FY 2005 Annual Report

The NIST Visiting Committee on Advanced Technology

U.S. Department of Commerce
Technology Administration
National Institute of
Standards and Technology

Report prepared by:
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Preface

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. The VCAT reviews and makes recommendations regarding general policy for NIST, its organization, its budget, and its programs within the framework of applicable national policies as set forth by the President and the Congress. It submits an annual report to the Secretary of Commerce for submission to the Congress. This fiscal year 2005 annual report covers the December 2004 meeting through the September 2005 meeting.

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 to the U.S. science and technology base and the economy. Over the past year, the Committee has been active in assessing NIST's progress in implementing its strategic plan, reviewing its strategic operational needs and sharing best practices for organizational development in response to external drivers, providing guidance on the U.S. Measurement System effort, and serving as a key interface to stakeholders. Throughout the year, the Committee seeks to cover a significant portion of NIST's program portfolio through direct discussion with NIST leaders, scientists, and engineers. Reactions and observations are discussed candidly with the NIST representatives and other guests involved at each meeting. This feedback is positively received, and the Committee sees much evidence of constructive response to it. At each quarterly meeting, the Committee also visits various NIST laboratories and discusses the research projects directly with the scientific and technical staff. These laboratory tours help the Committee assess NIST's progress towards executing its Strategic Plan.

Members of the Committee are selected from industry and academia solely on the basis of established records of distinguished service and are eminent in research, engineering, business, or other fields relevant to NIST's mission. Appointed by the NIST Director for staggered three-year terms, the members have diverse backgrounds and provide a representative cross-section of traditional and emerging U.S. industries. Three new members joined the Committee during 2005: Dr. John F. Cassidy, Dr. E. David Spong, and Mr. W. Wyatt Starnes. This report highlights the Committee's findings and recommendations along with a summary of observations. Detailed meeting minutes and presentation materials are available on the NIST web site at www.nist.gov/director/vcat.

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Principal Findings and Recommendations

The VCAT sincerely welcomes Dr. William Jeffrey as the 13th Director of NIST. Although Dr. Jeffrey has only been in this position for a few months, his focus on a new vision for NIST and the strategies to fulfill this vision are commendable. The Committee agrees with these priorities and supports Dr. Jeffrey's commitment to identify strategic opportunities that will help NIST establish investment strategies for responding to the nation's measurement and standards needs. Dr. Jeffrey's decisiveness is admirable and his understanding of the government and perception of NIST is impressive. The Committee applauds Dr. Hratch Semerjian for his outstanding leadership of NIST as the Acting Director from November 2004 through July 2005 and greatly appreciates his strong support of the VCAT.

With a high quality portfolio of programs, NIST is uniquely positioned to promote U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology to enhance economic security and improve the quality of life for all Americans. These programs consist of the NIST Laboratories, the Advanced Technology Program, the Hollings Manufacturing Extension Partnership, and the Baldrige National Quality Program, with each playing a distinctive role in the nation's technology infrastructure. The Committee continues to strongly believe that NIST's measurement science, standards, and technology provide the nation's underlying scientific and technical infrastructure that supports industry, universities, and other government agencies. Furthermore, as markets become more global, it is even more critical that NIST maintains a leadership role in promoting more open and fair international trade practices.

While operating under a tight budget environment, NIST has made significant contributions to many of the President's R&D priorities, including homeland security and nanotechnology, and has responded rapidly to a growing number of congressionally-mandated programs and presidential directives. For example, NIST has been playing a key role in response to the Help America Vote Act (HAVA) of 2002 by providing leadership and technical support for the development of voluntary voting system guidelines. Most recently, NIST has helped the nation respond to post-Hurricane Katrina rebuilding and improvement efforts. NIST's budget must continue to grow to provide the innovation infrastructure needed to respond to the measurement and standards challenges related to the current and next generation of technology.

NIST has been receptive to the Committee's guidance on strategic planning, including the need for more strategic partnerships and collaborations to leverage NIST's world-class technical expertise and highly specialized equipment and facilities. The VCAT also continues to advise NIST on strengthening its outreach activities for increasing the Institute's visibility.

The Committee is pleased to have had the opportunity during FY 2005 to meet separately with Deputy Secretary of Commerce David Sampson; Dr. John Marburger, Director, Office of Science and Technology Policy (OSTP); and Ms Andrea Petro, a Program Examiner in the Office of Management and Budget (OMB). The members of the VCAT were encouraged to learn of their strong support for technological innovation and their recognition of the importance of measurements and standards on international trade and the nation's economy. They also shared the Committee's concern that NIST lacked visibility and Dr. Marburger urged the VCAT to continue to advise NIST stakeholders on the value of NIST's programs. In addition, Deputy Secretary Sampson and Dr. Marburger emphasized the need for NIST to engage in more partnerships and collaborations to leverage its resources. The meeting with Ms. Petro provided an excellent opportunity for a discussion on the role of the VCAT, the importance of strategic evaluation and performance evaluation, and NIST's progress in these areas. The VCAT appreciated each of these meetings that highlighted NIST's significant contributions to the nation. These meetings helped the VCAT better understand the roles of the various organizations with respect to NIST and ways in which the members of the VCAT can better help NIST in the future.

