Statement of

Ross B. Corotis, Ph.D.
Denver Business Challenge Professor
Department of Civil, Environmental & Architectural Engineering
University of Colorado at Boulder
and
Chair, Committee on NIST Technical Programs
Laboratory Assessments Board
Division on Engineering and Physical Sciences
National Research Council
The National Academies

before the

Subcommittee on Technology
Committee on Science, Space, and Technology
U.S. House of Representatives

March 20, 2013

Summary

The Visiting Committee on Advanced Technology (VCAT) focuses primarily on the NIST portfolio, asking, "Is NIST doing the right things?" VCAT members are selected by NIST.

The National Research Council (NRC) committee is voluntarily engaged by NIST, and responsibility for its membership, activities, and reports lies completely with The National Academies. Since 1959 it has addressed the question, "Is NIST doing things right?" It operates with separate panels of technical experts and it has no interaction or reporting relationship with VCAT.

Eight years ago NIST replaced the NRC annual laboratory reviews with biennial ones and eliminated the overall summary report that noted findings common across the NIST laboratories.

Last year NIST asked the NRC to assess the assessment process itself, and it was concluded that peer assessment of quality was a crucial and vital part of an overall assessment strategy. The report develops guidelines for assessment by VCAT and NRC in three broad areas: management, the quality of scientific and technical work, and relevance and impact.

Sample quotations from recent reports:

- "NIST carries out in a superb fashion an absolutely vital role in supporting as well as facilitating the further development of the technological base of the U.S. economy." "The personnel and scientific programs [of its Measurement and Standards Laboratories] are among the best in the world."
- "Within the United States, there is no other laboratory worldwide… that has had the successes in physics that this laboratory has achieved during the past two decades." There has been no assessment, however, of the new Physical Measurements Laboratory since it was formed in 2010.
- "The Information Technology Laboratory's Special Publication series provides guidelines that are frequently adopted voluntarily in private-sector procurements and practices.
- "The Center for Nanoscale Science and Technology [founded in May 2007] now has facilities that are among the best in the world, and in many cases unique."

Recommendations:

- Reauthorize NIST at the fullest funding possible
- Encourage NIST to avail itself of the continued benefits of the NRC assessments, including:
    - Performing cross-cutting reviews as well as laboratory reviews;
    - Reinstating the practice of examining findings from individual reviews to create a summary report; and
    - Re-establishing and maintaining a formal, regular interaction between the NRC and the VCAT teams.

Chairman Massie, Ranking Member Wilson, and Members of the Subcommittee, it is my pleasure to address you today and comment regarding the quality of the laboratories of the National Institute of Standards and Technology, NIST.

I am Dr. Ross B. Corotis, chair of The National Academies Committee on NIST Technical Programs. The National Research Council (NRC) of the National Academies is the operating arm of the National Academy of Sciences, National Academy of Engineering, and the Institute of Medicine, chartered by Congress in 1863 to advise the government on matters of science and technology. My brief background is that I have three degrees from MIT and am founder of the Department of Civil Engineering at The Johns Hopkins University, past Dean of the College of Engineering and Applied Science for the University of Colorado at Boulder, and elected member of the National Academy of Engineering. I served for one year as a Jefferson Science Fellow at the Department of State, and I am currently a chaired professor at the University of Colorado at Boulder.

At the National Research Council of The National Academies I have since 2009 served as the founding chair of the Committee on NIST Technical Programs. Prior to that, I chaired the Panel assessing the Building and Fire Research Laboratory, now part of the Engineering Laboratory, and I was a member of the Board on Assessment of NIST Programs.

Congress mandates that NIST have an oversight committee, called the Visiting Committee on Advanced Technology, or VCAT. The VCAT focuses primarily on the NIST portfolio, or basically, the question "Is NIST doing the right things?" The VCAT members are selected by NIST, and they meet regularly in carrying out their duties to issue an annual report.

The National Academies' committee, on the other hand, is voluntarily engaged by NIST, and responsibility for its membership, activities, and reports lies completely with The National Academies (while seeking NIST recommendations for membership). The assessment of NIST laboratories by The National Academies has been provided for more than half a century (since 1959). Its task is basically to address the question, "Is NIST doing things right?" Therefore it operates with separate panels of technical experts for each laboratory and center assessed, with each panel composed of 15-20 experts from academia, industry, and other scientific and engineering environments, selected to cover the range of activities contained in the particular laboratory or center, with both breadth and depth. This past year none of the laboratories or centers were assessed individually; instead, the committee performed an assessment of the manufacturing-related programs, whose collective activities cut across the NIST laboratories and centers. While the focus of the committee assessment is on the quality of NIST activities, it does this in the perspective of NIST's mission "to promote the U.S. economy and public welfare."

