does stay on the small manufacturers and doesn't just go to those customers that might be—what centers might gravitate to without the federal pressure.

And those are the three really critical pieces that we need to be able to maintain within NIST, and I think we can do that within that budget.

Mr. MATHESON. Well, Dr. Jeffrey, I don't think anyone is going to disagree with those three factors as to what needs to be maintained, but it seems like the proposed budget cut runs completely counter to the desire to pursue these three factors, and I suspect there is a bipartisan group on this committee which disagrees with this proposed budget cut.

Mr. Chairman, I yield back the balance of my time.

Chairman WU. Thank you very much.

Dr. Ehlers.

Mr. EHLERS. Thank you, Mr. Chairman. And I apologize to you and to the witnesses for being late, but in fact, I was giving a speech to a German American group very worried about technology transfer.

Chairman WU. Dr. Ehlers, you are forgiven as the only Member of Congress to have ever been late.

Mr. EHLERS. Yes, but I try to be on time.

But it is ironic to come from that conference where a foreign country is very eagerly trying to determine how we do technology transfer and knowledge transfer, as they said, and learning about America and come here to this discussion.

First of all, Dr. Jeffrey, I am very pleased that you are heading NIST. It is an institution I have had a soft spot for, for many years. I have used their services as a scientist. I served on the review panel for NBS, as it was called back then where I really got to know the inner workings. And I am pleased with what you are doing.

The fact that it is in NIST instead of NBS indicates a definite change of function. Not in any way cutting back the traditional, but adding to it things such as MEP, ATP. In other words, ways to directly assist the manufacturing in this country.

I know you mentioned earlier that the Administration has some disagreements about the functions of the MEP, and particularly ATP. Let me assure you that they are wrong. And I have been fighting a battle with them for some years. And I have always been trying to find out who the little man in the basement of the White House is that holds that view, and I have yet to locate him, but yet the attitude there is of that nature.

I first worked with MEP, incidentally, when I was in the state legislature as well. It is a good program. I am not saying it can't be improved, and I am certainly willing to see a review and willing to look at new ideas, but I don't want the objective of that review to be—to change MEP for ideological reasons rather than pragmatic reasons. And I am very concerned about any attempts to change it, and that is why the Congress has always fought this.

ATP is a different matter. I think ATP does have to be restructured. I think it should be resurrected in a restructured form. And that could also be extremely useful. I will not defend the way it operated originally, even though it was not that bad, but I think it could be improved.

MEP can be improved as well, but it has to have the right motivation.

I am not here castigating you, or anyone, and particularly in the Administration, but I am very concerned about those ideologues, who simply think it is improper for the Federal Government to be working with industry in the way it does. And that I object to strongly, because other countries are trying to find out how we do it, because we do it so well. So it is actually idiotic to, on ideological grounds, try to kill a program that is helping industry, helping our nation, helping our economy. And I appreciate especially the report of—pardon me, the quotation from Dr. Williams, quoting Benjamin Franklin, who should be the patron saint of all industry and political leaders in this country, in which he said, "An investment in knowledge always pays the best interest."

Just yesterday, I testified before the House Budget Committee, along with Congressman Rush Holt, my fellow physicist. And he made the point, too, about investments—that there is no expenditure of money that we make in the federal budget that has a great-

er return than investment in science and technology. There is no question about it. So we have to continue in that. And I say if you want to review MEP and modify it just on the basis of making a good program better, God bless you, and we would be happy to work with you and help you.

But I would resist any impetus to do it on the basis of the beliefs of some people in the Administration that somehow this is something the government should not be doing and that we have to restructure it because of some ideological beliefs.

I am not negative on the Administration. I appreciate what they have done. I appreciate the President. He is a good man. I have had good conversations with him about these issues. And frankly, he is in tune with what I am trying to do. So whoever is saying that the Administration "has problems," I don't think is speaking for the President.

Having said that diatribe, I would be happy to hear comments from anyone on the panel who wishes to comment on my diatribe.

Dr. Jeffrey.

Dr. JEFFREY. If I could add just a word.

Thank you very much, sir. And obviously, I have one point that I want to make sure does not get lost on this, and that, you know, obviously we stand by—and I personally stand by to work with you and anyone else on this committee, to try to improve any program, and I look forward to that. So thank you.

Mr. EHLERS. Well, since you got three Nobel Prizes in 10 years, I don't think we have to worry about improving their research program, at this point. But ATP definitely needs improvement. MEP needs some tinkering, and I think that is the best approach to take.

I am sorry. My time has expired.

I yield back.

Chairman WU. I thank the gentleman.

Well, while I am going to be nicer to the little fellow in (and I am not referring to anyone in particular). The gentleman from Michigan referred to a little fellow in the White House——

Mr. EHLERS. The basement of the White House.

Chairman WU.—that he has been looking for—and Mr. Borrus, we are going to get to you eventually, but I am going to get this off my chest, first.

And Dr. Jeffrey, I love you like a brother. You have been terrific. This is not directed at you. Let us consider you a conduit from this end of Pennsylvania Avenue to what Dr. Ehlers has referred to as the fellow in the basement that he hasn't been able to find. What you have referred to as an ideology, but let us consider this a conversation with the philosopher in the White House who has repeatedly cut back on MEP, has repeatedly zeroed-out ATP, and I would like to ask that philosopher—I mean, Dr. Jeffrey, you must be embarrassed to be here, because you are a scientist, and you just told us that ATP is a fine program and is doing great things. Now, back 150 years, would that philosopher in the White House be opposed to public libraries and we would be counting on Andre Carnegie? If we were back in the time of Abraham Lincoln and there were debates when he was in the state legislature in Illinois, should the public be involved in building roads and canals or should that be

a private enterprise? Merely 100 years ago, is it a legitimate role for the Federal Government to ban child labor or to begin to work toward a 40-hour work week? There were nine old men across the street who felt it was not an appropriate role, and it wasn't until a while later, I am mixing my history a little bit, but it shook those nine old men up enough that they started letting some of that legislation live rather than stomping it out over at the Supreme Court.

