

VISITING COMMITTEE ON ADVANCED TECHNOLOGY  
National Institute of Standards and Technology

# 2013 Annual Report

Visiting Committee on Advanced  
Technology  
of the  
National Institute of Standards and  
Technology

U.S. Department of Commerce

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National Institute of Standards and Technology

## Preface

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The Visiting Committee on Advanced Technology (VCAT) of the National Institute of Standards and Technology (NIST) was established in its present form by the Omnibus Trade and Competitiveness Act of 1988 and updated by the America COMPETES Act. The VCAT is a Federal Advisory Committee Act (FACA) committee and its charter includes reviewing and making recommendations regarding general policy for NIST, its organization, budget, and programs within the framework of applicable national policies as set forth by the president and the Congress. In addition, the America COMPETES Act calls for the VCAT to comment on NIST's three-year programmatic plan in its annual report to Congress. This 2013 annual report covers the period from the beginning of March 2013 through February 2014.

The Committee reviews the Institute's strategic direction, performance and policies, and provides the Secretary of Commerce, Congress, and other stakeholders with information on the value and relevance of NIST's programs to the U.S. science and technology base and to the economy. At the first meeting of each year, the Director of NIST proposes areas of focus to the Committee and agreement is reached on a program for the year. Over the past year, the Committee has been active in assessing NIST's contributions to and progress in the following areas:

- NIST Safety Systems and Culture
- Cybersecurity
- Advanced Manufacturing
- NIST User Facilities and Partnership Models
- Forensic Science

The Committee reviews a significant portion of NIST programs through direct discussion with NIST leaders, scientists, and engineers. Reactions and observations of the Committee members are presented candidly to the NIST senior management and other attendees at each meeting. This feedback encourages continuous improvement in key areas in the overall operation. The Committee also visits various NIST laboratories and satellite facilities to discuss research projects directly with the technical staff. These laboratory tours help the Committee to assess the impact of NIST research, progress towards achieving research goals, the quality of the staff, institutional culture, and the efficacy of the facility infrastructure.

Under the Committee charter, the Director of NIST appoints the VCAT members. Members are selected on a clear, standardized basis, in accordance with applicable Department of Commerce guidance. Members are selected solely on the basis of established records of distinguished service; provide representation of a cross-section of traditional and emerging U.S. industries; and are eminent in fields such as business, research, new product development, engineering, labor, education, management consulting, environment, and international relations. No employee of the Federal Government can serve as a member of the Committee. Members are appointed for staggered three-year terms.

One new member was appointed during the period covered by this report: Dr. Rita Colwell (University of Maryland and The Johns Hopkins Bloomberg School of Public Health).

This report highlights the Committee's observations, findings and recommendations. Detailed meeting minutes and presentation materials are available on the NIST web site at [www.nist.gov/director/vcat](http://www.nist.gov/director/vcat).

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VCAT Members During the Period Covered by this Report

<p>Dr. Alan I. Taub, Chair University of Michigan Term: May 9, 2008 - May 8, 2014</p>	<p>Dr. Tony Haymet, Vice-Chair University of California, San Diego Term: September 1, 2009 - August 31, 2015</p>
<p>Dr. Sujeet Chand Rockwell Automation Term: April 1, 2010 - March 31, 2016</p>	<p>Dr. Uma Chowdhry DuPont (Emeritus) Term: October 1, 2010 - September 30, 2016</p>
<p>Dr. Rita R. Colwell University of Maryland at College Park Term: January 6, 2014 – January 7, 2017</p>	<p>Dr. Karen Kerr Agile Equities, LLC Term: June 1, 2011 - May 31, 2014</p>
<p>William M. Holt Intel Corporation Term: May 13, 2012 - May 12, 2015</p>	<p>Dr. Pradeep Khosla University of California, San Diego Term: June 2, 2008 - June 1, 2014</p>
<p>Dr. Roberto Padovani Qualcomm Technologies, Inc. Term: May 1, 2011 - April 30, 2014</p>	<p>Dr. Alton D. Romig, Jr. Lockheed Martin Aeronautics Company Term: April 15, 2009 - April 14, 2015</p>
<p>Dr. Darlene J.S. Solomon Agilent Technologies Term: January 3, 2010 - January 2, 2016</p>	<p>Dr. John J. Tracy The Boeing Company Term: January 7, 2013 – January 6, 2016</p>

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## 1. VCAT Focus in 2013

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In 2013, the VCAT focused its primary attention on NIST's role and programs in two key administration priorities – advanced manufacturing and cybersecurity. To address these issues, the VCAT in consultation with the NIST Director established two subcommittees to develop specific recommendations in each of the subject areas. The respective charges to these subcommittees and to the continuing Subcommittee on Safety are provided below:

### **VCAT Subcommittee on Cybersecurity – Roberto Padovani, Chair**

NIST's expertise in cybersecurity has garnered it a key role in the nation's response to growing cybersecurity concerns. From NIST's responsibilities outlined in the Executive Order on Improving Critical Infrastructure Cybersecurity to programs including the National Initiative for Cybersecurity Education, the National Cybersecurity Center of Excellence, and the National Strategy for Trusted Identities in Cyberspace, NIST is increasingly called upon to act as a technical expert and neutral convener in the development of cybersecurity solutions. The role of this VCAT subcommittee will be twofold:

1. To make recommendations to position NIST to best respond to the nation's cybersecurity needs. Specifically,
  - a. How can NIST ensure that it has the optimum balance between responding to short-term priorities and cultivating long-term technical expertise?
  - b. How can NIST confirm that its methods of partnership, collaboration, and communication are sufficient to meet stakeholder's needs?; and
2. To comment on what tools or mechanisms organizations require in order to address their cybersecurity risk. More specifically, (a) is the development of a fundamental cybersecurity risk measurement method important, (b) what role would economic modeling play in risk measurement, and (c) what tools do corporate Chief Risk Officers require to assess their cybersecurity risk?

### **VCAT Subcommittee on Manufacturing – Sujeet Chand, Chair**

NIST's FY 2014 budget request had a strong focus on manufacturing with increases to manufacturing-focused efforts in the labs and in its extramural programs. The VCAT is well positioned to give NIST advice on how to position itself so that the labs remain aligned with industry needs. Furthermore, the VCAT can help amplify the important role that the NIST laboratory programs have in regard to manufacturing by highlighting the critical infrastructural connections that NIST provides, such as measurement services and standards. The role of this VCAT subcommittee will be to:

1. Assess NIST's approach to meeting the needs of a changing technology landscape in advanced manufacturing. Particularly, review NIST's methods for identifying emerging trends and provide recommendations regarding NIST's mechanisms for developing technical capabilities with necessary agility; and
2. Review and provide recommendations regarding NIST's approach to research, collaboration, technology transfer, and outreach across multiple NIST programs on advanced manufacturing technology areas, using additive manufacturing as a case study.