STRATEGIC DIRECTION AND PERFORMANCE

Findings** — **NIST is aggressively undertaking new strategic planning activities to help ensure that programs and investment strategies are better aligned with NIST's mission and national priorities. For example, the VCAT commends NIST for its rapid responsiveness in redirecting its measurement and standards research to homeland security needs, one of our nation's highest priorities.

Recommendations:

- NIST has made a significant effort to refine its mission statement this year and it is now clear, concise, and appropriate. The staff should now make the effort to assure that its programs are aligned with this mission. This is critical for identifying the Institute's core competencies, developing program priorities, and establishing investment strategies that leverage NIST's unique expertise and facilities and help guide strategic partnerships and outreach activities.

- While NIST has made significant progress in its Homeland Security Strategic Focus Area by providing valuable contributions to this national priority, NIST should continue to develop more strategic approaches and performance metrics in its other focus areas related to nanotechnology, biosystems and health, and, in particular, information and knowledge management. In each of these rapidly growing areas, NIST has a significant opportunity to increase its measurement and standards expertise, in concert with industry, to help the U.S. build and maintain a more innovative and competitive market posture.

- To help evaluate progress in implementing the NIST Strategic Plan, NIST should continue to focus on the development and reporting of specific short-term and long-term metrics and other quantitative data, consistent with the Baldrige framework, which specifically address each of the Strategic Focus Areas and Strategic Working Groups. We commend NIST for restructuring the FY 2005 Balanced Scorecard used to define and evaluate NIST-wide performance goals and metrics throughout all levels of the Institute and look forward to reviewing the FY 2006 Balanced Scorecard.

- As NIST becomes more visible and the number of potential partnerships increases, the VCAT encourages NIST to finalize its partnership strategies, including a set of selection criteria based on the nation's priorities and NIST's existing and emerging core competencies. In addition, each partnership should include a clear commitment of resources, such as dollars, facilities, or people, from all parties.

- In recognition of the huge and ambitious effort required by NIST to lead the critically needed U.S. Measurement System (USMS) road mapping effort, the VCAT strongly urges the Institute to better define the scope of this effort, identify NIST's role in the USMS, and link this analysis to the Institute's vision and the next version of the Strategic Plan. The USMS effort should focus on emerging competitive areas rather than well-established areas that are no longer in need of NIST support.

OUTREACH

Findings** — **NIST's new and expanded outreach activities reflect senior management's commitment to raise the visibility of NIST by more clearly demonstrating the value and impact of its programs to key customers and stakeholders.

Recommendations:

- NIST should continue its efforts to refine the NIST message and provide examples of program impacts by industry segments that demonstrate the value of NIST to key customers and stakeholders. This outreach should focus on influential industry executives and other influential individuals in new and emerging NIST contribution areas.

- Program impacts should highlight how the capabilities of the world-class Advanced Measurement Laboratory (AML) have helped to increase NIST's contributions to the nation's standards and measurement infrastructure.

The AML is already contributing strongly to the emerging nanotechnology industry. NIST should identify other opportunities to leverage this national resource.

ORGANIZATIONAL EXCELLENCE

Findings — NIST's world-class talent, continued pursuit of organizational excellence, highly specialized facilities and equipment, and technical merit have resulted in significant achievements and numerous awards, including three Nobel Prizes. These attributes continue to support NIST's world leadership capability in providing the nation with the technical infrastructure needed for economic growth and homeland security.

Recommendations:

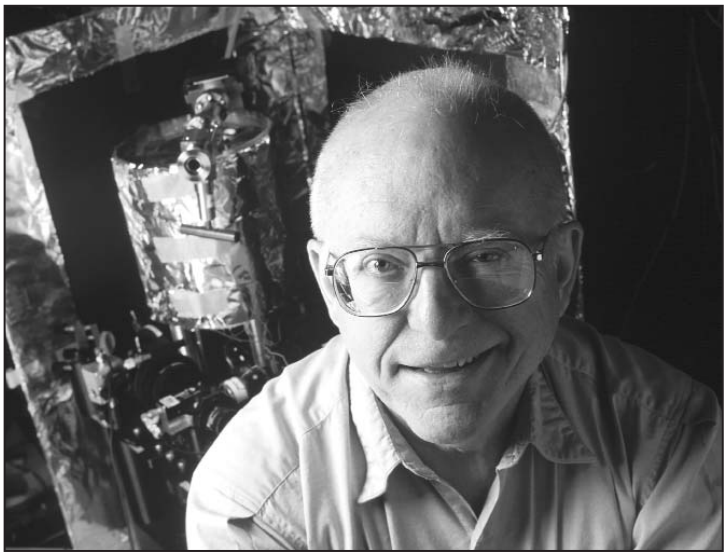
- The dramatic emergence of biomedical technology has created a unique opportunity and challenge for NIST. Continued U.S. leadership of this important field could be in jeopardy without the contributions of NIST in measurement technology and standards. This will require many new skills and changing priorities for NIST investment.

- The Committee recognizes the need to overcome the serious deficiencies associated with NIST's aging facilities in Gaithersburg and Boulder; however, due to budget constraints, the VCAT encourages NIST to develop new business cases to help justify and prioritize the needed renovations and repairs that tie to its Strategic Plan. This analysis should cover all of NIST's facilities, including the Advanced Chemical Sciences Laboratory and the newly constructed AML.