Now moving it to a more relevant period, space exploration. There is a very legitimate role for the private sector in low-orbit space exploration. But there are some folks who are thinking that NASA could be replaced in deep space exploration, and quite frankly, I just don't think the numbers crunch.

Now that philosopher down at the other end of Pennsylvania Avenue at OMB or somewhere else within a deep basement; you know, I have always said this Administration would privatize everything except for the Marine Corps. Then I went to Iraq. They are privatizing the Marine Corps! They are called contractors, and I don't know how many of them there are, because I don't know that anybody has ever done a count, but we are reducing our troop numbers, and we are outsourcing the Marine Corps. At some point, philosophy hits the hard wall of reality.

And I apologize to you for laying your ears back a little bit about this, but it is not directed at you, Dr. Jeffrey, because you are in a very uncomfortable spot of being a scientist representing a bunch of philosophers down at the other end of the street.

So just carry that message back, and tell me what they say over a beer some time.

AVAILABILITY OF VENTURE CAPITAL

Mr. Borrus, the Administration asserts that there is plenty of venture capital funds. And you say there isn't. Could you expand a little bit further on your comments about where venture capital has gone and why they are investing, shall we say, in more mature technologies and not, perhaps, in seed round and bridging the "valley of death"?

Mr. BORRUS. Venture investors will only commit large amounts of capital that they have at their disposal when they can assess, with some degree of specificity, at least three kinds of risks that venture investors look at. Technology risk, you know, is this something that is at all possible from a scientific standpoint? Can it be achieved at an appropriate price performance points to have an impact? Market risk, is there a growing market into which this new technological innovation has some hope of being sold by an innovative start-up, not a large established business that already has well-established distribution counts? Is the market large enough to generate the kind of return that venture capitalists look for? And execution risk, is this a team that can be built to execute on this business idea?

In a certain sense, you can define the seed stage of a de novo start-up's life as that point in time in which it is really not possible yet to assess those kinds of risks. It is really the point of time when you need to have a leap of faith and believe that if you do a little work and begin to transition an idea, a fledgling technology, a rudi-

mentary bit of science, out of the lab and toward the commercial marketplace, that you can begin to get your hands around technology risks, sales risks or market risks, and execution risks sufficiently to then convince yourselves it is worth committing a large amount of capital, say $5 to $7 million in an early stage, around an investment and that you can earn the kind of return by committing that capital that you need to earn to satisfy, as a venture investor, the investors who give you the money that you use to invest (your limited partners).

And so the bulk of the industry has gotten so large that it has moved away from being willing to take those kinds of leaps of faith. They have a lot of capital they need to commit. They can't commit it into small increments necessary to take the first few steps——

Chairman WU. Mr. Borrus, in some respects, the problem is that it takes the same amount of due diligence to invest a million dollars as it takes to invest $80 million?

Mr. BORRUS. Well, in some cases more. Yes.

Chairman WU. In some cases more due——

Mr. BORRUS. Thank you for——

Chairman WU.—diligence?

Mr. BORRUS. Thank you for making that point for me.

So——

Chairman WU. No, I didn't want to interrupt your——

Mr. BORRUS. No. No. I mean, at the end of the day, if you look at the data that the National Venture Capital Association collects, it is just very clear that the bulk of the industry is no longer doing very early stage, seed-stage investing. There are still some venture funds at the early stage investing, but the vast bulk of the money that is spent actually goes to much later stages in the start-up's life. It is not available for the riskiest——

Chairman WU. With my remaining minute and a half, two minutes, apparently, there is a philosophical disagreement at the other end of the street, and there is a concern about picking winners and losers. How would you try to address the picking of winners and losers, which some believe should be left to the private sector?

Mr. BORRUS. I think picking winners and losers is a profoundly misleading metaphor. In a certain sense, it is to substitute sloganeering for a thorough understanding of how risky early stage technology innovation actually works. No investor, neither public nor private investor, picks winners and losers. Ultimately, as the gentlemen to my left and right, I think, will testify, it is the market that picks winners and losers, by which I mean, of course, your competitors on the one hand and your customers on the other.

So investors don't pick winners and losers. What they do is they plant seeds. In this particular area of high-risk innovation, they plant technology seeds. And in the planting of seeds, there is a well-defined, historically-traditional role that the Federal Government can and should play of planting technology seeds in the areas of either private market failure or acute national need. And that is what ATP has done. That is what the Federal Government does in other programs, and it is an essential role.

Chairman WU. Mr. Borrus, let me interrupt you just with my last 30 seconds.

There are some concerns that ATP may benefit only a single company. Others say that the benefit is broader than that, it casts a broader shadow. What is your view of that particular discussion?

Mr. BORRUS. I think that view is completely, flatly wrong.

Look, all government development programs, to distinguish it from basic research funding, have to work through individual companies in a market economy, such as ours.

In ATP's case, all right, the measured social returns of the program far outstrip the total program dollars spent over the life of the program, as a whole, and of course, consequently, dwarf the amount of dollars going to any individual company. The resulting social benefits, in the form of jobs, in the form of seeding new technology industries that come into being, in the form of consumer benefits are exceptional, substantial. I mean, I suggest the critics who take that view ask those who have been diagnosed with breast cancer through ATP-funded digital mammography innovation and subsequently treated, because of the early detection that ATP-funded innovation enabled, ask them whether they think the benefits of the program only went to a company or two.

Chairman WU. Thank you, Mr. Borrus. I wanted to give you a chance to finish answering the question.

And Dr. Jeffrey, I just want to return, for a moment. Again, I still love you, but returning to that philosopher in the basement of OMB, you know, every person has a right to be a Luddite, but at least you should be a consistent Luddite. Now we provide plenty of funding at Department of Energy and other agencies that invest in private-sector technology. An example would be the Hydrogen Initiative, the Clean Coal Initiative, over at the CIA, the In-Q-Tel project that has been doing pretty much what ATP does. And Dr. Jeffrey, if I were you, I would be really angry that they are letting the CIA, in the investment realm, do things that they want to take away from you.