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During and in-between formal VCAT meetings, the manufacturing and cybersecurity subcommittees held multiple meetings and teleconferences including meetings with numerous external stakeholders from government and industry in order to gather data and develop their initial recommendations for consideration by the full VCAT.

**VCAT Subcommittee on Safety – Tony Haymet, Chair**

A culture change toward safety is well underway at NIST. It is moving from the “design-build” phase to one of continual improvement. While NIST has made substantial progress in developing a positive safety culture, further emphasis on safety is needed to ensure that safety remains a NIST core value. Towards this end, the Subcommittee on Safety chartered in July of 2012 will continue to:

1. Assess NIST’s progress in meeting senior leadership’s commitment to making safety an integral core value and vital part of the NIST culture; and
2. Identify strengths and opportunities for improvement in both approach and direction.

This 2013 Annual Report summarizes the work of the manufacturing and cybersecurity subcommittees and the recommendations that were ultimately adopted and issued by the VCAT in each of these two important areas. The report also provides our recommendations and comments about NIST’s continued efforts to establish a shared safety culture, NIST’s user facilities and partnership models, as well as the NIST budget.

## 2. Safety

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In 2012, as a result of an in-depth review by the VCAT Subcommittee on Safety, the VCAT reported that a cultural change toward safety is well underway at NIST. However, while NIST has made substantial progress in developing a positive safety culture, the NIST recordable incident data did not yet demonstrate a clear downward trend. The underlying driver of the incidents appears to be high-frequency, lower-consequence events (rather than low-frequency, higher-consequence events). The VCAT made recommendations to help NIST further improve its safety performance. While NIST still has issues to address, significant progress against these recommendations has been made.

2012 VCAT recommendations:

- *“NIST’s safety goal should be zero accidents. The VCAT encourages continued recognition of and reward for safety improvement.*
- *The VCAT recommends continued “grand rounds” audits of individual laboratory rooms led by senior, trained NIST executives.*
- *The VCAT recommends that NIST set a firm target for improvement in each Occupational Safety and Health Administration (OSHA) recordable statistic.*
- *The VCAT urges the NIST Director to distribute and discuss Incident Reporting and Investigation System (IRIS) statistics each reporting period. Based upon these reports, NIST leadership should identify top priority IRIS issues and action plans to reduce occurrence. Progress will be reviewed as a standing agenda item at the beginning of each VCAT meeting.*
- *The VCAT recommends that NIST concentrate its investigation time and reports on OSHA recordable incidents.*
- *The VCAT strongly urges increased “transparency” on all safety metrics, including easily accessible identification of the exact stage at which any non-closed IRIS cases are at any time.”*

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Response:

In 2013, NIST has made continued improvements in developing a positive safety culture. The NIST Director and Chief of the Office of Safety, Health, and Environment distribute and discuss IRIS statistics regularly through monthly presentations to the NIST Leadership Board, newsletters to all staff, and at town-hall meetings with all staff. The goal for safety is zero accidents; this goal is expressed at every town-hall meeting by the Director, and in other safety presentations and communications.

In 2013, NIST reduced its numbers of OSHA Recordable Cases (RCs) and Days Away, Restricted, or Transferred (DART) cases by 34% and 38%, respectively, compared to 2012. RCs are generally incidents that require medical treatment beyond first aid, and DART cases are a subset of recordable cases that resulted in employees missing days of work, being put on restricted duty, or being transferred to another job.

NIST plans to pursue the goal of zero accidents by reducing the most common types of OSHA-recordable incidents at NIST. Cases resulting from slips, trips, and falls; being stuck by/struck against an object; and overexertion have accounted for about 75% of NIST's OSHA recordables over the past several years. Over the past three years, slips, trips, and falls resulted in 37% of NIST's OSHA recordables and 37% of its DART cases. Efforts to reduce slips, trips, and falls are now underway.

NIST's approach to achieving zero injuries also includes adding safety goals to NIST Operating Unit (OU) Directors' annual performance plans.

To address the VCAT's recommendation on "grand rounds" and to eliminate common safety issues at NIST, NIST began a program called the Shared Standard of Safety Performance. NIST OU Directors in October agreed on the first set of common safety issues that everyone at NIST will strive to eliminate, correct, and avoid introducing in the future: obstacles in walkways, improper use of electrical cords, and improperly labeled chemical containers. This set of identified conditions becomes the NIST Shared Standard. As these conditions become nonexistent at NIST, another set of common safety issues will be introduced and become the next set of issues everyone at NIST will strive to eliminate. This cycle will be part of NIST's process for continually improving its safety performance. Dr. Gallagher launched the effort to all staff at a town-hall meeting in December 2013.

NIST streamlined the reporting and investigation of incidents for which the causes, corrective actions, and lessons identified are clear at the time of the incident. In such cases, OUs can submit both the initial incident report and the incident investigation report with little to no delay.

NIST also increased the transparency to the OUs on all IRIS-related metrics. As a result, the backlog of incident investigation reports outstanding for more than 20 business days decreased from 56 in October 2012 to less than 10 in January 2014.

**OBSERVATIONS:**

The VCAT has placed an emphasis on safety at NIST starting with the 2012 report. The Committee has seen a steady improvement in safety performance and was glad to note the recent recognition by the National Safety Council of Dr. Gallagher as one of its "2014 CEOs Who Get It", leaders who demonstrate a personal commitment to protecting worker safety and health. Driving a positive safety culture in any organization requires strong, dedicated leadership, and Dr. Gallagher has provided that leadership.

- NIST's OSHA-recordable and DART cases have decreased for each of the past three years. These results are attributable to NIST management attention supported by the VCAT's increased emphasis on safety.

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- NIST’s OSHA total recordable case rates and DART rates compare favorably to those of three Department of Energy national laboratories.
- NIST trained 28 senior executives on 37 common safety issues at NIST. The training covered what the issues are, why they are safety issues, and common ways they can be addressed.
- NIST has made significant progress in reducing the backlog of incident investigation reports outstanding for more than 20 business days. NIST can consider this issue closed.