- While NIST senior managers are to be commended for developing and beginning to implement an action plan that addresses operational and management issues raised in the latest Employee Survey, specific metrics should be developed to measure the success of these important efforts, as outlined in the Baldrige process.

BUDGET

Findings — The substantial FY 2005 budget increase for NIST and the Administration's proposed FY 2006 budget request for NIST are encouraging. However, NIST's rapid response to a growing number of unfunded congressionally-mandated programs and presidential directives continue to threaten the Institute's capability to invest in core competencies related to the current and next generation of technology.



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Nobel laureate John L. (Jan) Hall, a scientist emeritus in NIST and a fellow of JILA, is a co-winner of the 2005 Nobel Prize in Physics. He received this award for his "contributions to the development of laser-based precision spectroscopy, including the optical frequency comb technique." JILA is a joint research institution of NIST and the University of Colorado in Boulder.

Recommendations:

- With the expectation of continuing tight government budgets, NIST must invest its resources in areas of high national needs where the Institute can have a significant impact on the growth opportunities for U.S. industry. This will likely involve the redeployment of existing resources to new and higher value-added contribution areas.

- The continuing debate between the Administration and Congress over funding for the Advanced Technology Program (ATP) and the Hollings Manufacturing Extension Partnership (MEP) versus funding for the NIST laboratories must be resolved. Once these funding issues are resolved, NIST should be able to conduct long-range strategic planning activities more effectively.

Summary of Observations

STRATEGIC DIRECTION AND PERFORMANCE

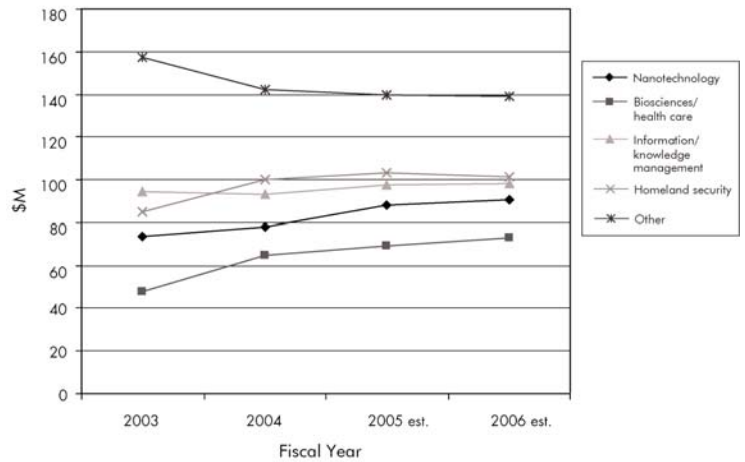
NIST leadership is aggressively undertaking new strategic planning activities to help ensure that programs and investment strategies continue to be aligned with NIST's mission and national priorities. The VCAT is pleased to learn that strategic planning will continue to be a key focus area for the new NIST Director.

Opportunities for Change

During the first quarter of FY 2005, NIST identified the needs and opportunities that will enable the Institute to continue to align its program portfolio more effectively with external drivers. These needs and opportunities were based on the annual review of operational plans, a trend analysis of NIST's strategic portfolio investments, and input to the NIST Senior Management Board (SMB) fall strategy retreat.

The NIST Strategic Plan provides a framework for the annual operational plans for each of the operating units (OUs). The third annual Director's review of the operational plans was held in October 2004 to ensure programmatic coordination and NIST-wide implementation of the Institute's long-range goals. Based on the data extracted from these reviews, NIST performed a trend analysis of its strategic portfolio investments from FY 2003-FY 2006 as shown in Figure 1 and Table 1. NIST concluded that there are opportunities for better alignment of NIST's program portfolio with external drivers, other agency-drivers have a large effect on portfolio changes, and that the investment in core metrology and measurements and standards has decreased.

Figure 1. Strategic Portfolio, FY03-FY06



Source: NIST Acting Director presentation to the VCAT, December 7, 2004

In November 2004, the SMB held a fall retreat to gather information about NIST's strategic environment and to synthesize the Institute's response plans. The strategic environment session included briefings on the post-election policy implications for NIST, the National Measurement System, and NIST's Strategic Working Groups (SWGs). This retreat provided the first forum for three SWGs to report in detail to the SMB on external trends and opportunities in homeland security, biosystems and health, and nanotechnology. Based on these briefings, NIST recognized that despite the budget climate, there are many programmatic growth opportunities for NIST in the Strategic Focus Areas and elsewhere. Furthermore, this input highlighted the need for NIST to be more responsive to customer and market needs by developing more effective NIST-wide interdisciplinary program management, greater sensitivity to managing risks, and more comprehensive marketing efforts. The SWG chairs provided abbreviated versions of these presentations to the VCAT, as well.

VCAT Panel on Best Practices for Organizational Development

The VCAT fully supported NIST in pursuing the needs and opportunities for change as soon as possible to best leverage the Institute's funding in 2005 and subsequent years. To help NIST successfully implement these changes that require special management attention, several Committee members participated in a panel

Table 1. Portfolio Changes: FY03-FY06 est.

