

VISITING COMMITTEE ON ADVANCED TECHNOLOGY
National Institute of Standards and Technology

2016 Annual Report

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

U.S. Department of Commerce

July 2017



Preface

The Visiting Committee on Advanced Technology (VCAT or the Committee) of the National Institute of Standards and Technology (NIST or the Institute) was established in its present form by the Omnibus Trade and Competitiveness Act of 1988 and updated by the America COMPETES Act in 2007 and the American Innovation and Competitiveness Act of 2017. 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. This 2016 annual report covers the period from the beginning of March 2016 through February 2017.

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
- Critical Facets of the NIST Core
 - Achieving Balance in NIST Laboratory Programs
 - Open Research and Development
 - Facility Needs

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.

Two new members were appointed during the period covered by this report: Dr. Gail Folena-Wasserman (MedImmune) and Mr. David Vasko (Rockwell Automation).

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. This report was prepared during a time of significant uncertainty with the transition to a new administration, and the uncertainty of the budget situation at the time with the FY2017 budget still unsettled at the time of the report, and the President's FY 2018 request having not yet been released. As a result, section 4B was amended accordingly.

VCAT Members during the Period Covered by this Report

Dr. Rita R. Colwell, Chair
University of Maryland at College Park
Term: January 6, 2014 – January 5, 2020

Mr. William M. Holt, Vice Chair
Intel Corporation
Term : May 13, 2012 – May 12, 2018

Dr. Allen Adler
The Boeing Company
Term : January 25, 2016 – January 24, 2019

Ms. Hemma Prafullchandra
HyTrust, Inc.
Term: October 27, 2014 - October 26, 2017

Dr. Rodney Brooks
Rethink Robotics
Term: June 1, 2014 – May 31, 2017

Dr. Theodore Sizer
Nokia Bell Labs
Term: August 28, 2015 – August 27, 2018

Mr. Michael Garvey
M-7 Technologies
Term: January 23, 2015 – January 22, 2018

Mr. David Vasko
Rockwell Automation
Term : February 2, 2017 – February 1, 2020

Dr. Waguih Ishak
Corning Incorporated
Term : January 25, 2016 – January 24, 2019

Dr. Gail Folena-Wasserman
MedImmune
Term : January 30, 2017 – January 29, 2020

Dr. Karen Kerr
GE Ventures, General Electric
Term: June 1, 2011 - May 31, 2017

Dr. David Wilson
Morgan State University
Term: March 23, 2015 – March 22, 2018

Dr. Roberto Padovani
Qualcomm Technologies, Inc.
Term: May 1, 2011 - April 30, 2017

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1. VCAT Focus in 2016

In 2016, the VCAT was charged with reviewing NIST's current definition of "core" and advise on how to ensure the correct balance, strength, and relevance in the areas of measurement science, standards development, and technology transfer in the coming years to include NIST's support of the NSCI initiative. In addition, the VCAT was briefed on the accomplishments of NIST over the past 4-8 years, what NIST is currently working on, and what still needs to be done; the various states of disrepair in NIST's facilities both at Gaithersburg and Boulder; and the continued need for an open research environment. With the transition of administration, it is also the time to review the attributes of an Undersecretary of Standards and Technology and the NIST Director. This 2016 Annual report summarizes the VCAT's work, observations and recommendations in these areas.

2. Safety

Safety has been a focus and priority of the VCAT for several years and the VCAT has been pleased that NIST has developed a safety culture focused on shared responsibility and continuous improvement. NIST has made substantial progress in developing a positive safety culture, and the VCAT continues to receive regular updates on the trends in safety incidents, programs on safety training for leaders and staff, and overall progress on the safety culture.

As a result of the 2014 NIST safety climate survey, NIST is taking a closer look at employee rights and responsibilities, unsafe conditions and practices, incident reporting and lessons learned, training, observations, and performance appraisals. Through this survey, NIST continues to improve in the following areas:

- What is reported – eliminate unwieldy reporting of minor incidents, while continuing to pay due attention to any lessons that can be learned from them.
- Improve on incident investigations – training, tools used, procedures, and support.
- Sharing lessons learned – grow IRIS email alert subscriptions, increase communication vehicles, incident trends, and keep communication positive.