**RECOMMENDATIONS:**

- NIST should establish a baseline against which to measure the success of its efforts to reduce slips, trips, and falls. NIST should continue to report to the VCAT regularly on progress.
- The VCAT recommends that NIST expand the number of common safety issues included in the NIST Shared Standard of Safety Performance.
- NIST should implement metrics to demonstrate the success of the NIST Shared Standard program in eliminating common safety issues at NIST.
- The VCAT recommends that NIST conduct a safety culture survey to assess its progress in making safety an integral core value and vital part of the NIST culture, and compare the results to those of the safety climate survey completed in June 2011.

### **3. NIST Role in Cybersecurity**

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In 2013, the NIST Director established the VCAT Subcommittee on Cybersecurity for 2013 to make recommendations and to comment on NIST’s ability to support the nation’s cybersecurity needs. The VCAT subcommittee was specifically asked:

1. To make recommendations to position NIST to best respond to the nation’s cybersecurity needs. Specifically,
  - a. How can NIST ensure that it has the optimum balance between responding to short-term priorities and cultivating long-term technical expertise?
  - b. How can NIST confirm that its methods of partnership, collaboration, and communication are sufficient to meet stakeholder’s needs?; and
2. To comment on what tools or mechanisms organizations require to address their cybersecurity risk. More specifically, (a) is the development of a fundamental cybersecurity risk measurement method important, (b) what role would economic modeling play in risk measurement, and (c) what tools do corporate Chief Risk Officers require to assess their cybersecurity risk?

#### **3a. Cybersecurity Activities at NIST**

Cybersecurity work is performed throughout the NIST Information Technology Lab (ITL). This includes basic research that characterizes macro-scale structures and dynamics of large-scale interconnected systems and identifies fundamental metrics that are indicators of the system’s inherent level of security and reliability. These fundamental metrics can be used to develop tools for cybersecurity risk management and feedback loops to mitigate risks. Applied research efforts are focused on designs, standardization, and tests that foster commercial deployment of new technologies to improve the security, robustness, and scaling of core Internet infrastructure. ITL develops standards, guidelines, tests, and metrics for the protection of non-national security federal information and communication infrastructure. ITL research on usable security recognizes that the user is often the most important part of a security solution, going beyond well-designed interfaces to address the mental models individuals use for risk calculation. ITL has researchers focused on accelerating the development and

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adoption of correct, reliable, testable software and has an established statistical expertise to fortify its cybersecurity work.

The National Cybersecurity Center of Excellence (NCCoE) takes a more short term approach by providing businesses with real-world cybersecurity capabilities based on commercially available technologies. The center brings together experts from industry, government, and academia to demonstrate integrated cybersecurity that is cost-effective, repeatable, and scalable. The NCCoE accelerates the adoption of secure technologies by collaborating with innovators to provide real-world cybersecurity capabilities that address business needs.

Overall, ITL's cybersecurity work is targeted towards a number of key application areas through specific projects such as Cloud Computing, Smart Grid, Cyber-Physical Systems (CPS), Trusted Identities, Security Automation, Voting Standards, Health Information Technology (IT), Big Data, and Quantum Information Science.

### **3b. Optimum Balance for NIST's Cybersecurity Efforts**

The VCAT was asked how NIST can ensure that it has the optimum balance between responding to short-term priorities and cultivating long-term technical expertise. As described above, NIST has deep expertise in many technical and scientific areas critical to cybersecurity technologies. Because of this expertise, partnership with the cybersecurity community, and successful leadership in cybersecurity standards, NIST is frequently asked by the Administration and Congress to lead new cybersecurity efforts. When meeting these requests, it is important for NIST to maintain the scientific and technical capabilities and thought leadership necessary for the long-term health of NIST's cybersecurity programs.

ITL's cybersecurity activities occur within and are driven by the fundamental and unique characteristics of the IT landscape. Specifically, IT advances quickly, is pervasive, is intrinsically complex, and is an emerging area of measurement science. The ITL strategy must be agile, adaptive, and forward-looking; responsive to all areas of science and society; cognizant of intrinsic complexity with solutions "as simple as possible but no simpler;" and inclusive of basic and applied research, development, technology transfer, and standards.

The ITL has about 370 employees, a quarter of which are in the Computer Security Division. A number of researchers in other ITL Divisions contribute to NIST's cybersecurity efforts. In addition, NIST/ITL hosts 170 guest researchers, 10-20 of whom work in the Computer Security Division.

When asked to research or develop cybersecurity guidelines or standards, NIST begins by examining what is happening within IT to see how the relevant digital technologies are evolving in the area of concern. Second, NIST examines the changing threat environment exploring what are the classes of attacks relevant to the area of concern. Lastly, NIST looks across the research community in cybersecurity to determine if it can leverage internal and external capabilities to address the area of concern.

### **3c. Methods of Cybersecurity Partnership, Collaboration, and Communication**

The VCAT was asked how NIST can confirm that its methods of partnership, collaboration, and communication are sufficient to meet stakeholders' needs. As a non-regulatory federal agency, NIST's efforts have the most impact when they have the support of the relevant communities. This is especially true in cybersecurity, where the stakes are high, the community is diverse, and the landscape evolves quickly. To ensure success, NIST collaborates closely and extensively with relevant stakeholders to develop cybersecurity solutions through a variety of mechanisms, from partnerships with the NCCoE, standards frameworks such as the recent Cybersecurity Framework for Critical Infrastructure, competitions like the Secure Hash Algorithm competition, and more traditional methods such as ongoing workshops and conferences.

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The Cybersecurity Framework for Critical Infrastructure is a recent illustration of one of NIST's efforts to collaborate with diverse stakeholders to develop a robust standards framework. Recognizing that the national and economic security of the United States depends on the reliable functioning of critical infrastructure, the President under the Executive Order "Improving Critical Infrastructure Cybersecurity" directed NIST in February 2013 to work with stakeholders to develop, by February 2014, a voluntary framework for reducing cyber risks to critical infrastructure. NIST worked with hundreds of U.S. businesses across multiple industries, with academia, and with state and local governments to create a Cybersecurity Framework reducing the cybersecurity risks that we face from hackers, foreign countries, and our nation's enemies. This framework was created in a public-private partnership involving over 3,000 individuals in workshops across the country, illustrating the outstanding work that can be accomplished when NIST partners with the private sector. The Framework provides guidance to an organization on managing cybersecurity risk. A key objective of the Framework is to encourage organizations to consider cybersecurity risk as a priority similar to financial, safety, and operational risk while factoring in larger systemic risks inherent to critical infrastructure.