Program	Total (STRS+OA)	OA
Nano	+23 %	+40 %
Bio	+52 %	+62 %
I/KM	+4 %	-9 %
HS	+20 %	+29 %
Other	-13 %	+20 %

Source: NIST Acting Director presentation to the VCAT, December 7, 2004

presentation and discussion during the June 2005 VCAT meeting to share industry's best practices for developing organizations that facilitate alignment of programs with external drivers. The topics covered portfolio-level investment decision-making processes, empowerment of managers to respond rapidly to new opportunities, and creation of more flexible staffing. To respond to new growth areas in a resource-constrained environment, the panel members emphasized the importance of a careful evaluation and prioritization of an organization's customers based on the changing scientific and technical needs of the nation.

Sharpening the NIST Mission and Core Competency Review

The new NIST Director is committed to maintaining strategic planning as a high priority for NIST. As a first step, Dr. Jeffrey has been focusing on sharpening the NIST mission and goals with specific implementation strategies to promote innovation and competitiveness. Within this framework, NIST is in the process of identifying its top-level core competencies to help establish NIST's priorities and investment strategies that tie to the NIST mission and respond to national priorities. NIST core competencies will fall under the categories of measurement science, standards development and deployment, and technology development and deployment. These core competencies also will help guide NIST's strategic partnerships as well as outreach activities. The VCAT commends Dr. Jeffrey for his sense of urgency in examining the NIST mission more closely and identifying the Institute's core competencies.

Implementation of Strategic Plan

NIST is continuing to implement the Strategic Plan through the use of budget initiatives, competence funding, Strategic Working Groups (SWGs), Operating Unit (OU) operational plans, and strategic partnerships. These mechanisms will help the Institute build on existing core competencies and expand capacity in its strategic areas.

***Budget Initiatives* —** NIST is continuing to develop programmatic budget initiatives in strategic areas. In FY 2005, NIST received modest increases of $3 million for advances in manufacturing in support of nanomanufacturing research and nanoelectronics, and $6 million for advances in measurement science, standards, and services in support of competence and quantum information services. A significant increase of $18 million was appropriated to NIST for measurements and standards for public safety and security, including $2 million in support of advanced fire fighting technologies; $2 million in support of biometric identification standards related to the USA PATRIOT Act; $10 million in support of cybersecurity activities; and $4 million for the Office of Law Enforcement Standards to fund the highest priority homeland security research projects. Congress also provided an additional $500 thousand in support of NIST's activities related to the Help America Vote Act. No additional funding was provided for NIST's budget initiatives related to biosystems and health.

The Committee is encouraged by the President's FY 2006 budget request that includes significant increases in strategic initiatives for NIST, including $19.6 million for advances in manufacturing; $3 million for measurements and standards for homeland security; and $17.2 million for new measurement horizons for the U.S. economy and

science. A breakdown of the major programs within these initiatives is shown in Table 2.

Table 2. STRS Initiatives in FY 2006 President's Budget Request ($K)

Advances in Manufacturing	**[19,600]**
National Nanomanufacturing and Nanometrology Facility	10,000
Nanomanufacturing Research	4,000
Measurements and Standards for International Trade	4,000
Manufacturing Enterprise Integration	1,600
Measurements and Standards for Homeland Security	**[3,000]**
Standards, Technology, and Practices for Buildings & First Responders	2,000
Standards for Biometric Identification	1,000
New Measurement Horizons for the U.S. Economy and Science	**[17,195]**
Building Competence for Advanced Measurements Program	4,000
Biosystems and Health	7,195
Interoperability and Security for Complex Scientific Systems	2,000
Quantum Computing	4,000
STRS Initiative Total	**$39,795**

Source: NIST Acting Director presentation to the VCAT, March 15, 2005

Competence Funding — The NIST-wide competence fund is continuing to support high priority, fundamental research within NIST. In FY 2005, $1.9 million was used to provide "seed" funding for a new set of five-year competence projects. In addition, the $2.8 million[1] available from the FY 2005 funded competence initiative was used to support short-term awards for competence projects in measurement services and for a one-time "exploration" competition. These one-time "exploration" projects are intended to lead to new measurement science and new technology in such areas as metrology for the development of organic radio frequency identification (RFID), nanoscale detectors for quantifying electromagnetic fields, and thermodynamic temperature ratio measurements in support of next generation temperature scales.

Figure 2. Developing New Measurement Science Competencies

FY 2006 Competence Projects

- Quantum Optical Metrology with N-Photons
- Intrinsic Force Standards based on Atomic and Molecular Interactions
- Fundamental Metrology for Carbon Nanotube Science and Technology
- Metrology for the "Fate" of Nanoparticles in Biosystems
- Vision Science as a Basis for Optical Metrology
- An Alternative Approach to Mass Metrology

Source: NIST Director presentation to the VCAT, September 13, 2005

For FY 2006, six new five-year competence projects totaling $5.1 million per year have been selected that will focus on strengthening NIST's core strength in measurement science as shown in Figure 2. For future years, NIST plans to request development of proposals based on a gap analysis of the Institute's core competencies.