And with that, I would like to turn to the gentleman from Michigan, Dr. Ehlers.

JOINT UNIVERSITY OF MARYLAND–NIST INSTITUTE

Mr. EHLERS. Well, I have already given my diatribe, so I won't add to yours.

But I do want to have one specific question, Dr. Jeffrey, that I am asking on behalf of the Committee.

You highlighted the recently-created joint institute with the University of Maryland. There is some concern. Was Maryland selected through a peer-reviewed, competitive process or what—if not, what—why—how did this come about without peer review, if there was no peer review?

Dr. JEFFREY. The review was done internally by looking at, basically, the statistics that the National Science Foundation and National Academy of Science have in terms of ranking different institutions, in terms of physics, and in this case, since it is a physics-based institution, that looked at metrics by their ranking in terms of their publications, the grad students, the ability to expand into the quantum era. And one of the other attributes was the synergy in terms of the expertise. Maryland, actually, came out very well. The University of Maryland came out very well in all of those. And

one very important point is that Maryland is one of the best institutions in terms of condensed matter physics. And NIST is, essentially, one of the best institutions in the purely quantum phenomena.

What we end up with is that some of the work that we have been doing in the quantum realm, creating new forms of matter, Bose-Einstein condensates and Fermion condensates, we are basically at the point where we have got the quantum physicists that have been trained as quantum physicists creating these forms of matter that are essentially acting sort of like quantum liquids. And we have another entire branch of physics, condensed matter physics, where the University of Maryland excels, that actually has a lot of theory and nomenclature in that area. And by combining these two institutions together, we actually believe that we can cross physics disciplines and accelerate the field.

So we looked very hard at all of the various metrics that are kept by the Academy and kept by the Science Foundation and made a determination. We then did put out a Federal Register Notice to explain our intent, and we only had one university, other than the University of Maryland, that came back and, in further analysis and discussions with them, they agreed they were not the right institution.

Mr. EHLERS. Now if you are going to be working on the Bose-Einstein condensate, are you taking that work away from the scientists at Boulder and—or is this supplementary or——

Dr. JEFFREY. Yes, this is definitely supplementary. This is not removing the Nobel Prize winning work out in Colorado at all. It is really extending beyond that.

Mr. EHLERS. I see. All right. Thank you very much, and I must say I am intrigued by the Chairman's words about the philosopher. I had never thought of this person as being a philosopher, but since I haven't met that person, I don't know.

With that comment, I would yield back.

Chairman WU. Dr. Ehlers, it is the task of this committee to elevate all discussions.

Mr. Borrus, the Federal Government has invested, to date, perhaps a little bit over $7 billion in the National Nanotechnology Initiative over a multi-year period, and the Administration is requesting approximately another billion and a half investment in the National Nanotechnology Initiative for fiscal year 2008. Their justification has been that it will bring about the development of a whole new industrial sector, but the challenge is that current federal funding is very much focused on basic research in nanotechnology. We have heard from the nanotech industry about the gap in funding between research and having proof of concept getting to the point where it will attract venture funding.

In your view, should the ATP program be one component of the federal Nanotechnology Initiative?

Mr. BORRUS. To echo Mr. Hall, one word, yes.

Chairman WU. Thank you.

Now we do live in a world of budgetary constraints. Now there is a general agreement, and we hear this from both ends of Pennsylvania Avenue about the need for a strong innovation agenda, which includes significant funding increases for research and devel-

opment, and on my part, I hope for education, both K–12 and higher education.

Now the Administration has, thus far, focused primarily on basic research in the Competitiveness Initiative. Should the ATP program be a significant component of the federal innovation agenda? And if it is a one-word answer yes, why?

Mr. BORRUS. Yes.

Why? You only unleash the social impacts that benefit the Nation when you transition something out of the lab and into the commercial marketplace. As I have tried to indicate, there are some major gaps in financing for that precise part of the problem. And you have to bridge that. I am trying to fill it, but I obviously, by myself, am not going to be able to fill very much of it. There is clearly a role for other federal funding mechanisms, and in particular for ATP, there as well.

And maybe I should elaborate on my nanotech piece. It is beginning to trickle out a little. Many of the things I look at and consider investing in these days have a nanoscale-engineering component to it. I think, by the way, that it is probably wrong to think about nanotechnology as a new, emerging industry. It is a technology that will be very widely applied across a very big number of industries. It is already beginning to transform chemistry, transform material science, ultimately will have very significant impacts in the manufacturing industries as well.

Facilitating that transition holds out one of the best hopes for generating the kind of innovation and revival and continued leadership by American industry as a whole, that can sustain a growing standard of living in this country in light of the challenges that we face.

Chairman WU. Are there any other questions from the members present?

If not, I would just like to say that we all strongly support NIST, and especially the NIST laboratories. They have done well in terms of federal financial support, and they have done even better in terms of their success. Three Nobel Prizes is just the tip of the iceberg. What we want is a balance between the laboratory enterprise and the other very important things that NIST does. And we would like, we will insist upon a sensible, fact-based set of policies in science and in economics for our economy's sake. As much as we may have interesting discussions with philosophers, when we get down to science and running our economy, I think that it is wise to pay heed to fact-based, numbers-based constraints.

And Dr. Jeffrey, I would look forward to working with you to develop that. I believe that you want to do that.

And I want to thank the panelists, all of you who made this journey to this wonderful frosted town today to make significant contributions to this very, very important discussion.

I thank you all very much.

I want to thank all of you for coming. The witnesses are excused, and this hearing is now adjourned.

[Whereupon, at 11:50 a.m., the Subcommittee was adjourned.]

Appendix 1:

Answers to Post-Hearing Questions

ANSWERS TO POST-HEARING QUESTIONS

Responses by William Jeffrey, Director, National Institute of Standards and Technology, Technology Administration, U.S. Department of Commerce

Questions submitted by Chairman David Wu

MEP

Q1. The Administration indicates that it believes its proposed cut to MEP can be absorbed by increased charges to small manufacturers, increases in efficiency, cost-reduction at MEP Centers, and consolidation of Centers. Please provide the Committee with the NIST analysis that justifies these claims.