The Framework relies on existing standards, guidance, and best practices to achieve outcomes that can assist organizations in managing their cybersecurity risk. By relying on those practices developed, managed, and updated by industry, the Framework will evolve with technological advances and business requirements. The use of standards will enable economies of scale to drive innovation and development of effective products and services that meet identified market needs. Market competition also promotes faster diffusion of these technologies and realization of many benefits by the stakeholders in these sectors.

Established in 2012, the NCCoE is a public-private collaboration for accelerating the widespread adoption of integrated cybersecurity tools and technologies. In addition to an update about the purpose and organization of the NCCoE, the VCAT heard from Vernon Lee, the Federal Civilian Chief Technology Officer for Microsoft Services, one of the NCCoE's industry partners. Mr. Lee impressed upon the VCAT the utility to industry of having access to NIST's expertise in cybersecurity through a public-private partnership such as the NCCoE.

More broadly, the Computer Security Resource Center website, <http://csrc.nist.gov/>, demonstrates the depth and breadth of partnership and communication mechanisms used for cybersecurity efforts. For outreach, NIST relies on standards such as Federal Information Processing Standards (FIPS) and international and national consensus standards; guidelines through special publications and NIST internal or interagency reports; and journal and conference research papers. NIST uses workshops, conferences, and forums both as hosts (33 events) and as participants to develop consensus and share its research. During Fiscal Year (FY) 2013, NIST posted nine draft special publications and three draft interagency or internal reports for public comment. In the same period, NIST published two FIPS publications, thirteen special publications, ten interagency or internal reports, and twelve security bulletins. NIST develops reference implementations and demonstrations; conformance verification activities; and test, tools, and other conformance determination tools. NIST is active in and often leads national and international committees. NIST also has strong representation and leadership within the Networking and Information Technology Research program, including co-chairing the Cyber Security and Information Assurance Interagency Working Group. Through these various mechanisms, NIST engages a number of partners from industry, academia, international, and federal, state, and local governments.

**OBSERVATIONS:**

- The VCAT is pleased with the progress achieved within the NCCoE, especially the enlisting of more than a dozen industry partners and the continued effort to recruit additional partners. The projects and use cases under development are highly relevant and the expansion of such projects is only limited by resources at this stage.

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- The VCAT is also very pleased with the level of effort and planning ITL puts into its outreach and partnership mechanisms and encourages it to continue and expand such activities. It also recommends studying mechanisms for obtaining measurable feedback about such partnerships from the stakeholders for further improving the effectiveness of such key efforts.
- A major NIST accomplishment in 2013 has been the execution in the implementation of Executive Order 13636, namely the creation of the Cybersecurity Framework for Critical Infrastructure. The Framework was completed on time and the VCAT is particularly pleased with NIST's approach to attract and engage the largest possible set of stakeholders both public and private, and with NIST's role as the convener and facilitator of a joint development effort. The feedback VCAT has received has been unanimously positive. The VCAT is also pleased to learn that NIST intends to participate in future activities related to the framework and that it is also investigating long term governance solutions.
- The VCAT is also satisfied that NIST is achieving a good balance between the needs to cover short-term activities, such as the Cybersecurity Framework development, and long-term needs such as fundamental research. The VCAT was concerned that short-term activities would undermine the efforts in fundamental research but at this point in time it does not appear to be the case.
- The VCAT values highly the ability of NIST to contribute independent technical expertise to international standards development processes for cryptography. In 2014, VCAT will lead an effort to validate NIST's internal development processes.

**RECOMMENDATIONS:**

- The VCAT recommends that NIST continues to participate in the activities related to the Cybersecurity Framework beyond the publication of its first version. It also encourages NIST to investigate long-term governance solutions for the effort.
- The VCAT recommends that NIST remain vigilant about the tradeoffs between short-term activities and the need for world class capabilities in the fast changing and extremely complex security landscape. This is an area that should be closely monitored and the VCAT recommends that some metrics be employed to assess such balance going forward. These metrics could also be applied to other major programs.

#### **4. NIST Role in Advanced Manufacturing**

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In 2013, the VCAT continued to review Advanced Manufacturing research programs at NIST. The NIST Director established a VCAT Subcommittee on Manufacturing for 2013 to examine NIST manufacturing programs with respect to how NIST is meeting the changing technology landscape, how NIST is coordinating advanced manufacturing programs across the labs, and how NIST is approaching collaboration and outreach. NIST continues to use a number of partnering mechanisms to support engagement with industry, academia, and other government laboratories. The VCAT was specifically asked to consider the following questions:

1. Assess NIST's approach to meeting the needs of a changing technology landscape in advanced manufacturing. Particularly, review NIST's methods for identifying emerging trends and provide recommendations regarding NIST's mechanisms for developing technical capabilities with necessary agility; and
2. Review and provide recommendations regarding NIST's approach to research, collaboration, technology transfer, and outreach across multiple NIST programs on a single advanced manufacturing technology area, using additive manufacturing as a case study.

#### 4a. NIST's Programs in Advanced Manufacturing

Enhancing U.S. manufacturing competitiveness through the delivery of measurement science, standards and technology is a fundamental part of NIST's mission. Long-term economic competitiveness is strengthened by the development and deployment of advanced manufacturing technologies that are enabled by NIST measurement science. NIST aligns its research and services with industry needs through partnerships with manufacturers, academic and government laboratories, and through staff participation in national and international standards activities. Technology and knowledge transfer from NIST to promote U.S. competitiveness is enabled through various agreements and intellectual property tools such as NIST inventions, patents, and licenses. Visiting scientists and postdoctoral researchers develop technical expertise through research experiences at NIST.

- The NIST Laboratories address complex measurement challenges, ranging from the very small (nanoscale devices) to the very large (vehicles and buildings), and from the physical (renewable energy sources) to the virtual (cybersecurity and cloud computing). Research at NIST is underway to develop and deliver the measurement science tools that will support advanced manufacturing technologies, including materials modeling and simulation, nanomanufacturing, biomanufacturing, smart manufacturing, and robotics.
- NIST user facilities support innovation in materials science, nanotechnology discovery and fabrication, and other emerging technology areas through the NIST Center for Neutron Research, which provides world class neutron measurement capabilities to the U.S. research community, and the NIST Center for Nanoscale Science and Technology, which supports nanotechnology development from discovery to production.
- The Hollings Manufacturing Extension Partnership (MEP) is supporting technologies and practices that increase the competitiveness and resilience of our nation's small and medium manufacturing base. A federal-state-local partnership, MEP is enabling future growth with a focus on education and training, accelerating the adoption of new technologies, responding to evolving supply chains, and implementing environmentally sustainable processes.
- The new Advanced Manufacturing Technology Consortia (AMTech) program will provide funding to establish industry-led consortia to create technology roadmaps to identify and tackle long-term research and development (R&D) challenges shared by industry. AMTech-supported consortia will enable university research capabilities to be focused on industry-driven R&D, lower the risk to investment in new technologies, and accelerate technology transfer.
- The Advanced Manufacturing National Program Office (AMNPO) is an interagency office hosted by NIST, which serves as the central point of contact for federal programs in advanced manufacturing. The purpose of the AMNPO is to create and implement a whole-of-government advanced manufacturing strategy. The AMNPO is also responsible for planning and executing the proposed National Network for Manufacturing Innovation (NNMI) program.