Strategic Working Groups — Beginning in 2003, NIST established three SWGs as an important mechanism in helping NIST-wide planning activities in strategic areas: Homeland Security, Biosystems and Health, and Nanotechnology. These SWGs are now fully operational and are beginning to make progress. Comprised of multi-disciplinary technical staff from NIST, the SWGs have been assessing external trends in strategic areas, coordinating activities with other agencies and organizations, and providing valuable input to the Director and the SMB. These SWGs have been developing sequentially with different priorities related to their program areas. Each SWG has completed inventories of current NIST's research projects in their respective areas to allow informed strategic planning. The VCAT is pleased to learn that NIST is addressing some of the SWGs operational issues that were shared at the SMB fall strategy retreat held in early FY 2005. Recently, the NIST Director requested the SWGs to explore and recommend options for investment strategies in their respective areas. A fourth SWG for Information and Knowledge Management is still in the planning stages and a fifth SWG for Manufacturing may be established. Setting priorities across Strategic Focus Areas is currently carried out within the OU with cross-OU collaboration enhanced by the SWGs. In the future, the priority-setting process will change as the OUs

[1] $2.8 million in new competence funding reflects the post-rescission and other adjustments to base.

strategically focus on NIST's critical areas and make decisions based on funding, facilities, and competencies.

- *Homeland Security* - Established as the first SWG in 2003, the Homeland Security SWG has significantly helped to coordinate NIST activities with national priorities, resulting in NIST's rapid response to homeland security needs in a wide range of areas as described below. Based on an extensive inventory of NIST's current and proposed homeland security projects and competencies, an understanding of the customers' technology needs, and recognition of NIST business practices, the Homeland Security SWG developed a strategic vision and mission for NIST's involvement in Homeland Security as shown in Figure 3. Their analysis of customer needs included interactions with key stakeholders and a massive literature search on homeland security documents, such as those published by the Administration, the Department of Homeland Security (DHS), and the Department of Justice. For example, the *National Strategy for Homeland Security* published by the Office of Homeland Security in 2002 identified several science and technology initiatives. This document is still guiding our nation's activities and NIST's expertise is needed in many of these areas.

Every NIST laboratory is now involved in homeland security activities with a total STRS investment of $68 million in FY 2005. As recommended by the VCAT, the Homeland Security SWG developed seven performance metrics to assess NIST's success in meeting the nation's priorities in homeland security as shown in Figure 4.

Figure 3. Strategic Vision for NIST's Involvement in Homeland Security

Vision: "NIST will be the Nation's key source for standards, measurements, test and evaluation methods, and data needed to satisfy evolving requirements for public safety and Homeland Security technologies.

In meeting this responsibility, NIST will be flexible and responsive while maintaining its scientific excellence, autonomy and integrity, and its accountability to other stakeholders."

Source: NIST Director presentation to the VCAT, September 13, 2005

Figure 4. Performance Metrics Homeland Security at NIST

- Changes in U.S. operational systems
- Influence on U.S. industry product/system development
- Impact of NIST planning on DHS/Congress/White House
- New standards developed and adopted/other impacts on U.S. standards community
- New measurement technologies developed
- Support for other agencies
- NIST staff detailed to influential positions at DHS

Source: Dr. James Hill presentation to the VCAT, September 13, 2005

Photo credit: NIST

NIST electrical engineers Chris Holloway and Galen Koepke place transmitters in a protected air vent at the old Washington Convention Center prior to the implosion of the building on December 18, 2004. This experiment is aimed at improving emergency radio communications for first responders.

The SWG then applied these metrics to NIST's activities demonstrating the Institute's outstanding progress and significant contributions to homeland security. NIST's accomplishments include the development of measurements and standards in such areas as biological agents; radiation dosimetry; nuclear, radiological, and explosive materials; emergency response equipment; biometrics; cryptology; critical infrastructure protection; and personal protection equipment. Furthermore, NIST plays a major role in responding to three homeland security presidential directives for standards for the nation's critical infrastructure, screening procedures, and personal identity of federal employees and contractors. In fact, OSTP cited NIST's major homeland security accomplishments in its April 2005 publication, *Science and Technology: A Foundation for Homeland Security*, as shown in Figure 5. In addition, NIST is a key component of the DHS standards portfolio. NIST staff members also serve in leadership positions in standards organizations with an interest in homeland security. For example, Mary Saunders is co-chair of the American Standards Institute (ANSI's) Homeland Security Standards Panel and Kathleen Higgins is chair of the ASTM Committee E-54 on Homeland Security Applications. The VCAT is impressed with NIST's extensive involvement in national homeland security planning and policy activities, including membership on several NSTC subcommittees.

Figure 5. NIST Accomplishments
Science and Technology
A Foundation for Homeland Security
April 2005

- Key player of and requirements for SAFECOM
- Development of biometric identifiers for US-VISIT
- Development of four radiation detection standards for common radiation detectors
- Completion of WTC Towers Investigation with recommendations for changes to building and fire codes, standards, and practices
- Leadership of interagency Internet Engineering Task Force to advance standards and specifications related to internet security and completion of 40 cyber security standards and guidance documents.

Source: Dr. James Hill presentation to the VCAT, September 13, 2005

For the future, NIST will continue to review roadmaps and other external documents to identify the Institute's unique competencies that are still needed to impact the nation's homeland security needs. The Committee applauds the Homeland Security SWG for its efforts in providing productive working relationships with stakeholders, a NIST-wide perspective in homeland security, guidance and advice, and a NIST "face" in homeland security.