The VCAT was pleased to see the progress that NIST has made in the implementation of its workplace inspection program. With the relative plateau in NIST's Occupational Safety and Health Administration recordable incidents, which have stayed the same as in FY15, having clearly defined roles and responsibilities and a larger cadre of staff trained in spotting issues should help NIST further drive down incidents. The VCAT was also pleased to hear of the progress that NIST continues to make with its radiation safety program. NIST has indeed come a long way since the plutonium contamination event in June 2008, which is evident from the results of the September 2016 unannounced inspection by the Nuclear Regulatory Commission (NRC), where NIST was praised for its proactive identification and correction of issues and the transparent nature in which the NIST staff kept NRC informed.

RECOMMENDATIONS:

1. Continue to report to the VCAT on safety metrics and safety initiatives.

3. Maintaining a Healthy NIST Core

In the recent past, NIST has demonstrated its extraordinary competence and capability in becoming a center of action and responsibility in national priorities including advanced manufacturing, advanced communications, cybersecurity, forensic science, and disaster resilience. NIST has also garnered new extramural programs, including Manufacturing USA (formerly the National Network for Manufacturing Innovation), and has improved the execution of the Hollings Manufacturing Extension Partnership. NIST's success in these areas is a testament to the culture of exceptionalism that NIST has demonstrated since its founding in 1901.

Despite these achievements, there remains much to be done. A number of laboratory initiatives have been left unfunded or funded at levels far below the commensurate need. At the same time, new technical challenges continue to emerge that would benefit from NIST's approach and expertise. With an eye toward keeping NIST in a strong position, the VCAT has spent the past year examining areas where we see NIST facing the biggest risk. The VCAT is concerned that without growth in budget the scope of NIST's responsibilities threatens to outrun NIST's abilities to build the foundational research and development core that support these engagements. We have toured laboratories where advanced science is conducted, and the facilities are woefully inadequate and suffer from years of deferred maintenance and upgrades due to budget constraints. NIST's need for sophisticated laboratory facilities is urgent and increasing, just as NIST's abilities are being called upon to further explore the necessary research for addressing the extended responsibilities with which it is being tasked.

As a leading research organization, NIST must be able to collaborate with the best in the world, compete for extraordinary personnel, and operate at the speed of innovation in order to effectively deliver on its mission. NIST's extramural programs must have significant room for growth to reach maximum impact.

3a. Achieving Balance in NIST Laboratory Programs

In the past, the VCAT has expressed concern that NIST was a "victim of our own success" and being stretched too thin, emphasizing the need for balance between the core mission and externally-driven activities. To gain more insight on this topic, the VCAT heard from a both external stakeholders and internal program managers and then discussed the challenges with a panel of NIST Laboratory Directors.

The stakeholders provided several examples of how NIST, though its unique role and its technical capabilities, contributes to an innovative ecosystem. One example provided was the new metrology techniques, standard reference materials, and data standards created through activities like the Materials Genome Initiative allow a wider community to exchange information. Another example was the neutral, independent position NIST maintained in creating a collaboration environment

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assists in managing natural tensions and conflicts. NIST provides guidance to industrial partners on navigating the international standards process, and adds credibility to standards. Finally, the VCAT heard how NIST's products and services are valuable to a broad suite of customers who, for example, want a calibration certification traceable to NIST or a reference standard for monoclonal antibodies to improve drug formation stability.

The VCAT also heard how several programs with strong convening aspects impacted NIST's core research and development capabilities and mission delivery.