Until eight years ago, The National Academies committee reviewed each NIST laboratory annually and issued reports that summarized its assessment for each laboratory; the reports also included an overall assessment of NIST that summarized findings common across the laboratories. More recently, the committee has reviewed each laboratory every other year, with slight exception, and has issued separate reports on each laboratory or center being assessed. Notably, no overall assessment of NIST has been reported for several years. The National

Academies committee operates completely independently of VCAT and has no interaction or reporting relationship with VCAT.

About a year ago, NIST and VCAT decided that the assessment process itself should be reviewed and assessed. Therefore, NIST contracted with The National Academies to create a study committee. The committee on assessment practices was chaired by Dr. John W. Lyons, a former Director of NIST, the first permanent director of the Army Research Laboratory (ARL), and a Distinguished Research Fellow at the Center for Technology and National Security Policy at the National Defense University. I was a member of that committee, which held several meetings, as well as a workshop of invited participants form the government, private industry, and academia. That committee's task was not focused solely on NIST, but it certainly encompassed agencies such as NIST. It issued a workshop report, as well as a final report, which concluded that the type of peer assessment of quality being conducted by The National Academies was a crucial and vital part of an overall assessment strategy, as was the type of management and policy review being performed by VCAT. Indeed, the report concludes that it is only with both aspects of assessment that an organization can be fully assessed to its greatest advantage. The report develops guidelines for assessment in three broad, crucial areas: assessing management, assessing the quality of scientific and technical work, and assessing relevance and impact. The fact that the assessments conducted by The National Academies are carried out by individuals selected without NIST veto privilege, and that the reports are not made available to NIST for editorial review or approval (although items are provided for fact-checking) prior to public release, further validates the objectivity and independence reflected in the findings of The National Academies assessments by leading experts.

Having been involved in The National Academies assessment of NIST since 1999, I can attest to the overwhelming conviction that NIST is performing vital functions for the United States at a level comparable to or better than the best practices anywhere else in the world. Its unique mission of "providing essential reference data and measurement capabilities to promote the U.S. economy" places it at a crucial nexus for the development and promotion of private industry. It consistently develops standards and advances technology with the goal of enhancing the successful role of private industry to compete in a world market. NIST constantly monitors when its activities promote private industry and public welfare. Standard Reference Material forms an essential underpinning for industry, and to be effective it must be timely and not overly expansive or too restrictive.

The following statements from the committee report of a few years ago remain as valid today: "NIST carries out in a superb fashion an absolutely vital role in supporting as well as facilitating the further development of the technological base of the U.S. economy." "The personnel and scientific programs [of its Measurement and Standards Laboratories] are, by scientific measure, among the best in the world." Two other quotations are germane here: "NIST has undergone a remarkable transformation…from an organization devoted to producing excellent science and standards in an orderly, incremental fashion using a single-principal-investigator mode of operation to an entrepreneurial, outward-looking, customer-focused research organization…" and, "The Board notes, with strong approval, the continued growth of institutional collaborations between NIST and other organizations…[and] balancing its traditional roles in metrology and

standards development with its newer, broader roles in technology development related to national needs."

Rather than use my words for the quality of the various laboratories, I quote briefly from the 2010 and 2011 reports of five of the nine individual laboratories. (For consistency and faithfulness to those assessments I will use the separate laboratory titles before the recent reorganization into six laboratories that include two user facilities).

> "The projects reviewed by the Panel on Materials Science and Engineering fulfill the mission of the … Laboratory. They are formulated well and conducted in generally excellent facilities by an outstanding technical staff."
>
> "The work of the Building and Fire Research Laboratory is of the highest technical quality."
>
> "Within the United States, there is no other national laboratory or facility that focuses on the missions of the NIST Physics Laboratory (now Physical Measurement Laboratory), and there is no other laboratory worldwide working on the physics of standards and technology that has had the successes in physics that this laboratory has achieved during the past two decades."
>
> "The Manufacturing Engineering Laboratory has excellent staff and exceptional facilities. Its work is essential in supporting the NIST mission of promoting U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology."
>
> "The Information Technology Laboratory is a well-managed science and engineering facility contributing in important ways to the nation's scientific and technical research and development needs. The ITL supports the NIST mission through its own mission 'to promote U.S. innovation'."
>
> "The Center for Nanoscale Science and Technology [which was founded in May 2007] has two components with complementary purposes—the research program and the NanoFab facility. It is maturing impressively as a state-of- the-art nanoscience and nanotechnology center of excellence aligned with the overall mission of NIST. All of the CNST facilities are among the best in the world, and in many cases they are unique."