- *Biosystems and Health* - Formed in early 2004, the Biosystems and Health SWG has been focusing on assessing external trends and strategic opportunities for NIST with input from across NIST and from stakeholders in industry and other government agencies. One of the goals was to identify and analyze projects of mutual interest across the NIST OUs. The Biosystems and Health SWG used several

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NIST researcher Tammy Oreskovic deposits smooth muscle cells onto a polymer scaffold. Oreskovic and colleagues study what conditions produce the best cell growth and use a bioreactor (foreground) to test whether the resulting engineered tissues can withstand mechanical stresses similar to those produced by a beating heart.

analysis tools to help guide their decisions including the criteria from Michael E. Porter's 1980 publication, *Competitive Strategy: Techniques for Analyzing Industries and Competitors*. Based on their assessments, the SWG is developing strategy papers that outline the need for NIST's growth in nanobiosensing, bioimaging, and systems biology. For example, in the area of biosensing, the National Cancer Institute and the Food and Drug Administration are seeking NIST's expertise for developing imaging standards for lung cancer tumors. This is one of several NIST's interactions with the Department of Health and Human Services (HHS). As recommended by stakeholders, a USMS workshop will be held on bioimaging to further explore the measurement and standards needs and the importance of NIST in this area. Members of this SWG also have been assigned as representatives to other USMS workshops efforts to keep track of other USMS activities in biosystems and health. The VCAT is pleased to learn that the Biosystems and Health SWG is planning to develop milestones and metrics of success for bioimaging and nanobiosensing by mid-December 2005.

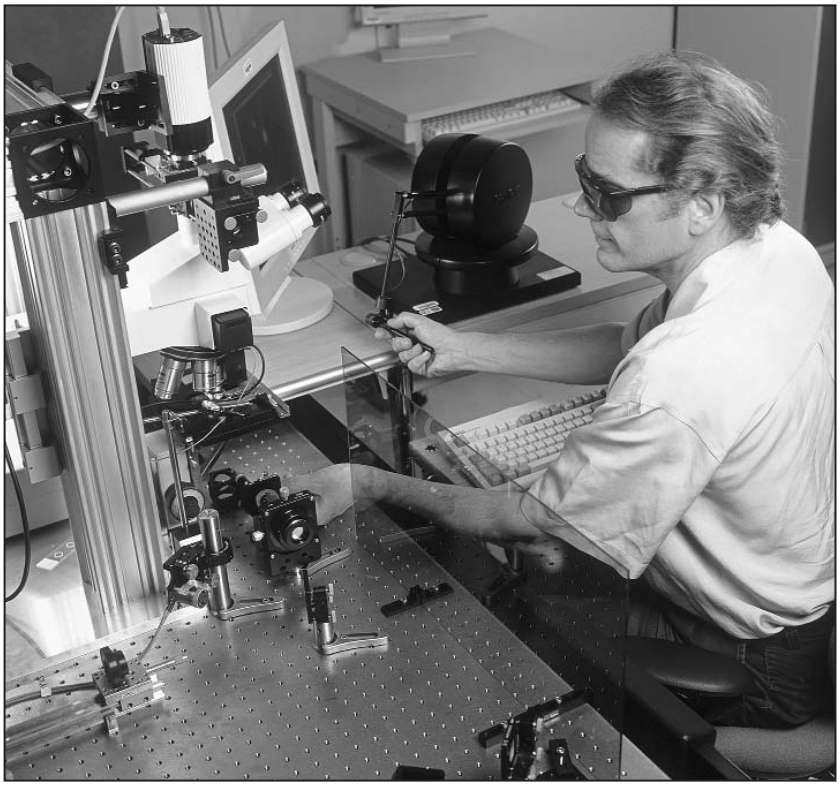

Photo credit: NIST

Physicist Thomas LeBrun uses a special joystick to manipulate nanowires with "optical tweezers." A highly focused laser beam attracts microscopic objects and can be used to pick up and precisely position nanocomponents for building semiconductor circuits or biosensors smaller than a red blood cell. Tools for manipulating nanocomponents will help accelerate research on the performance of new nanotechnologies.

- *Nanotechnology* - The Nanotechnology SWG was formed in August 2004 to help align NIST programs with the National Nanotechnology Initiative (NNI), increase awareness of NIST's nanometrology activities, and develop a users' access program to leverage NIST's nanofabrication facility in the AML. Since its inception, the Nanotechnology SWG has been actively involved with the NNI through the National Science and Technology Council (NSTC) Subcommittee on Nanoscale Science, Engineering and Technology, including contributions to a series of reports that outline strategic objectives for the NNI. Other examples of NIST's interactions with the NNI include hosting the NNI Interagency Grand Challenge Workshop on Instrumentation and Metrology with over 200 metrologists from across the nation and participating in the NNI Research Directions II Workshop. The Nanotechnology SWG is currently conducting an assessment of NIST nanotechnology projects to identify the gaps and investment options where NIST needs to improve its skills and resources in nanotechnology research to achieve the highest impact. The Nanotechnology SWG also has begun a search for a world-class expert in nanofabrication to work at NIST and help increase the Institute's contributions in this area. In addition, an assessment and development of a business plan for a National Nanomanufacturing and Nanometrology Facility (N^3F) at NIST is underway.

- *Information and Knowledge Management* - An Information and Knowledge Management SWG has been in the planning stages for over a year. The Committee is very disappointed with the lack of progress, and highly encourages NIST to establish this SWG to help the Institute develop a NIST-wide strategy and tactics for implementing the Information and Knowledge Management Strategic Focus Area where there is a huge opportunity for NIST's research to make a significant impact across many industry sectors.