A1. The annual reported benefits by manufacturing clients of the MEP Centers conducted through an independent survey demonstrates a significant level of cost savings and efficiency improvements for the MEP clients. For example, the latest MEP client survey results (released January 2007 and reflecting FY 2005 benefits) demonstrate that MEP helped 16,448 clients create and retain 53 thousand jobs; increase and retain sales of nearly $6.3 billion; and generated cost savings of just over $1.3 billion (both recurring and non-recurring). These impacts resulting in reduced costs and potentially increased profits for the client could be used to support increased fees for future services. With increased revenues streams from client fees, MEP centers may offset, in whole or in part, the reduction in federal funds. The FY 2008 Budget request would also encourage these Centers to be more efficient by reducing their overhead costs, including marketing costs.

Q2. How many MEP Centers could be operated effectively under the proposed budget of only $46 million? What analysis has NIST performed to arrive at this conclusion?

A2. MEP is required by statute to use a merit-based process for awarding funds. The specifics of how many centers and where they might be located is unknown at this time. The MEP Director will work with the Centers to develop options that consider each center's customer base, constraints, and opportunities. Actions taken by any center or group of centers will be assessed against their ability to maintain support to the small manufacturers. If the requested budget is enacted, we will work with the centers to examine alternatives and optimize the best plan for operating at the $46.3 million level that ensures the maximum benefit to small manufacturers.

Q3. What specific discussions has NIST held with MEP Centers and their state funding agencies about the proposed 56 percent funding reduction?

A3. MEP meets quarterly with MEP Center Directors and uses these quarterly meetings to discuss information such as the Administration's federal budget priorities and proposed MEP program operations under a reduced budget.

Additionally, we had discussed an MEP re-competition, but based upon inputs from the MEP Center Directors, Congressional Members and Staff, and others it became clear that the process of the re-competition would be disruptive to current Center operations. We therefore decided not to hold this re-competition.

VCAT

Q4. How did you incorporate recommendations from the Visiting Committee on Advanced Technology (VCAT) into the new initiatives in the FY08 budget, including those carried over from the FY07 request? What recommendations did the VCAT make that were not included in the new initiatives?

A4. The Visiting Committee on Advanced Technology (VCAT) is a source of external input that is often focused around the expertise of the individual VCAT members. NIST takes into consideration VCAT input when developing new programs or evaluating the course of current programs.

The VCAT is only one of many sources of recommendations that NIST considers while developing new programs and initiatives. NIST also takes into account Congressional, Administration, and Agency priorities, and the requirements and needs of industry, business, and academic communities as well as the broad trends we see in science and technology.

Shortly after arriving at NIST as the Director, Dr. Jeffrey tasked senior management to develop a strategic vision for biosciences and health. NIST is working with industry, academia, and the National Institutes of Health (NIH) to develop this vision, of which the FY07 bio-imaging initiative was the first component. This is an

ongoing planning process, for example, NIST is developing a prospective economic study in the area of biopharmaceuticals that will be available this fiscal year.

The VCAT is very much involved in this process, and for this year's VCAT meetings, decided to have breakout sessions in the broad areas of bioscience, nanotechnology, and information technology to discuss strategies and industry needs and opportunities with NIST staff.

National Research Council Review Process

Q5. You have made two major changes in the National Research Council (NRC) review process: in December 2006 you directed the NRC to switch from a full-agency review of NIST to reviewing only half of the labs at a time, and you omitted all mention of assessing cross-cutting and multi-disciplinary programs in your formal charge to NRC. Why shouldn't the NRC review all of NIST's programs in the same cycle, and why should it not provide an analysis of cross-cutting work? What external review will be done of cross-cutting programs?

A5. Under the past system with annual reviews, the NRC report would often come out in about January while the next review would be scheduled to start in approximately March. This left very little time to implement recommendations from the NRC report and properly measure the effectiveness of these changes.

The new biennial review process is consistent with the recommendations of the National Academies regarding the evaluation of R&D programs. Specifically, the National Academy's Committee on Science, Engineering, and Public Policy report titled *Evaluating Federal Research Programs: Research and the Government Performance and Results Act* states that the useful outcomes of basic research cannot be measured directly on an annual basis but instead highlights the need for assessment that evaluates the quality and relevance of the research as well as the leadership of that research, all of which are seen as good predictors of eventual usefulness. The biennial review process directly addresses these metrics.

The NRC report was by and large a compilation of individual laboratory reports. Cross-cutting and multi-disciplinary program reviews were only tangentially addressed. NIST's new contract with NRC includes an explicit option for special studies that may include cross-cutting issues involving not only the NIST Laboratories but also from areas such as the Hollings Manufacturing Extension Partnership program.

In addition to the cross-cutting and multi-disciplinary program review that can be done under the NRC contract, NIST's Visiting Committee on Advanced Technology also looks at NIST-wide programs.

VCAT and NIST Budget Initiatives

Q6. In its most recent report (FY05) the VCAT noted that biomedical technology created "a unique opportunity and challenge for NIST." The FY04–05 NRC assessment of NIST recommended that NIST undertake "comprehensive, cross-laboratory planning efforts in both the biosciences and health." However, only one of the fourteen combined FY07 and FY08 budget initiatives is in the field of biotechnology (Bio-imaging). How did NIST determine that these recommendations were of low priority, and what is NIST's plan for work in the fields of biosciences and health in FY08 and future years?

A6. NIST considers the input from many stakeholders and draws on many information sources when developing new programs and initiatives and when evaluating the course of current programs. NIST's stakeholders include Congress and the Administration, as well as industry, the business community and academia. The methods used to obtain stakeholder input range from conducting economic impact and planning studies to outreach activities, such as the U.S. Measurement System study.

Topics developed from these stakeholder feedback processes form the basis for many proposed initiatives which are then rigorously evaluated and screened. Each initiative is evaluated based on a series of questions including the difficulty of the problem, the NIST role and cost, and the impact of the solution.