#### 4b. Responding to the Changing Manufacturing Technology Landscape

The VCAT was asked to assess how NIST responds to rapidly changing technology in manufacturing. New manufacturing technology, such as nanomanufacturing, requires new measurement science to overcome barriers to successful development and commercialization.

NIST presented three programmatic case studies as examples of how NIST identifies emerging trends in manufacturing and develops new technical capabilities and research programs to address these trends. In many cases, completely new measurement science is needed to overcome manufacturing challenges.

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- MEMS (MicroElectroMechanical Systems) are miniaturized mechanical and electro-mechanical elements that are made using semiconductor fabrication techniques. MEMS researchers and developers have demonstrated a large number of microsensors and devices for a wide range of applications including temperature, pressure, inertial forces, motion, magnetic fields, biometrics, video, and audio. Early MEMS device implementations — primarily as accelerometers in airbag systems in the automotive industry — established the value and robustness of this technology. MEMS devices are now important components of smart phones, tablet computers, lab-on-a-chip diagnostic systems, and implantable medical devices. Global MEMS industry revenues are projected to grow from about \$11 billion in 2012 to \$22 billion in 2018. The NIST MEMS project began in 1987 to provide new measurement capabilities for small scale devices. At the time, calibration of such devices was extremely difficult — preventing broader adoption. NIST highlighted several research projects including new measurements for microheating elements, thermal flat displays, gas sensors, microwave power sensors, and single molecule nanovials. The MEMS Technology Working Group, co-chaired by NIST, has over 60 industry and university members.
- Industrial Control Systems (ICS) Security: Factory control systems need to be protected from vulnerabilities that may arise as a result of their increased connectivity, use of wireless networks and sensors, and use of widespread information technology. Effective cybersecurity standards are essential to realize the full potential of smart manufacturing. Cybersecurity standards are difficult to deploy because they have to complement safety-critical and time-sensitive requirements of advanced factory control systems. One of the most important outputs of the NIST project is the measurement science necessary to develop standards for securing factory control systems against cyber attack, and to specify the test methods and metrics to ensure that the standards have been correctly implemented and do not negatively impact the performance of the system.
- The ICS Security Framework developed by NIST is documented in NIST Special Publications (SPs) SP-800-82 and SP-800-53. The documents provide guidance for secure ICS including supervisory control and data acquisition, distributed control systems, and other systems such as Programmable Logic Controllers. As ICS and IT networks are becoming increasingly integrated, there is less isolation for ICS from the outside world than ever before, creating a critical need to secure the systems from remote, external threats. Wireless networking also places ICS at greater risk from those in close proximity to equipment. The framework is based on a “defense-in-depth” strategy, layering security mechanisms so that impact to one mechanism as a result of failure is minimized. NIST SP 800-82 has been downloaded over 2.5 million times since its release and is widely referenced in the controls community.
- Neutron-based measurements for soft materials (nSoft) is a NIST-led consortium of industrial, government, and academic members designed to further the NIST mission to promote U.S. innovation and industrial competitiveness by advancing measurement science and reducing barriers for industrial research using neutron-based measurements for soft materials. The range of applications for which neutron scattering provides valuable insight is extensive and growing.

The Subcommittee agreed that these programs were outstanding examples of building new competences and capabilities within NIST to meet new technology challenges to serve U.S. manufacturing companies.

#### **4c. Collaboration and Coordination of Research Activities in Advanced Manufacturing**

The VCAT was asked to assess NIST’s approach to research, collaboration, technology transfer, and coordination across multiple NIST programs in the area of additive manufacturing. NIST presented an overview of laboratory programs and industrial service programs supporting additive manufacturing as a case study. Additive manufacturing is a relatively new program at NIST. The strategic planning and coordination between the NIST labs

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is in the early stages and provides the VCAT an opportunity to assess NIST's processes for planning and coordination including coordination with extramural programs.

NIST provided an overview of laboratory programs to develop measurement science for additive manufacturing. NIST's research focus is to overcome technical barriers that are preventing broad adoption of additive manufacturing. The five technical program thrusts are:

- Materials characterization
- Process control and uncertainty
- Qualification of materials and processes
- Certification of parts produced by additive manufacturing
- Systems integration

Additive manufacturing processes employ a wide range of mechanisms and materials. The initial scope of the NIST program addresses fused deposition of metals. Specifically, NIST is looking at high strength steel alloys (Inconel 625 and Cobalt-Chromium). The metal-based additive manufacturing market segment is smaller than the polymer-based market, but growing. Research on metals processes will be applicable to non-metal processes.

Initial NIST research results in additive manufacturing are being used by industry researchers and standards developers. NIST work in metal powder characterization, process characterization test artifact development (soon to be an ASTM Standard), and test protocol development is already being used by industry developers to measure additive manufacturing machine performance.

NIST plays a leading role in standards related to additive manufacturing, including its leadership of the ASTM strategic standards planning effort. NIST conducted a roadmapping workshop for Measurement Science for Metal-Based Additive Manufacturing in December 2012. The results of this workshop are being used as a foundation for ASTM F42 Committee's strategic plan. NIST chairs the ASTM F42 Test Methods Subcommittee. NIST worked with ASTM and International Organization for Standardization (ISO) to implement a joint standards development plan where additive manufacturing standards published by ASTM will be recognized by ISO.

NIST additive manufacturing programs have substantial interactions with industry, government agency, and academic stakeholders. NIST serves on the Advisory Board for the America Makes Consortium and is a member of the Additive Manufacturing Consortium. NIST participates in the federal government Interagency Working Group on Additive Manufacturing, which includes the Office of Science and Technology Policy (OSTP), National Aeronautics and Space Administration (NASA), NIST, the National Science Foundation (NSF), the Defense Advanced Research Projects Agency (DARPA), Army, Navy, Air Force, and the Department of Energy (DOE). NIST is working on specific research projects together with industry partners that include GE, Honeywell Aerospace, Pratt & Whitney, and Carpenter Powder. Academic research partners include University of Louisville, Carnegie Mellon University, Virginia Tech, North Carolina State University, and Penn State University.

