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REPORT IN BRIEF

An Assessment of the National Institute of Standards and Technology

Center for Nanoscale Science and Technology, Center for Neutron Research and Information Technology Laboratory: Fiscal Year 2011

Laboratory Assessments Board · Division on Engineering & Physical Sciences · September 2011

Since 1959, the National Research Council (NRC), at the request of the National Institute of Standards and Technology (NIST), has annually assembled panels of experts to assess the quality and effectiveness of the NIST measurements and standards laboratories. In 2011, the NRC evaluated three of the six NIST laboratories: the Center for Nanoscale Science and Technology (CNST), the NIST Center for Neutron Research (NCNR) and the Information Technology Laboratory (ITL). Each of these was addressed individually by a separate panel of experts; the findings of the respective panels are detailed in three separate reports. The following report summaries highlight some of these findings and recommendations.

Center for Nanoscale Science and Technology

The CNST has two components with complementary purposes of the research program, composed of three groups (Electron Physics, Nanofabrication Research and Energy Research), and the NanoFab facility. Individuals from beyond NIST and elsewhere at NIST can interact with the CNST through collaborations with the scientific research staff in the research program and through use of the NanoFab to fabricate structures or devices.

The CNST has matured significantly over the past 2 years since the previous NRC review, and has achieved nearly steady state in terms of staffing and projects. The center's research program consists of leading nanoscale research that may provide the basis for future nanoscale measurement and characterization techniques. The CNST supports researchers from industry, academia, NIST and other government agencies. The number of users as reported to the panel is impressively high, and the increasing use by industry users appears consistent with the NIST/CNST mission. Even greater use should be possible with enhanced communication about the CNST capabilities relative to those available elsewhere.

The staff, projects, and facilities of many of the CNST programs are outstanding and in several instances unique. Much of the research is original, innovative, scientifically outstanding, and among the best of its kind. Almost all of the projects are clearly focused on the stated mission of NIST as they seek to develop understanding that will lead to standards and precision measurement at the nanoscale. A fair amount of the research is directed toward developing unique instrumentation.

Summary of Recommendations

The CNST should:

- Further diversify the user base for the NanoFab facility. The capabilities are so outstanding that they would be in greater demand if more potential users knew about them.
- Continue to increase the CNST focus on industry as its key customer. Specific focus should be on the industrial segment that requires state-of-the-art nanofabrication capability and access to outstanding scientific staff.

- Actively manage the balance between high-quality science and service. The first can lead to the second, but only if time is allowed for the sufficient maturation of the research. The current balance is appropriate but needs to be monitored very closely if it is to be preserved.
- Continue the effort to mature the focus and stature of the newer research groups, especially the Energy Research Group. This effort would include more strategic planning and the identification of research issues of central importance to the energy landscape in the U.S.
- Consider enhancing the professional development of postdoctoral staff by offering opportunities (possibly through partner institutions such as universities) to learn skills needed for non-academic careers—for example, in entrepreneurship.

NIST Center for Neutron Research

The NCNR is a national user facility with a mission to ensure the availability of neutron-measurement capabilities to meet the needs of U.S. researchers from industry, academic institutions and other government agencies. The NCNR provides a high flux of neutrons to an evolving suite of high-quality instruments and sample environments. The current array of thermal- and cold-neutron instruments at the NCNR enables measurements over a wide range of timescales, energy scales, and length scales.

Over the next few years, the cold-neutron capabilities at the NCNR will be increased by more than 25 percent through the center's Expansion Project. The enhancements include the recent completion of a new building for technical services and administration, expansion of the guide hall, the installation of a new cold source and the acquisition of new instruments, as well as improvements to some existing instruments. The new instruments and upgrades will ensure that the NCNR continues to provide users with access to internationally competitive instruments.

Some Key Findings

- A signature feature of the NCNR is a culture and environment that promotes respect for science, user education and training, and internal leadership development.
- The NCNR has been and continues to be a leading facility in cold-neutron research. The Expansion Project will significantly improve the capabilities of the facility. Continued support to upgrade instruments and develop the next generation of state-of-the-art instruments should enable the NCNR to remain among the best user facilities for neutron research in the world.
- The NCNR is a safe, secure, and reliable facility serving the needs of a robust neutron-scattering community through an open-call, merit-based proposal process.
- The NCNR has best-in-class instruments and capabilities in the area of soft condensed matter. A focus area in neutron-scattering measurements of membrane proteins has been significantly enhanced over previous years through collaborative partnerships involving the NCNR and other NIST laboratories and external collaborators.