- *Manufacturing* - NIST is considering establishing an SWG for manufacturing to help coordinate the Institute's efforts in this area that take place in almost every OU and program at NIST. This action is in response to the Administration's increased emphasis on manufacturing, especially in the area of interoperability where, according to three prospective economic studies, NIST has an important role and can make a significant impact. In addition, Dale Hall, the Director of NIST's Manufacturing Engineering Laboratory, serves as the acting chair of the NSTC's Interagency Working Group on Manufacturing R&D, which was established in 2004 to provide policy guidance on the federal manufacturing effort and to promote communication and collaboration among its fourteen member agencies.

Operating Units Operational Plans — The third annual Director's review of the annual operational plans for each of the OUs was held in October 2004 to ensure programmatic coordination and NIST-wide implementation of NIST's long-range goals in FY 2005. Based on this review, NIST identified needs and opportunities to help the Institute better align its program portfolio with external drivers, as described under the "Opportunities for Change" section of this report (page 4). The VCAT is looking forward to receiving a summary of the FY 2006 review.

Strategic Partnerships — NIST is continuing to establish new strategic partnerships with industry, universities, and other government agencies as a way to leverage the Institute's programmatic impacts on the nation's priorities and to take advantage of expertise outside of NIST. For example, in December 2004, NIST formed a significant new partnership with DaimlerChrysler, Ford Motor Company, and General Motors whereby scientists and engineers from each of these organizations will engage in pre-competitive research activities to improve the manufacturing competitiveness of the U.S. automotive industry. During FY 2005, NIST also signed Memoranda of Understanding (MOUs) with HHS to collaborate on programs that facilitate the development and delivery of innovative medical technologies and with Utah State University to enhance collaborations in the development and calibration of optical sensors for defense, homeland security, weather prediction, and climate research. NIST also is exploring strategic partnerships in specific program areas with several other organizations.

As NIST becomes more visible and the number of potential partnerships increases, the need for a well-defined plan for strategic partnerships that best meet the nation's needs is critical. The VCAT has encouraged NIST to finalize its partnership strategies, including a set of selection criteria based on the nation's priorities and NIST's existing and emerging core competencies. The NIST Director has expressed his commitment to develop guidelines for establishing new strategic partnerships. One important criterion will be identifying a clear commitment of resources from all parties prior to entering into an MOU.

U.S. Measurement System

Following several years of discussions with the SMB and the VCAT regarding the importance of defining a process for developing a 21st century view of the nation's measurement system and reaffirming a dynamic leadership role for NIST, the Institute publicly launched an ambitious USMS Initiative in April 2005 to address this challenge. NIST is leading a USMS road mapping effort to assess and identify crucial current and future measurement-related needs of the entire U.S. economy, including both the private and public sectors. By road mapping America's priority measurement needs and

reporting regularly to USMS customers and stakeholders on the state of the USMS, NIST plans to create, over time, a strong private-public partnership that will strengthen the U.S. infrastructure for innovation.

The new NIST Director refined the USMS effort to reflect available resources within the existing organization structure and to leverage the extensive knowledge and expertise of the NIST staff. While maintaining the original timetable as shown in Table 3, the revised plan calls for NIST to conduct an in-depth assessment for an initial set of 3-5 sectors led by various teams with participation throughout the Institute. The VCAT agrees that this new approach can provide NIST with valuable "lessons learned" before proceeding to the next set of sectors. According to the revised plan, the initial sectors could be related to semiconductors, nanotechnology, biosciences, homeland security, the environment, or automotive. The Committee is recommending that the USMS effort focus on emerging competitive areas rather than well-established areas that are no longer in need of NIST support. NIST is in the process of developing an extensive USMS measurement needs database that already includes more than 300 existing roadmaps and workshop reports. In addition, NIST is conducting focused technical USMS workshops and these results also will be included in the database.

The USMS effort is now a component of NIST's strategic planning efforts for identifying national needs and the NIST role. The Committee commends NIST for embarking on this critical effort and strongly urges the Institute to better define the scope of the first road mapping activity, identify NIST's role in the USMS, and link this analysis to the Institute's vision and the next version of the Strategic Plan to leverage its unique capabilities in the highest priority areas most effectively. The VCAT is pleased to learn that in the long-term NIST plans to develop budget initiatives based on the analysis of NIST's role in support of the USMS.

Table 3. USMS Timetable

Begin internal and external engagement	February 2005
Public launch	April 2005
Collect and analyze customer and stakeholder information	Ongoing
Convene USMS summit	January 2006
Release assessment of USMS needs	July 2006
Develop plans to address critical needs	October 2006
Publish USMS roadmap	December 2006
Report to the Nation on the state of the USMS	January 2007
Monitor and report on progress	Ongoing
Update roadmap	Ongoing
Repeat overall process	Every 4 years

Source: Dr. Richard Kayser's presentation to the VCAT, June 14, 2005

Extramural Programs

Advanced Technology Program — The goal of the ATP is to accelerate the development of innovative technologies for broad national benefit by co-funding R&D partnerships with the private sector. ATP investments align well with NIST's strategic focus areas in projects conducted externally as well as in the NIST laboratories. For example, ATP recently completed an evaluation of 768 projects awarded since 1990 and identified 109 projects that have a direct impact on homeland security in nine categories of national importance[2]. These projects total $518.5 million in ATP cost-shared awards. Although there have been significant economic benefits to the nation associated with the ATP, the program is faced with the challenge of operating under financial instability as the Administration and Congress continue to debate ATP's future.