There is a clear need for improved measurement technologies in the biosciences and health related research. NIST's core capabilities are sure to have an impact in the measurements and standards gap that exists in the area of bio-imaging, especially as it relates to clinical diagnostic tools such as MRI. NIST is working with industry and academia to further evaluate the most significant and urgent measurement barriers that, if addressed by NIST, would have most impact to U.S. bioscience and health care industry.

Questions submitted by Representative Phil Gingrey

MEP

Q1. Please elaborate on and provide several examples of how the Manufacturing Extension Partnership program leverages the applied research coming out of our nation's universities to help small and medium-sized manufacturers compete in the global market place. We know this type of assistance requires time and significant efforts, yet has large potential. How do you plan to continue to support this activity while reducing the funding for the program?

A1. A major focus of the MEP program is to build upon our foundation of process improvements with clients to develop innovation and growth services that will position U.S. manufacturers to meet the increasing demands of the global marketplace. Moving research from universities and federal labs is a key to providing manufacturers with access to the technologies needed for the development of innovative processes and new products. Recent examples include:

- The Montana Manufacturing Extension Center (MMEC) located at Montana State University helped Universal Bio-availability Environmental/Soil Test Inc. (UNIBEST) bring to the marketplace an innovative soil analysis device. This "cherry tomato-sized" capsule is filled with unique resin beads that allow direct analysis/measurement in the field, thereby reducing the amount of material that must be transported to and handled in a laboratory. In addition to working on the preliminary design of the manufacturing process and machinery for the soil analysis capsule, MMEC also prepared cost estimates for the design and fabrication. The capsules for soil testing currently make up about 95 percent of UNIBEST manufacturing demand, but the manufacturer expects that to change because they are working to obtain EPA approval of the same technology for use in environmental testing and monitoring.
- The Oklahoma Alliance for Manufacturing Excellence—an MEP Center—was instrumental in the implementation of the Oklahoma Nanotechnology Applications Project (ONAP). The ONAP extends financial support and technical services for the application of nanotechnology in Oklahoma's manufacturing and business community. One of the first awardees, SouthWest NanoTechnology (SWeNT), manufactures high quality carbon nanotubes. With the new manufacturing techniques developed at the University of Oklahoma, SWeNT plans to diversify its manufacturing processes and mass produce a "commercial grade" of carbon nanotubes at a substantially lower price than is currently possible. The production volumes are expected to increase more than 30 fold while costs are expected to fall by 90 percent.

The FY 2008 Budget request would maintain a network of MEP centers funded according to their performance and need, and would encourage these Centers to be more efficient by reducing their overhead costs, including marketing costs. Centers could also ask MEP clients to cover more of the cost of the services through modestly increased fees.

Questions submitted by Representative Jim Matheson

MEP

Q1. An OMB justification for the MEP budget cut was that almost 20 percent of MEP clients are manufacturing firms with more than 250 employees and these firms would be able to make up the funding difference due to their size. Does the Administration now consider manufacturers with more than 250 employees as outside the traditional definition of a "small business"? What evidence does the Administration use that justifies MEP clients with more than 250 employees can charge more for their services?

A1. I am unaware of the OMB justification to which you are referring. The data describing the fraction of MEP business serving clients with more than 250 employees was provided by the MEP in their analysis of their business ("Making a Difference for America's Manufacturers"), and was not a delineation chosen by the Administration.

In characterizing the size of clients, MEP uses the size guidance developed by the Small Business Administration (SBA) Office of Size Standards. In the current *Table of Small Business Size Standards,* effective July 31, 2006, the majority of industries with 500 or fewer employees are considered small businesses.

The cost savings and efficiency improvements reported by manufacturing clients of MEP Centers result in reducing costs to MEP's clients and could be used to support increased fees for future MEP Center services. The annual reported benefits by manufacturing clients of the MEP Centers conducted through an independent survey demonstrates a significant level of cost savings and efficiency improvements for the MEP clients. For example, the latest MEP client survey results (released January 2007 and reflecting FY 2005 benefits) suggest that MEP helped 16,448 clients create and retain 53 thousand jobs; increase and retain sales of nearly $6.3 billion; and generated cost savings of just over $1.3 billion (both recurring and non-recurring). These impacts resulting in reduced costs and potentially increased profits for the client could be used to support increased fees for future services. With increased revenues streams from client fees, MEP centers may offset, in whole or in part, the reduction in federal funds.

ANSWERS TO POST-HEARING QUESTIONS

Submitted to R. Stanley Williams, Senior HP Fellow in Quantum Science Research, Hewlett-Packard Corporation

These questions were submitted to the witness, but were not responded to by the time of publication.

Questions submitted by Chairman David Wu

Q1. Your testimony points out that the mission creep at NIST has stretched the scientific staff very thin. What are the possible consequences for U.S. industry if NIST starts to lag behind in its core measurement and standards role? What NIST missions are falling behind, or are in danger of falling behind, because of this mission creep?

Q2. You recommend that NIST should resist the temptation of adding new programs in FY08 to justify a funding increase until it is clear that current missions are adequately served. How do you suggest that NIST seek outside evaluation for determining whether current mission needs are being met? Are the current review by the National Research Council and input from the Visiting Committee on Advanced Technology sufficient?

Questions submitted by Representative Phil Gingrey

Q1. Given that the President intends to double the National Institute of Standards and Technology's (NIST) research budget over the next ten years, what process do you think NIST should use to prioritize where it spends this new money? For example, do you believe NIST should perform a formal needs assessment with involvement from the external community to prioritize its research?

ANSWERS TO POST-HEARING QUESTIONS

Responses by Michael Borrus, General Partner, X/Seed Capital

Questions submitted by Chairman David Wu

Q1. How has the role of U.S. venture capital for high-technology companies changed in the last five years? Is there still a need for early-stage seed funding that can be filled by the Advanced Technology Program (ATP)?

A1. Answered in submitted written and oral testimony and throughout oral responses (see pp. 40–44, pp. 89–93).

Q2. The ATP has been characterized by its opponents as "picking winners and losers" among technology companies. Do you agree with this characterization?