NIST is actively coordinating additive manufacturing research programs across the NIST labs and other NIST organizations. The NIST programs that contribute to additive manufacturing include:

- Standards development, process measurement, materials system integration (Engineering Laboratory)
- Materials modeling, non-metallic materials characterization (Material Measurement Laboratory)
- Sensors, with a focus on temperature, emissivity, and laser interactions (Physical Measurement Laboratory)
- Integration, statistical analysis (ITL)
- External research awards (AMNPO)

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- Education and training (MEP)
- Manufacturing trends analysis, market research on additive manufacturing (NIST Economics Office)

**OBSERVATIONS:**

- Manufacturing is vital to the American economy. Efficient manufacturing of complex goods is key for a successful export economy and creating manufacturing jobs in America. Manufacturing must be considered fundamental to future economic growth.
- The VCAT fully supports the work at NIST, and feels strongly that NIST's measurement science mission, its unique and longstanding relationship with industry, and its broad portfolio of programs make it a critical element of the Administration's efforts to strengthen manufacturing in America. The VCAT observed that NIST's project portfolio in advanced manufacturing is well aligned with industry needs and the quality of work is world-class.
- The VCAT notes the agility of the NIST organization in responding to renewed focus on advanced manufacturing.
- The NIST lab programs that were reviewed by the VCAT demonstrated inter-lab collaboration as well as collaboration with third parties. The Committee notes significant examples of technology transfer activities that go beyond patents and licensing to include training, publications and new products. In particular, user facilities at NIST are highly beneficial for training.
- The VCAT notes that NIST's technical staff and leadership understands the potential of Additive Manufacturing and the barriers to its commercial implementation and NIST researchers have identified key R&D needs to move Additive Manufacturing forward.
- NIST is aware of global activities in Additive Manufacturing. The VCAT notes collaboration with European Union through ISO and ASTM international standards committees.
- The VCAT believes that the long standing support of U.S. manufacturers provided by the NIST Labs and the well-established MEP program will be significantly strengthened by the addition of the new AMTech and NNMI programs to the NIST portfolio.

**RECOMMENDATIONS:**

- The VCAT recommends that NIST consider publishing technology and standards roadmaps where measurement science is an enabler for advanced manufacturing technologies such as Additive Manufacturing.
- The Committee acknowledges NIST's leadership in convening workshops and developing roadmaps in new initiatives such as Additive Manufacturing, and recommends expansion of such workshops to produce roadmaps for additional advanced manufacturing areas.
- The VCAT strongly endorses the dedication and commitment of NIST leadership to apply NIST resources in a way to maximize agility and responsiveness of the organization.
- The VCAT strongly supports the growth of budget and capabilities within NIST to expand focus on advanced manufacturing leveraging the well-established core NIST focus on metrology and standards which remain critical to industry.
- The VCAT recommends that the Additive Manufacturing portfolio be fully resourced.
- The VCAT strongly recommends that NIST continues to take a lead role in global standards for Additive Manufacturing.
- The VCAT believes that the way NIST has positioned itself in Additive Manufacturing with the America Makes program is a good base that needs to be expanded as future NNMI's are launched.

- The VCAT endorses the overall approach that the NIST leadership has presented to the Committee to optimize the synergy between the NIST advanced manufacturing laboratory programs and the new extramural initiatives.

## 5. NIST User Facilities and New Partnership Models

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In 2013, the VCAT reviewed NIST's substantial and expanding portfolio of partnership models. NIST leverages its unique facilities, from dedicated user facilities to centers of excellence to consortia, to expand its capacity for research and to generate increased opportunities for impact on industry.

### 5a. User Facilities

NIST houses two unique user facilities, the NIST Center for Neutron Research (NCNR) and the Center for Nanoscale Science and Technology (CNST). The NCNR provides neutron measurement capabilities to the U.S. research communities, offering its instrumentation for use by all qualified applicants. The CNST supports the U.S. nanotechnology enterprise from discovery to production by providing the U.S. research community with access to world-class nanoscale measurement and fabrication methods and technology, with a shared-use NanoFab giving economical access to and training on commercial tools, and a NanoLab offering opportunities to collaborate on creating and using the next generation of instruments and methods. The NCNR and CNST have similar practices for partnership, but differ in important ways.

The NCNR allocates beam time based on scientific merit and programmatic relevance. The NCNR publishes biannual calls for proposals, which are critically reviewed for scientific merit by experts external to the NCNR. Proposals that are favorably reviewed by referees and recommended by the Beam Time Allocation Committee (BTAC) are then scheduled for experiments in the next six-month period (typically beginning three months after proposals are due). Researchers requiring beam time in the very near future may submit a Quick Access Proposal, which will be reviewed by the BTAC and held to a higher standard. NIST also has instrument time reserved for NIST research or programmatic research for a consortium of institutions that builds and operates a particular instrument. Beam time for non-proprietary research is provided without charges; beam time for proprietary research is provided for full cost recovery.

The CNST NanoFab provides access to facility tools and processes based on impact of NanoFab use and relevance to NIST, and technical or innovative quality and value to CNST mission. Applications are reviewed weekly, with project approval typically about two weeks from application submission. All NanoFab rates are based on the operating cost to the CNST, though non-proprietary research that advances the CNST mission may be eligible for reduced rates. Researchers may also collaborate with the multidisciplinary scientists and engineers in the CNST's NanoLab to create and use the next generation of nanoscale measurement instruments and methods.

#### **OBSERVATIONS:**

##### NIST Center for Neutron Research

- The VCAT was pleased to see the successful completion of the NCNR Expansion Project, which addresses a significant supply-demand mismatch in the United States. This expansion, the world class staff at the NCNR, and the NIST commitment to add innovative instrumentation to the existing suite of world-class instruments at the NCNR are key reasons why the NCNR ranks among the top three neutron research facilities in the world.
- The VCAT was pleased to learn about the nSoft consortium being launched by NCNR and MML, which is a positive example of how NIST is working to promote industrial utilization of this one-of-a-kind facility.

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- The VCAT also appreciates the role that the NCNR plays in supporting advanced manufacturing with new funds in 2014 being used to support a significant capability and capacity upgrade to the engineering diffractometer, which is an instrument used by industry on a number of challenges including the investigation of residual stresses in pipes, automobile components, and aerospace parts.