- **Smart Grid Program** In 2007, NIST coordinated the development of a framework that included standards to achieve interoperability of smart grid devices and systems. In 2008, when stimulus funds were allocated smart grid deployments through the Department of Energy, there were concerns that the standards currently in place were insufficient. NIST was therefore tasked to coordinate the development of relevant standards, an activity that required NIST to put much of its electrical metrology work on hold. The Smart Grid Interoperability Panel, which NIST initiated to solicit input and cooperation from private and public sector stakeholders in developing the smart grid standards framework, has successfully been transitioned to a nonprofit private-public partnership organization.
- **Cybersecurity Framework** As directed by Executive Order 13636, NIST worked with stakeholders to develop a voluntary framework to reduce cybersecurity risks to critical infrastructure. This process, which included workshops throughout the country and other forms of stakeholder engagement, strengthened NIST's long-standing collaborative relationships with industry and helped it establish new relationships, partnerships, and collaborations with new sectors and organizations. However, these efforts required NIST to divert staffing and other resources from other important work and continues to require NIST to dedicate resources to the increasing interest in how to implement and deploy the framework.
- **Advanced Communications** NIST's recently expanded efforts to develop measurement solutions for advanced communications technologies have included the formation of the 5G Wave Model Channel Alliance. Less than a year after its founding, the 5G Alliance has tripled in participation and has plans for workshops co-located with relevant stakeholder industry meetings. The growth of NIST's support role in this area include a burden on NIST technical staff and the costs of a contract to support the working group and online data repository.

The VCAT also discussed the challenges of balancing investment in the R&D programs while meeting external demands and mandates with a panel of NIST Laboratory Directors. In a number of areas, convening activities provide an opportunity for high-profile contribution, effective mechanisms to disseminate research results and standards products, and unique opportunities to gather stakeholder input. At the same time, they can draw valuable resources from NIST's intramural research programs, threatening the long-term health of NIST's capabilities.

OBSERVATIONS:

Since 2012, NIST has seen a growth in its Laboratory budget. The increase has supported new capacity for scientific research to support national priorities, primarily advanced manufacturing, cybersecurity, advanced communications, and disaster resilience. NIST has addressed these priorities through a combination of intramural research and externally-focused programs. However, these increases have not met the need in these areas. In addition, other national priorities have also been only partially funded or left unfunded. Without adequate resources and research facilities, the Nation will lose a critical element of its innovation ecosystem.

Over the past year, the VCAT has reviewed examples of extraordinary unfunded Legislative or Executive branch demands placed on NIST in Smart Grid standards, the Cybersecurity Framework, the Presidential Commission on Cybersecurity, and responsibilities for Public Safety Communications. NIST has superbly executed on these demands, demonstrating the function of its outstanding underlying technical capability – but unless carefully managed, unfunded mandates can drain that well of expertise.

3b. Open Research Environment

The VCAT was briefed on the importance of an open research environment at NIST. The most important program for NIST is its world-leading scientific research program. Since 1974, NIST has not seen substantial growth in federal staff but, has grown nearly tenfold in guest scientists. The growth in guest scientists enables NIST to maintain its world-leading scientific research program by bringing in the best-minds from around the world to conduct the necessary fundamental and technical research to carry out its mission. Enacting extensive bans on foreign guest researchers would affect NIST's ability to continue to be a world-class scientific research laboratory.

OBSERVATIONS:

NIST is a critical partner with the private sector to develop the infrastructure necessary for innovation. This engagement is a key piece of the ecosystem that supports the competitiveness of the U.S. economy. To transfer the technology, methods, and standards developed at NIST and through these partnerships to the American private sector inescapably involves participation of scientists and engineers who are the best in the world, and who are sometimes foreign nationals. These efforts enhance the competitiveness of American industry.

Put succinctly, in order for NIST to execute its mission successfully, it must have access to the best minds in the world. While many highly talented scientists and engineers are US citizens, it is necessary to recognize that the pool of talent in other countries may exceed our own. It is in the interest of NIST – and, indeed, the Nation – for NIST to maintain an open research environment that balances information, intellectual property, and physical security with collaboration and scientific collegiality.