A2. See oral responses, p. 90.

Q3. The Federal Government has invested more than $7 billion in the National Nanotechnology Initiative (NNI) over the past six years, and the Administration is requesting $1.45 billion for FY08. Does the "valley of death" lack of early-stage seed funding for technology start-ups also exist in the field of nanotechnology? In your view, should the ATP be a component of a federal nanotechnology initiative? If so, why?

A3. See oral responses, pp. 89–93.

Question submitted by Representative Phil Gingrey

Q1. Given that the President intends to double the National Institute of Standards and Technology's (NIST) research budget over the next ten years, what process do you think NIST should use to prioritize where it spends this new money? For example, do you believe NIST should perform a formal needs assessment with involvement from the external community to prioritize its research?

A1. As one of the very best federal research labs, NIST has scientists who are fully competent to determine the institution's research priorities and they should consequently be accorded a very substantial role in the priority-setting process. However, NIST is also the primary federal research lab entrusted with interacting with essentially all U.S. industries—because all rely on metrology—and with playing a significant role to enhance long-term U.S. technological competitiveness. Consequently, NIST should also solicit substantial input from Universities and from the broad private sector in setting priorities. A formal needs assessment with input from the relevant external communities—including, inter alia, the academic science and technology communities, technology-intensive industries, long-term technology investors—would indeed insure that NIST priorities rested on the strongest possible foundation of insight into future needs.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Peter Murray, Vice President, Welch Allyn, Incorporated

Question submitted by Chairman David Wu

Q1. The Administration indicates that it believes its proposed cut to MEP can be absorbed by increased charges to small manufacturers, increases in efficiency, cost-reduction at MEP Centers, and consolidation of Centers. Do you agree with this assessment? How would the proposed cut affect the Oregon MEP?

A1. I do not agree with this assessment for the following reasons:

A. Increased charges to small manufacturers will reduce revenues and force the MEPs to seek larger manufacturing clients,

B. I am on the board of the Oregon MEP and feel that the organization is very well run and has little to no room to absorb further cost reduction and,

C. Consolidation and further cost reduction activities will divert already scare managerial resources away from providing client services or badly needed marketing efforts.

Questions submitted by Representative Phil Gingrey

Q1. Given that the President intends to double the National Institute of Standards and Technology's (NIST) research budget over the next ten years, what process do you think NIST should use to prioritize where it spends this new money? For example, do you believe NIST should perform a formal needs assessment with involvement from the external community to prioritize its research?

A1. I agree with Ranking Member Gingrey that the prioritization of the proposed increase in funding for NIST must follow a formal needs assessment with involvement from the external community.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Michael J. Ryan, President and CEO, TUG Technologies Corporation

Questions submitted by Representative Phil Gingrey

Q1. Given that the President intends to double the National Institute of Standards and Technology's (NIST) research budget over the next ten years, what process do you think NIST should use to prioritize where it spends this new money? For example, do you believe NIST should perform a formal needs assessment with involvement from the external community to prioritize its research?

A1. Because NIST plays such a significant role in establishing standards for technical applications across our country, we should develop a clear process for aligning the private sector with the important standards setting for the benefit it provides across the Nation. I believe that a needs assessment would be useful. It would allow and provide a catalyst for private science to benefit from a government body and optimize the needed change process; especially in the manufacturing sector. Our county is being out-paced by other countries globally serving a global market. The MEP represents a national tool for manufacturing system changes that requires an education of the decision-makers so that our U.S. based companies can compete "on a level playing field." The MEP provides the needed support. We should try to enhance it's ability, not restrict it.

Appendix 2:

Additional Material for the Record

Subsequent to Dr. Jeffrey's testimony, the NIST Director has decided not to pursue a recompetition of the MEP centers. The NIST Director sent the following message to the MEP centers on February 26, 2007:

To: Hollings MEP Center Directors

From: Dr. William Jeffrey

Director

National Institute of Standards and Technology

Subject: Proposed Recompetition of MEP Centers

During my recent testimony to the House Science and Technology Committee (Subcommittee on Technology and Innovation), I mentioned the prospect of running a competition of the MEP centers this year. The proposed competition was intended as a contingency to ensure the strongest network possible regardless of final appropriations. Based upon inputs from the Centers, Congress, and others, it has become clear that the process of the competition will be disruptive to the current operations. We have, therefore, decided not to hold this competition.

As the FY 2008 budget process progresses, I will ensure that the MEP Program Director, Roger Kilmer, works with you to examine alternatives as dictated by the proposed and final approved FY 2008 funding level. Thank you for your valuable input and obvious passion for this program.

STATEMENT OF DARYL G. HATANO
VICE PRESIDENT, PUBLIC POLICY
SEMICONDUCTOR INDUSTRY ASSOCIATION

The Semiconductor Industry Association (SIA) appreciates the opportunity to submit testimony on the importance of NIST to the competitiveness of the U.S. semiconductor industry.

The SIA strongly supports doubling NIST as envisioned in President Bush's American Competitiveness Initiative and the House Democrats Innovation Agenda's call for a doubling of basic research in the physical sciences across all agencies.

Today I would like to share the impact of semiconductor technology advances, the role NIST metrology research plays in furthering these advances, and NIST's potential contributions to the challenges we face as we approach the physical limits of our current technology. Simply put, the country whose companies are first to market in this technology transition will likely lead the coming nanoelectronics era the way the U.S. has led for half a century in microelectronics, and NIST can play a critical role in ensuring that America earns this leadership position.

NIST Contributes to U.S. Semiconductor Competitiveness

The semiconductor industry employs 234,000 people across the U.S., directly contributes $60 billion to U.S. GDP and is America's largest export sector. The U.S. industry has 46 percent of the $248 billion world semiconductor market, down four percentage points from the 50 percent market share in 2000 but still about twice that of the next leading industry.

SIA's support for increased NIST funding is part of our overall innovation agenda calling for a doubling of funding for NSF, NIST, Department of Energy Office of Science; $20 million for the Defense Department to co-fund with industry the university Focus Center Research Program; increased availability of green cards and H–1Bs visas through immigration reform; increasing the number of science, technology, engineering and math graduates and improved K–12 math, science education; a permanent and enhanced R&D credit; and increased awareness of the impact of foreign tax incentives.