Center for Nanoscale Science and Technology

- The VCAT endorses the operating model of the CNST which is designed in a way that facilitates collaboration with industry partners. Specifically, the provision of state of the art capabilities, full time professional staff, flexible access models, and multiple options for collaboration and the protection of intellectual property (IP) make the CNST an industry friendly national facility.
- In addition to providing direct support to its users, the CNST also facilitates the access of the external community to the broader research capability of NIST which has helped launched new collaborations and partnerships to the mutual benefit of NIST and the external participants.
- The VCAT was also pleased to see the impact that CNST has in helping to train the next generation of scientists and engineers. While Science, Technology, Engineering, and Math (STEM) education is not directly a part of the CNST mission, the Center has had a positive effect both through the training of post-docs (25% of whom go straight to industry), and through their proactive NanoFab Community College Internship program, which is helping to train the next-generation work force that is needed to support broader industrial work in nanotechnology.

**RECOMMENDATIONS:**

- The VCAT endorses the strong foundation of unique facilities and world-class expertise of the Centers and their strong ties to industry. The VCAT recognizes the need for and recommends continuing to fund modernization and expansion of capacity of the facilities to meet industry demand.
- The VCAT recommends that NIST continues to broaden the mechanisms of technology transfer beyond licenses, publications, and training, through mechanisms such as remote access and broadening the industry sector users.

## 5b. Other Partnership Models

This year VCAT reviewed NIST's efforts to develop additional partnerships and external capacity in areas of national priority. These models include the NCCoE, NIST's new Centers of Excellence program and its first Center in advanced materials, and the Center for Advanced Communications (CAC).

NIST's Centers of Excellence program, first funded in FY 2013, are strategic engagements that allow NIST to carry out its mission by leveraging capabilities in universities and other research organizations.. The Centers of Excellence will provide an in-depth disciplinary environment in which NIST, academia and industry can collaborate in pursuing research focused on innovations in measure science and development of new technology focused on emerging areas of national need. The first Center of Excellence will focus on advanced materials with the goal of reducing the time required to move materials from discovery to market through modeling and computation. By combining NIST's expertise and experience in materials science, materials characterization, reference data, and standards with leading research capabilities for designing, producing, and processing advanced materials, the Advanced Materials Center of Excellence will create a collaborative environment and concentration of scientific and technical capability to accelerate materials discovery and development; provide opportunities to transition new breakthroughs in advanced materials to industry, convene multidisciplinary and multi-sector communities for in-depth discussions; and provide training opportunities for scientists and engineers in materials metrology. In

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December, NIST selected a consortium led by Northwestern University to establish the Center for Hierarchical Materials Design (CHiMaD).

The new CAC is a third new model to increase NIST's capability and capacity for partnership and impact. A partnership between NIST and the National Telecommunications and Information Administration (NTIA), the CAC will promote interdisciplinary research, development and testing in radio frequency technology and spectrum sharing for public safety and commercial broadband applications. To support the CAC partnership, NIST is establishing a new Communications Technology Laboratory based at the Boulder campus that will be a hybrid user facility for test beds and R&D management capability.

**OBSERVATIONS:**

- The VCAT has previously endorsed the concept of NIST leveraging external partners and the general Centers of Excellence model. The Committee was pleased to see the launch of the first Center of Excellence, the CHiMaD, and looks forward to the launch of the newly funded additional Centers of Excellence.
- The VCAT strongly endorses the new organizational approach for the Communications Technology Laboratory since would be difficult to fit into a single existing laboratory.

**RECOMMENDATION:**

- The VCAT would like follow-up discussion on NIST's selection of additional Center of Excellence areas and progress in refining the Center of Excellence model to ensure that they are meeting NIST needs.

## **6. Forensic Science**

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In 2013, VCAT was briefed on NIST's efforts in forensic science, including the history of NIST's role in forensic measurements, a memorandum of understanding between NIST and the Department of Justice (DOJ) to create a National Commission on Forensic Science, as well as the role of NIST's laboratory programs in developing forensic measurement science and standards. NIST will enable measurement science and related standards to support scientifically valid and accurate forensic analysis in order to strengthen all aspects of our justice system. Two primary roles for NIST in this area are the development and application of measurement science to support validation of forensic measurements and the coordination of guidance to support forensic laboratories. More specifically, NIST will 1) co-chair the National Commission on Forensic Science, 2) administer and coordinate support for discipline-specific guidance groups, 3) conduct research supporting the development and dissemination of methods, standards, and technical guidance for forensic science measurements; and 4) test and validate select existing forensic science practices and standards as appropriate.

The National Commission on Forensic Science, which builds off a National Academy of Science 2009 report "Strengthening Forensic Science in the United States," is co-chaired by the NIST Director Patrick Gallagher and the Deputy Attorney General James M. Cole of the DOJ. The Commission includes federal, state and local forensic science service providers; research scientists and academics; law enforcement officials; prosecutors, defense attorneys and judges; and other stakeholders from across the country. This breadth of experience and expertise reflects the many different entities that contribute to forensic science practice in the U.S. and will ensure these broad perspectives are represented on the commission and in its work. The Commission will assess and prioritize as appropriate forensic measurement methods as well as scientific guidance and protocols for evidence seizure, testing, and storage.

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NIST is responsible for the administration and coordination for guidance groups that will promote scientific validity and reliability in forensic science. These guidance groups will replace an existing ad hoc system of scientific working groups that are funded by a variety of agencies and have different sizes, structures and output. The groups' impact within their respective fields also varies. NIST seeks to leverage the best work of the existing working groups to standardize activities and output across disciplines. NIST collected public comment on the structure of guidance groups, and has developed a plan for the Organization of Scientific Area Committees (OSAC).

The NIST laboratories will perform research to characterize and improve the accuracy and efficacy of many forensic approaches, aiding practitioners by providing tools for crime scene investigation, laboratory analysis, and court room use of this evidence while also enabling NIST laboratories to innovate completely new approaches to forensic science disciplines.

**OBSERVATION:**

- The VCAT recognizes the critical role of NIST in forensic science and applauds the progress to date in the establishment of the National Commission on Forensic Science with the DOJ. The VCAT will continue to monitor NIST progress in this area.

**RECOMMENDATION:**

- The VCAT recommends that NIST continue to strengthen the science base that supports forensic data/information used in the U.S. criminal justice system. The 2014 budget increase is consistent with this need and the Committee hopes to see growth in the future.