3c. Facilities Needs

Facility deficiencies are the number one risk at NIST. Given that a majority of the buildings in Gaithersburg were built in the 1960's and in Boulder, the 1950's, both campuses are in serious need of repair. The conditions of the facilities not only affect the research but, also the people conducting the research. Every 3 years, a Facility Condition Assessment is performed, creating a metric called the Facilities Condition Index (FCI). Based on the studies, both campuses are in poor condition, falling below the fair rating of 85. Gaithersburg received a FCI rating of 84 and Boulder received a rating of 82. To list a few of the facilities deficiencies and the effects:

- Lack of temperature stability affects optics;
- Humidity fluctuations affects sensitive measurements;
- Vibration problems affects sensitive spatial measurements;
- Equipment from the 1950's means that replacement parts/components are difficult to obtain.

The current funding to support the improvements to the facilities is just under \$50 million, which falls far short of the Federal Facilities Council recommendations of 3-4% of current replacement value, which would be \$80-107 million. This has created a backlog of \$346.2 million, the largest category is for mechanical-electrical system repair and replacement, totaling \$209.8 million. Maintaining mechanical, humidity, and electrical stability in the laboratories is necessary to conduct the kind of research NIST requires. To summarize, based on a 2006 report the impacts of the conditions of NIST's facilities have led to a productivity loss of about 20%.

OBSERVATIONS:

NIST's research in measurement science pushes the boundaries of the possible, exceeding the capabilities of what can be done anywhere in the world. However, many of the research teams are housed in increasingly outdated, unreliable, deteriorating, and potentially unsafe facilities that directly limit measurement capabilities. In recent years, the capital budget has been squeezed in the budget process, damaging NIST's capabilities for updating and renovating its facilities built in the 1950s and 1960s to match 21st century research needs.

The VCAT is aware that significant investments are badly needed in renovating deteriorating facilities on NIST's campuses, notably Building 245 in Gaithersburg and Building 1 in Boulder. These investments will enhance safety and security of NIST's facilities and strengthen the research they house. The VCAT has observed the slow pace of these renovations and also learned that these investments address only part of a larger problem of significantly underfunded maintenance and renovation funds. As NIST's footprint, scope of responsibilities, and complexity and sensitivity of research has grown, its budget for repairs and maintenance has been flat or decreasing. NIST currently has a maintenance backlog of \$346M, with an annual appropriation for maintenance and repair averaging less than \$50M, insufficient to address the need.

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RECOMMENDATIONS:

1. NIST's facilities maintenance budget must be increased to a level commensurate with the need – that is, to a base of about \$107M per year. NIST's facilities maintenance budgets have dropped significantly over the past several years creating a backlog of deferred maintenance. At current funding levels NIST will lose the capabilities to support the kind of boundary-pushing, high-precision science required of it.
2. To accommodate increased demand for measurement science solutions in existing and emerging technology areas the NIST research budget should grow by approximately 10% per year to achieve a base of approximately \$1B. The VCAT applauds NIST's increased performance and responsibilities for advanced manufacturing and cybersecurity over the past few years but there are still many unmet demands that increased funding would address. Furthermore, the VCAT encourages NIST to continue to pursue stronger programs in advanced communications, bioscience, and resilient infrastructure and communities.
3. The VCAT recommends increased funding for Manufacturing USA, the Hollings Manufacturing Extension Partnership (MEP) program, and the Baldrige Performance Excellence program to fund additional industry-driven manufacturing institutes, enable the MEP program to serve more small and medium manufacturers, and support the Baldrige program's efforts to promote the adoption of cybersecurity best practices respectively. The VCAT recognizes the unique position NIST's extramural programs play in the Nation's innovation ecosystem, especially in advanced manufacturing, and encourages continued expansion in those programs. Further, we are encouraged by the active participation NIST's scientists have had in the Manufacturing USA program and the renewed focus of MEP on technology transfer, and the potential expansion of Baldrige into Cybersecurity. We recommend that NIST continue to strengthen these interactions.
4. To most effectively meet stakeholder demand, NIST should be able to maintain maximum control over the allocation of budgetary resources. NIST's Scientific and Technical Research and Services budget line should be under NIST leadership's discretion to ensure a strong, stable, and flexible funding base is available to NIST's laboratory programs. This will ensure maintenance of the intramural expertise, long-term research perspective, and programmatic agility so critical to NIST's mission delivery. With the ever-increasing pace of innovation, NIST must be able to look forward to establish intramural capabilities before the demand arises.
5. New technological priorities, convening requirements, and programmatic mandates must be adequately supported with additional funds in their first year. Furthermore, NIST must plan for the full lifetime needs of these programs. NIST is a long-standing institute and while new and important demands always take priority, previous demands cannot simply be abandoned. Many demands of NIST's expertise have a long life; while the funding requirements may taper off, they do not become zero.
6. NIST must retain an atmosphere of openness and collaboration conducive to maintaining its ability to work with the best scientists in the world. The VCAT is mindful of the risks