The Exponential Increase in Transistors Drives Economic Growth

As the enabling technology behind computers, telecommunications, consumer electronics, and the Internet, the industry's ability to continually make better, faster, and cheaper chips is driving increased productivity and creating more jobs throughout the economy.

For over three decades the industry has followed Moore's Law, which states that the number of transistors on a chip will double every eighteen months. The transistor is the basic building block within the semiconductor chip and can be thought of as an electronic switch or as retaining one bit (a one or a zero) in memory. The transistor is composed of a series of precisely etched and deposited layers of materials and semiconductors, with as many as two billion transistors integrated on a single silicon chip, are the most complex product manufactured on the planet.

Today the cost of making one million transistors is one penny.

The impact of Moore's Law on our economy is immense. Harvard economist Dale Jorgenson has noted that "The economics of Information Technology begins with the precipitous and continuing fall in semiconductor prices." Professor Jorgenson quantified the rapid adoption of IT in the U.S. for driving substantial economic growth in the U.S. gross domestic product since 1995, concluding "Since 1995, Information Technology industries have accounted for 25 percent of overall economic growth, while making up only three percent of the GDP. As a group, these industries contribute more to economy-wide productivity growth than all other industries combined." [1]

To see the impact of the productivity gains on a single sector, it is instructive to consider the benefits the government (Federal, State, and local) receives as a consumer of semiconductors. The Department of Commerce's Bureau of Economic Analysis has data indicating that the government sector of the economy purchased $8.1 billion of computers in 2004, but that they would have had to spend $46.7 billion for that same amount of computing power if they had to pay 1995 prices. The cumulative benefit from technology improvements and resulting price declines from 1995 to 2004 is $181 billion of "free" computing. In this tight budget year, it is important to remember that the federal investments made to support basic research are not

[1] Dale W. Jorgenson, "Moore's Law and the Emergence of the New Economy" in "2020 is Closer than You Think;" 2005 SIA annual report.

only beneficial to the overall U.S. economy, but also allows the government itself to do more with less as a result of falling computing costs.

The Roadmap Sets a Timetable for Technology Advances

To continue the exponential growth of the number of transistors on a chip, over 800 hundred chip experts around the world contribute to "The International Technology Roadmap for Semiconductors" (ITRS).[2] The North American participation of the ITRS is under the auspices of the SIA. NIST has been a strong supporter of the ITRS—in fact one of the first meetings of what is now the ITRS was held at NIST's Boulder, Colorado facility. Today NIST co-chairs and has four people on the Metrology technical working group, and also has representatives on the Emerging Research Devices and Materials, Assembly and Packaging, Factory Integration, and RF for Wireless working groups.

The ITRS identifies the milestones that must be reached in all aspects of semiconductor manufacturing for technology trends such as Moore's law to continue. One example of a roadmap characteristic is microprocessor transistor gate lengths—a critical dimension that affects the processor's speed. When SIA testified about the NIST budget before this committee in 2004, the transistor gate length was 37 nanometers.[3] This year it will shrink to only 25 nanometers, and it is targeted to decrease from 14 nanometers in 2012 and eight nanometers in 2017. (Note: a nanometer is one-billionth of a meter. A human hair is 100,000 nanometers in width, and a red blood cell is 5,000 nanometers in width.) If these and other milestones identified in the ITRS are reached, microprocessors would be five times faster.[4]

The ITRS lists the technical barriers at each stage of production that must be overcome if we are to continue to enjoy the benefits of chip technology advances. One important set of challenges is in the area of metrology. New metrology tools and techniques are needed to accurately perform critical measurements as new materials, processes, and device structures are introduced.

About 100 key measurements and controls have been identified by the ITRS metrology working group as critical to future semiconductor technology advances from now until 2020. Examples of the types of metrology challenges confronting industry over this timeframe are:

- Integrating metrology at the factory level;
- Measuring the thickness of layers deposited on a wafer, the lengths of transistor gates, and the aspect ratio of the depth and width of trenches etched on a chip;
- Measuring the roughness of line edges at the nanoscale;
- Detecting impurities in new substrates; and
- Insuring that metrology within a chip accounts for variations across a single chip and across a wafer with hundreds of chips.

NIST's Ability To Meet The Challenges Has Not Kept Pace With Advance Of Technology

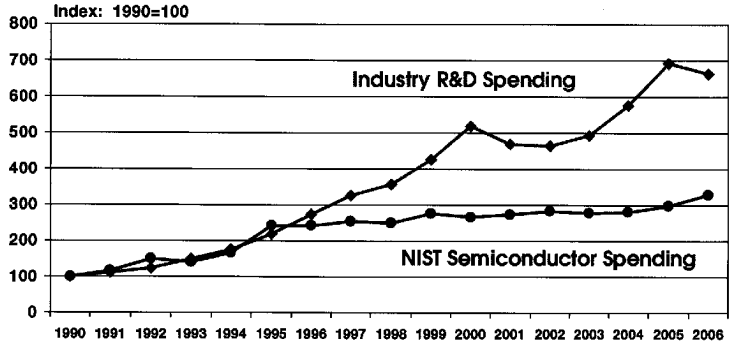
NIST is the leader in semiconductor metrology research. Its 6th annual nanoelectronics metrology conference next month is expected to attract 250 attendees from all over the world and the conference proceedings will be published by the American Institute of Physics. However NIST's efforts are insufficient given the magnitude of the technical challenges that must be overcome to continue the current rate of technology advances. As an indication of the shortfall, NIST spending on semiconductor research has only increased 35 percent since 1995. As an indication of the growing technical challenge as circuits continue to shrink, the semiconductor industry's total investment in R&D increased 143 percent during that period. See Figure 1.

[2] *http://www.itrs.net/*

[3] Testimony of Daryl G. Hatano, Semiconductor Industry Association, Before the House Science Committee Subcommittee on Environment, Technology, and Standards; April 28, 2004.