After reading these five glowing reports I feel it is incumbent upon me to mention that no expert serving on a National Academies study committee is allowed to receive any remuneration for participating in the assessments.

A few examples of where NIST makes a difference can be gleaned from the 2010 and 2011 assessments.

For instance, for the Information Technology Laboratory, the assessment report states, "The Digital Library of Mathematical Functions is without peer in the broader community, and the

NIST Special Publication 800* series is renowned for providing technically sound, unbiased, relevant guidelines that are frequently adopted voluntarily in private-sector procurements and practices and often mandated by the Office of Management and Budget for use by the federal government."

For the Materials Science and Engineering Laboratory the Hydrogen Storage project is developing the metrologies necessary for the rapid, high-throughput measurement of the hydrogen content of novel materials proposed for hydrogen storage and for electrodes in nickel metal hydride (Ni-MH) batteries, is addressing computationally critical issues related to the nation's deteriorating highway infrastructure in collaboration with the Federal Highway Administration (FHWA), was the first to develop and certify the Bi2Te3 Seebeck coefficient SRM for the calibration of nanomaterials measurement apparatus, and finally was the first to prove the predictions that a soft FM is forced to reverse by rotating its spins when next to a hard FM (the so-called exchange-spring FM, of interest to DARPA).

The Building and Fire Research Laboratory is addressing computationally critical issues related to the nation's deteriorating highway infrastructure, also in collaboration with FHWA, is a global leader in the realm of understanding material flammability, and in 2005 assumed the leadership of the National Earthquake Hazard Reduction Program, NEHRP.

Within the Physics Laboratory (now Physical Measurement Laboratory), which now houses four Nobel Prize winners, the Ionizing Radiation Division has programs of major importance to national security with performance standards for radiation-detection devices used for the detection of nuclear explosives, and the development of national x-ray standards for security-screening systems for the Department of Homeland Security's Domestic Nuclear Detection Office. The NIST Internet Time Service is used more than 3 billion times every day to synchronize commercial timekeeping devices, helping industry meet Securities and Exchange Commission requirements to synchronize the time-stamping of hundreds of billions of dollars of electronic financial transactions. The Electron and Optical Physics Division forms an important resource for the National Aeronautics and Space Administration and the National Oceanic and Atmospheric Administration for many different satellite missions. The Physics Laboratory uses its expertise in single-molecule optical detection to elucidate the folding conformational thermodynamics of single ribonucleic acid (RNA) molecules and single DNA molecules in electrophoresis. This information is crucial to understanding RNA-based enzymes or ribozymes and should make it possible to probe the folding and unfolding of biomolecules in chemically active states.

The Center for Nanoscale Science and Technology NanoFab is providing outstanding service with unparalleled capabilities to a broad range of users. Under research, for instance, the experimental effort in the area of laser manipulation of atoms is superb. It is leading to an entirely new method of producing focused-ion beams through laser trapping of metallic atoms using a magneto-optical trap ion source (MOTIS).

And finally, in the Manufacturing Engineering Laboratory, the Precision Engineering Division provides the foundation for dimensional measurements ranging over 12 orders of magnitude (from kilometers to nanometers), developing traceable standards that are crucial to the current

and future competitiveness of U.S. industry and the military (for instance, the Laboratory provides unique capabilities assisting the U.S. Army in making measurements of local damage on body armor impacted by projectiles to an accuracy of 0.1 mm).

As these recent reviews attest, the Information Technology Laboratory, the Center for Nanoscale Science and Technology, and the Physics Laboratory, as well as the other laboratories and centers, indicate their tremendous strengths. I should note, however, that there has been no assessment of the Physical Measurement Laboratory, the Material Measurement Laboratory, nor the Engineering Laboratory since they were formed in 2010.

After these accolades, I would like now to take a moment to address the issue of whether NIST could be doing something to be more effective in advancing its mission of promoting U.S. innovation and industrial competitiveness to enhance security and quality of life. The only area in which NIST has not, it appears, had a stellar track record is in managing crosscutting programs. The recent review of manufacturing-related programs provided a welcome and promising outcome, and it would be interesting to see whether the expanding biosciences program is also following a sustainable trajectory.