Some Recommendations

- The NCNR management should continue to take care that the next generation of senior researchers continues to develop and remain excited about their research and that they are not overly burdened with administrative and other duties that are not characterized as research.
- Collaborative efforts with the NIST Material Measurement Laboratory and the Physical Measurement Laboratory should be maintained to aid the NCNR in extending its leadership in cold-neutron research. Future partnerships with the NIST Center for Nanoscale Science and Technology should be explored to strengthen the capabilities and impact of the NCNR.
- Care should be taken to ensure that the proposal review process continues to work effectively as the NCNR facility expands.

With the Expansion Project well underway, the panel has provided instances of retrospective review of the NCNR in order to provide a benchmark for comparison as the facility goes through a major upgrade.

Information Technology Laboratory

In support of its mission and strategic goals, the ITL has formed a very strong scientific and technical team with core competencies in technology development in information technology measurement and testing, mathematical and statistical analyses for measurement science, modeling and simulation for measurement science, and information technology standards development and deployment. The ITL focuses its research and development agenda on eight broad program areas: complex systems; cyber and network security; the enabling of scientific discovery; identity management systems; information discovery, use and sharing; pervasive information technologies; trustworthy information systems; and virtual measurement systems. The ITL now has a number of programs in these broad areas.

Summary of Some Observations

- ITL programs are focused on research and development that advance measurement science, standards and technology.
- The technical merits and scientific caliber of the current ITL programs are very high relative to comparable programs worldwide as measured by publications and especially by outstanding products.
- The Software and Systems Division (SSD) has made great strides in addressing concerns raised in the 2009 NRC report.
- The ITL has struggled with how crosscutting programs—those that involve work in a collaborative fashion across divisions—would be managed, since they do not fit neatly into the divisional structure.
- The Statistical Engineering Division (SED) is continuing on an even keel with strong leadership and technical expertise. However, as observed in the 2009 report, the division workload is growing but the division is not.
- The Computer Security Division (CSD) is also understaffed, although neither performance nor morale has as yet been affected.
- The Advanced Network Technologies Division (ANTD) is doing an excellent job in responding to several national priorities in both the short and long term, including its continued outstanding activities in Internet infrastructure protection and its newer efforts in smart grids and public safety communications.

Summary of Some Recommendations

- If the ITL is to maintain its prominence of the SED and CSD, it should consider plans to address the growth that will be needed to support the expanding workload of each of these divisions (the SED more that the CSD).
- The ITL should acquire a permanent chief of the ANTD.
- The ITL should devote attention to strategic, long-term technical needs in cloud computing that NIST may be called on to address in the future—including questions surrounding the scale of cloud computing and how such a scale could be accommodated in a laboratory or simulation environment.

Panel on Neutron Research: Tonya L. Kuhl, University of California, Davis, Chair; **Meigan Aronson,** Stony Brook University and Brookhaven National Laboratory; **Frank S. Bates,** University of Minnesota, Minneapolis; **Donald M. Engelman,** Yale University; **Paul A. Fleury,** Yale University; **Christopher R. Gould,** North Carolina State University; **Peter F. Green,** University of Michigan; **Alan J. Hurd,** Los Alamos National Laboratory; **James R. Lee,** Sandia National Laboratories; **John B. Parise,** Stony Brook University and Brookhaven National Laboratory; **Sunil K. Sinha,** University of California, San Diego.

Panel on Nanoscale Science and Technology: Julia M. Phillips, Sandia National Laboratories, Co-Chair; **Harold G. Craighead,** Cornell University, Co-Chair; **Ilesanmi Adesida,** University of Illinois, Urbana-Champaign; **Stephen Y. Chou,** Princeton University; **Robert E. Fontana, Jr.,** International Business Machines Corporation; **Daniel J.C. Herr,** Semiconductor Research Corporation; **Kanti Jain,** University of Illinois, Urbana-Champaign; **Max G. Lagally,** University of Wisconsin-Madison; **Amanda Petford-Long,** Argonne National Laboratory; **Henry I. Smith,** Massachusetts Institute of Technology; **John T. Yates, Jr.,** University of Virginia.

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