[4] ITRS Table 4c.

NIST budget has not kept pace with industry needs since 1995



NIST S/C Spending ($M)	$6.4	$7.5	$9.5	$9.0	$10.6	$15.5	$15.5	$16.2	$15.9	$17.5	$16.9	$17.5	$18.1	$17.8	$18.0	$19.0	$21.0
R&D Spending ($B)	$2.6	$2.9	$3.2	$3.9	$4.6	$5.7	$7.1	$8.5	$9.3	$11.1	$13.5	$12.2	12.1	12.9	15.0	18.0	17.25

Note: Industry data for calendar year, NIST Fiscal year starting in October of prior year. NIST semiconductor spending refers to the Office of Microelectronics Programs and the Semiconductor Electronics Division. In addition, NIST estimated in 2006 that there was an estimated $9M on broader research of value to semiconductors in other NIST divisions, and this will be increased to $11m by reallocating existing resources.

Source: SIA Databook, NIST

Support for increased funding for NIST semiconductor work has come from many quarters. In February 2005 the Defense Science Board Task Force on High Performance Microchip Supply issued a report that concluded "Semiconductor technology and manufacturing leadership is a national priority that must be maintained if the U.S. military is to continue to lead in the application of electronics to support the warfighter."[5] In its list of recommendations, the DSB singled out a NIST increase as a key element in a program to keep U.S. leadership in semiconductors:

> *"NIST is best positioned to focus research on many of the metrology challenges identified in the International Technology Roadmap for Semiconductors. When it was established in 1994, the NIST Office of Microelectronics Programs was to start at $12 million in annual funding and grow to $25 million. This level was not achieved, but this task force considers this activity an important contribution to the national microelectronics supply issue."*[6]
>
> Defense Science Board Task Force on High Performance Microchip Supply February 2005

Finding a New Switch

We are beginning to reach the fundamental limits of the CMOS,[7] the process that has been the basis for the semiconductor industry for the past 30 years. By introducing new materials into the basic CMOS structure and devising new CMOS structures and interconnects, further improvements in CMOS can continue for the next ten to fifteen years, at which time CMOS begins to reach its physical (layers only a few atoms thick) and power dissipation limits. For the U.S. economy to continue to benefit from the information technology productivity improvements described above, there will need to be a "new logic switch" to replace the current CMOS-based transistor.

There are a number of candidates for the new switch, including spintronics (changing a particle's spin) and molecular electronics (changing a molecule's shape). There are many metrology challenges as scientists search for the new switch. For example, molecular electronics advances require the measurement of intrinsic molecular conduction in single molecules and in ~2 nm thick molecule monolayers. Ad-

[5] The Defense Science Board Task Force on High Performance Microchip Supply, February 2005 p. 27.

[6] Ibid. p. 61.

[7] Complementary Metal Oxide Semiconductor

vances in spintronics will require development of capabilities to measure spin densities and material polarization at the nm-size scale.

To identify the new logic switch to replace the transistor, the SIA has launched the Nanoelectronics Research Initiative (NRI) that pulls together semiconductor companies, 23 universities in 12 states, State governments, and the National Science Foundation. The House Appropriations Committee report singled out the NSF's work with the NRI as well as its Silicon Nanoelectronics and Beyond program and encouraged such work to be continued.[8] NIST scientists have been participating in NRI meetings and SIA and NRI are discussing with NIST officials how this participation might be expanded.

NIST involvement in the effort to find a new switch is absolutely critical. As noted at the outset of this testimony, the country whose companies are first to market will likely lead the coming nanoelectronics era the way the U.S. has led for half a century in microelectronics. The impact on the U.S. economy and national security should the U.S. not lead in the nanoelectronics is unfathomable.

SIA Recommendations to Congress for NIST and Other Research Agencies

The SIA supports a significant increase for the NIST Scientific and Technical Research Services for FY 2008 along the lines of the Administration's budget request and the House Democrats Innovation Agenda's call for a doubling of basic research in the physical sciences across all agencies within five years. In particular SIA supports the increased funding for the newly created NIST Center for Nanoscale Science and Technology which will engage in research on many of the challenges outlined in this testimony, and full funding of the facilities budget for the Advanced Measurement Laboratory.

The budget increases at NIST aimed at metrology issues should be done in concert with increased appropriations for other programs in semiconductor research at universities. SIA supports the significant increases in the NSF budget envisioned by the American Competitiveness Initiative and the House Democrats' Innovation Agenda; and in particular encourages increased funding on National Nanotechnology Initiative. SIA also urges Congress to appropriate $10 million for the Defense Department's Government-Industry Co-sponsorship of University Research program.[9] Coupled with an expected $10 million from DARPA, this appropriation would allow the Defense Department to leverage $20 million from industry to fund the $40 million Focus Center Research Program that supports semiconductor research at 38 universities across the country.[10]

Summary

NIST defines its mission as "To promote U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology in ways that enhance economic security and improve our quality of life." There is no better opportunity for NIST to fulfill its mission than to expand its interactions with the semiconductor industry and solve the metrology challenges associated with advancing CMOS technology to its ultimate limits and finding a new switch to ultimately replace CMOS technology.

For the past five decades, semiconductors have become ever faster, better, and cheaper, and today are a major driver of growth in economic productivity. Congress must increase the NIST laboratory budget if the country is to continue to enjoy the benefits of every increasing semiconductor capabilities at ever decreasing costs.

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[8] "The Committee commends NSF for its Silicon Nanoelectronics and Beyond program and its partnership with the Nanoelectronics Research Initiative, which involves the sponsorship of research in the areas of information' technology and electronics. The Committee encourages NSF to continue its support for such research in Fiscal year 2007." House Report 109–118—Science, State, Justice, Commerce, And Related Agencies Appropriations Bill, Fiscal Year 2006.

[9] The Government-Industry Cosponsorship of University Research (GICUR), program element number 0601111D8Z, is funded through the Office of the Secretary of Defense.

[10] For further information on the Focus Center Research Program, see *http://fcrp.src.org*