I would like to highlight the unique position of NIST to step forward and serve this great country when there are unusual situations. I am speaking now most vividly of the events of September 11, 2001. NIST was directed by Congress to do a thorough, complete, technically-based, unbiased investigation into the World Trade Center Disaster. Their two-volume CD, issued in September, 2005, is the excellent, unquestioningly authoritative, detailed account of exactly what happened to the buildings that day. I might add that this is a subject of which I know quite a bit, since my 40-year career has been in the field of structural safety and reliability, and I have chaired the Executive Committee of the International Conference on Structural Safety and Reliability, the American Society of Civil Engineers Committees on the Safety of Buildings and on Probabilistic Methods in Mechanics, the American Concrete Institute's Committee on Structural Safety, and the Live Load Committee for the Minimum Design Loads for Buildings and Other Structures Standard. NIST's role in the investigation of the 9-11 building collapses, and the establishment by Congress in 2002 for NIST to serve as the home for the National Construction Safety Team Act are indicative of the vital and essential role NIST fills for our country.

Finally, my recommendations to the Committee on Science, Space, and Technology, as a representative of the National Research Council's Committee on NIST Technical Programs, is to reauthorize NIST, and to encourage NIST to avail itself of the continued benefits of the NRC assessments, including (1) performing cross-cutting reviews as well as laboratory reviews; (2) reinstating the practice of examining findings from individual laboratory and crosscutting reviews to create a report summarizing overall institution findings common across the individual reviews; and (3) reestablishing and maintaining a formal, regular interaction between the NRC and the VCAT teams.

Again, I very much appreciate the opportunity to share with you today the findings of The National Academies assessments of NIST. I would be happy take the Subcommittee's questions.

Ross B. Corotis, NAE

Denver Business Challenge Professor
Department of Civil, Environmental & Architectural Engineering
University of Colorado, Boulder, Colorado 80309-0428

Dr. Corotis received both his undergraduate and graduate education at The Massachusetts Institute of Technology, where he was an NSF Graduate Fellow. His degrees are in civil engineering, with an undergraduate minor-equivalent in economics and a doctoral concentration in structural mechanics.

He was on the faculty at Northwestern University for eleven years and then moved to Johns Hopkins to establish the Department of Civil Engineering. In 1994 he became the Dean of the College of Engineering and Applied Science at the University of Colorado at Boulder, and in 2001 returned to the Department of Civil, Environmental & Architectural Engineering as the Denver Business Challenge Professor of Engineering. With a background in structural mechanics and stochastic vibrations, Dr. Corotis' primary research interests are in the application of probabilistic concepts to civil engineering problems, where he has expanded traditional studies of structural reliability into risk and decision modeling for the built environment.

Dr. Corotis has chaired the ASCE Structural Division Committees on the Safety of Buildings and the Technical Administrative Committee on Structural Safety and Reliability, the Engineering Mechanics Division Committee on Probabilistic Methods, the ACI Committee on Structural Safety, and the Subcommittee on Live Loads of the ASCE Minimum Design Loads Standards Committee. He was a member of the CIB Commission on Actions on Structures, the IFIP Committee on Reliability and Optimization of Structures, the Executive Committee of the International Association for Structural Safety and Reliability, the steering committee of the National Research Council's Natural Disasters Roundtable, and past Editor of the journal *Structural Safety* and the ASCE *Journal of Engineering Mechanics*.

He was awarded the ASCE Walter L. Huber Civil Engineering Research Prize in 1984, named Civil Engineer of the Year by the ASCE Maryland Section in 1986, Engineer of the Year by the Baltimore Engineers' Week Council in 1989, Outstanding Engineering Educator by the ASCE Maryland Section in 1992, and is past President of the ASCE Maryland Section. He was named an honorary Distinguished Engineering Alumnus of the University of Colorado at Boulder in 2000, elected to the National Academy of Engineering in 2002, and in 2006 won the Boulder campus teaching award. In 2005 he won the Senior Research Prize of the International Association of Structural Safety and Reliability. He is the chair of the NRC's Committee on NIST Technical Programs, and a member of the NRC Laboratory Assessment Board and the Board on Infrastructure and the Constructed Environment. He is the author of more than 200 publications.

Dr. Corotis is a member of Sigma Xi, Tau Beta Pi, and Chi Epsilon and is both a registered professional engineer (Colorado, Maryland, and Illinois) and structural engineer (Illinois).