## **7. NIST Budget and Planning**

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### **7a. NIST Three-Year Programmatic Plan 2015-2017**

The Committee has read and reviewed the draft NIST three-year programmatic plan as of February 2014 and believes that it accurately portrays the near-term path of activity and development at NIST. The Committee appreciates NIST management's efforts to develop a longer-term strategic perspective of evolving agency needs and challenges that are evident in this programmatic plan. NIST's longer-term priorities are evident in the three key perspectives of National Priorities, Long-Term Trends, and Internal Processes. By showing how NIST is growing capabilities in the long-term scientific and structural trends that are shaping national priorities, the NIST Three-Year Programmatic Plan illustrates a long-term vision for NIST's contributions towards key areas of national importance.

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**7b. NIST Budget (Dollars in Millions)**

	<b>FY 2013 Enacted</b>	<b>FY 2014 Enacted</b>	<b>FY 2015 Request</b>
<b>STRS</b>	<b>\$579.8</b>	<b>\$651.0</b>	<b>\$680.0</b>
Laboratory Programs	517.1	578.0	597.5
Corporate Services	17.3	17.3	17.3
Stds Coord. and Spec. Prgs.	45.4	55.7	65.2
<b>ITS</b>	<b>\$133.6</b>	<b>\$143.0</b>	<b>\$161.0</b>
Advanced Manu. Tech. Consort.	10.6	15.0	15.0
Hollings Manuf. Ext. Prg.	123.0	128.0	141.0
Mfg. Innovation Inst. Coordination			5.0
<b>CRF</b>	<b>\$55.9</b>	<b>\$56.0</b>	<b>\$59.0</b>
Const. & Major Renovations	11.8	11.8	14.8
Saf. Cap., Maint., Maj. Repairs	44.1	44.2	44.2
<b>Total NIST Appropriation</b>	<b>\$769.3</b>	<b>\$850.0</b>	<b>\$900.0*</b>

\* Excludes transfer of \$4.9 million from Department of Justice / Election Assistance Commission to NIST

The FY 2015 Budget Request also includes a separate Opportunity, Growth, and Security Initiative. At NIST, this Initiative would provide an additional \$115 million that would help strengthen NIST's cutting edge R&D capabilities and facilities. The initiative would also support industry and government efforts to address today's biggest challenges in advanced manufacturing, cybersecurity, advanced communications, forensic science, and other areas of critical national importance.

A major element of the Opportunity, Growth, and Security Initiative is \$2.4 billion for NNMI to support the President's goal of creating 45 manufacturing innovation institutes over 10 years. At this time, the Administration is working with Congress on authorizing legislation for the program. In anticipation of authorization and funding of the program, NIST, through the AMNPO, has made significant progress to clarify policies and guidelines for the NNMI, including IP rights and institute performance metrics. In addition, through AMNPO, NIST has supported interagency collaboration leading to the establishment of NNMI institutes, including America Makes, the National Additive Manufacturing Innovation Institute, the Lightweight and Modern Metals Manufacturing Innovation (LM3I) Institute, and the Digital Manufacturing and Design Innovation (DMDI) Institute supported by the Department of Defense (DoD), and the Next Generation Power Electronics Innovation Institute supported by the DOE. Four more institutes are planned for 2014, as announced by the President in the State of the Union on January 28, 2014, including a DOE-led Advanced Composites Manufacturing Innovation Institute. NIST continues to work with congressional leaders on bipartisan, bicameral legislation authorizing the NNMI.

**7c. FY 2013 Appropriations**

The FY 2013 appropriation was an increase of \$73 million over FY 2012 enacted, which became a net increase of \$18.5 million after sequester and rescission. The VCAT endorsed NIST's plans for allocating the program increases towards:

- Restoration of Core Programs (\$20 million)
- Advanced manufacturing R&D (\$15.2 million)
  - o Advanced Materials (\$5.2 million)
  - o Biomanufacturing (\$2 million)
  - o Nanomanufacturing (\$2 million)

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- Smart Manufacturing (\$2 million)
- Advanced Neutron Technologies (\$2 million)
- Embedded standards (\$2 million)
- Cybersecurity (\$5 million)
- NIST Centers of Excellence (\$7 million)
- Disaster Resilience (\$2 million)
- AMTech (\$7 million)

This allocation allowed NIST the flexibility to restore core programs and capabilities that were cut under the sequester, but retained the Administration’s support of key priorities, including manufacturing, cybersecurity, and disaster resilience.

### 7d. FY 2014 Appropriations

The FY 2014 appropriation was an increase of \$81 million over FY 2013 enacted. Of this increase, \$70 million is directed to Scientific and Technical Research and Services. These appropriations support national priorities including:

- Advanced manufacturing (\$30 million increase),
- Cybersecurity (\$9 million increase)
  - Research (\$5 million increase)
  - National Initiative for Cybersecurity Education (\$4 million increase)
  - National Cybersecurity Center of Excellence (\$15 million)
- Disaster resilience (\$1 million increase)
- Forensics (\$5 million)
- Greenhouse gas measurements (up to \$3 million)
- Centers of Excellence, including the Center for Hierarchical Materials Design awarded in December 2013 (\$15 million)
- AMTech (\$5 million increase)
- MEP (\$5 million increase)

### 7e. Impacts of Government Shutdown

The 17-day Government Shutdown in October was highly disruptive to NIST’s operations and impact. The October VCAT meeting, one of the three annual meetings, was cancelled due to the shutdown. Across the Gaithersburg, Boulder, and Charleston campuses, 253 NIST employees (8%) were “excepted” to work during the shutdown; the rest of the staff were furloughed and all guest researchers were barred from campus. The Shutdown delayed the release of the draft Cybersecurity Framework by almost two weeks, from its originally scheduled release date of October 10<sup>th</sup> until October 22<sup>nd</sup>, with significant negative media coverage. NIST’s user facilities were significantly impacted by the Shutdown: CNST’s NanoFab cancelled over 340 reservations and NCFR cancelled about 70 experiments. These cancellations resulted in lost income for the facilities, hampering their maintenance, upgrade, operations, and therefore effectiveness; and in research delays, negatively impacting industry, academic, and government research.

#### **RECOMMENDATIONS:**

- The VCAT endorses both the increase in NIST budget and the technology areas identified for increases.
- The VCAT continues to strongly support the request for full funding of the NNMI program at the requested level. The Committee also appreciates the recent Congressional action to enact NNMI.

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- The VCAT supports the approach that NIST is taking to make AMTech effective despite the reduced budget level. It is important to also continue the effort to strengthen the alignment of the extramural programs, particularly AMTech and NNMI programs.
- The shutdown of the NIST facility had serious detrimental impact and the VCAT recommends a means of ensuring continuous operation of the NIST facility.