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associated with this, but believes that they can be adequately mitigated by robust internal processes and controls proactively managed by NIST Leadership.

7. NIST, working with Congress and the Administration, should be allowed to adopt authorities and best practices across the Government that would enable NIST to have the necessary speed and workforce quality. These include Other Transaction Authority and premium pay authorities.

4. NIST Budget and Planning

4a. NIST Budget (Dollars in Millions)

	FY 2016 Enacted	FY 2017 Enacted	FY 2018 Request	+ / (-) Over FY 2017 Enacted
STRS	\$690.0	\$690.0	\$600.0	(\$90.0)
Laboratory Programs	605.2	604.7	544.3	(60.4)
Corporate Services	17.3	17.3	11.3	(6.0)
Stds Coord & Special Pgms	67.5	68.0	44.4	(23.6)
ITS	\$155.0	\$153.0	\$21.0	(\$132.0)
Hollings Mfg Ext Partnership	130.0	128.0	6.0	(122.0)
Manufacturing USA	25.0	25.0	15.0	(10.0)
CRF	\$119.0	\$109.0	\$104.0	(\$5.0)
Construc & Major Renovations	60.0	60.0	60.0	0.0
Saf, Cap, Maint & Maj Repairs	59.0	49.0	44.0	(5.0)
Total, NIST Discretionary	964.0	952.0	725.0	(227.0)

4b. FY 2017 Appropriations and FY 2018 Request

At the time the VCAT drafted the recommendations in this report the President's FY 2017 Request had not yet been voted on by Congress, and the FY 2018 Request had not yet been released. The VCAT has discussed these budget levels. The VCAT is disappointed that the FY 2018 President's Budget Request decreases total NIST funding by nearly 24% from FY 2017 enacted levels. The Committee offers the following observations:

- NIST Leadership should be applauded for the logical and thorough effort they made to accommodate the cuts required by the President's FY 2018 Budget Request. NIST, led by Acting Director Rochford and supported by the strong team of senior leaders at the Associate Director and Lab Director levels, was able to identify areas of lower priority while preserving NIST's core capabilities.

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- The Committee is concerned about the decreasing support for the NIST infrastructure and facilities. As previously noted, recommended support for facility maintenance is more than double that in the FY 2018 Budget Request. Without adequate support, NIST facilities will fall further into disrepair, undermining the science and engineering work of the NIST staff and causing increased safety risks. The Committee also notes that it is likely that repair funds will be increasingly pulled from programmatic resources, compounding the already steep cuts outlined in the FY 2018 request.
- In our experience, uncertainty and the threat of decreasing resources is likely to cause high-performing staff to look for other opportunities. Because of this, the Committee is concerned that NIST's outstanding research staff, which is so critical to its success and mission delivery, may be tempted to seek other opportunities. In addition, since NIST's exceptional scientists are a significant recruiting tool, losing those top researchers because of budget uncertainty would likely have significant long-term effects.