Hollings Manufacturing Extension Partnership — The Hollings MEP is a nationwide network of local centers offering technical and business assistance to smaller manufacturers. Despite the dramatic FY 2004 budget reduction of 63 percent for the MEP, the national system was maintained while operating with only $40 million in FY 2004. This budget reduction was a huge challenge for the management as they explored different operating

[2] *The Nation's Homeland Security and the NIST Advanced Technology Program*, March 2005

plans. The Economic Development Administration provided $7 million directly to the Centers. MEP also began working more closely with other agencies, including the Department of Labor and the Department of Defense, to help them reach small firms. As a result of this reduction, about 320 field and headquarters personnel lost their jobs causing morale problems and about 50 of the more than 400 field locations were forced to close. Other negative impacts included some fragmentation of the system as some Centers sought other sources of support that took them away from the MEP mission, financial instabilities, and loss of trust in the federal partner. The positive impact of the budget reduction was that the value of the MEP "brand" was significantly increased at the federal level and full funding was restored in FY 2005. In addition, MEP's leadership was able to examine the strengths and weaknesses of the system and explore opportunities to work with other federal agencies.

The MEP impacts are impressive. In a new survey of the MEP clients covering projects completed in FY 2003, 4,865 clients around the country reported that as a result of the MEP services, they realized almost $686 million in cost savings; invested $912 million in modernization, including plant and equipment, information systems, and workforce training; increased or retained $4.1 billion in sales; and created and retained 50,315 jobs. As another example, the MEP is supporting improvements in manufacturing supply chains as illustrated by the successful Wisconsin MEP Original Equipment Manufacturer Supplier Development Consortium in which 236 Wisconsin suppliers participate. This consortium held over 60 supplier conferences in 2005. In addition, the MEP centers are involved with the Hurricane Katrina recovery efforts. For example, the MEP centers in the gulf coast region have been surveying small manufacturers in their area to determine the extent of their needs and identify ways in which the MEP network can provide assistance.

The VCAT commends MEP's leadership and success in exploring new opportunities to make MEP an even more effective program that will help the nation's small and medium-sized manufacturers become more competitive and recognizes the importance of a stabilized budget to more efficiently reach this goal. MEP should continue its extensive outreach efforts to ensure that the program's stakeholders are aware of the program's valuable contributions to the competitiveness of our nation's smaller manufacturers.

Baldrige National Quality Program — The VCAT continues to recognize the Baldrige program as one of the government's most highly leveraged and effective programs that help organizations achieve performance excellence. The program reached a major milestone in 2005 with the receipt of the 1,000th application for the prestigious Malcolm Baldrige National Quality Award. Vice President Cheney presented the 2004 Baldrige Award to four recipients in a ceremony held in July 2005. These recipients represented four of the five Baldrige Award categories: manufacturing, small business, education, and health care. About 1,200 individuals attended the Quest for Excellence® Conference XVII where the 2004 Baldrige Award recipients shared their exceptional performance practices, their journey to performance excellence, and their lessons learned. There were 64 applications submitted for the 2005 Baldrige Award, of which 50 percent represent the health care industry.

Performance Evaluation

The VCAT encourages NIST to continue to improve its performance evaluation system as a way to be more responsive to a diverse stakeholder community and to the internal needs of the organization.

Performance Metrics — The VCAT commends NIST leadership for restructuring the FY 2005 Balanced Scorecard that includes a new section for evaluating programs and new types of customer satisfaction methods, as recommended by the Committee. The Balanced Scorecard, introduced in 2004, is used internally to define and evaluate NIST-wide performance goals and metrics throughout the Institute. These goals represent the top priorities of NIST's senior managers in four key areas: programs, people, resources, and

customers. Each priority area includes a set of corresponding goals, evaluation metrics, and accountability mechanisms. All of the elements of the Balanced Scorecard were incorporated in the senior management performance plans. Many of the program goals are aligned with other OMB and Department of Commerce (DoC) metrics. For example, the NIST/DoC FY 2005 Plan for Success includes a set of evaluation metrics in five high priority areas. The VCAT appreciated the opportunity to review the "stoplight" mid-year progress report on the Balanced Scorecard and looks forward to receiving regular updates as well as expressing a willingness to provide more guidance on its status and implementation.

While NIST has a performance measurement and evaluation system that responds to such government-wide initiatives as the Government Performance and Results Act of 1993, the President's Management Agenda, and the Program Assessment Rating Tool, the Institute needs to develop a system to help evaluate progress in implementing the NIST Strategic Plan. To meet this challenge, NIST should continue to focus on the development and reporting of specific short-term and long-term metrics and other quantitative data, consistent with the Baldrige framework, which address each of the Strategic Focus Areas and SWGs. The VCAT is pleased to learn that NIST has just completed a first step in the Baldrige process, as described in the "Organizational Excellence, Baldrige at NIST" section of this report (page 15).

Economic Studies — NIST initiated two new economic studies in FY 2005. A retrospective study will cover the economic assessment of the role and impact of measurement in the entire U.S. semiconductor industry to help examine NIST's value. The other study will be a prospective economic assessment of the costs to the U.S. biotechnology industry from inadequate technological infrastructure and should help to validate NIST's role in this emerging area. The Committee commends NIST for initiating these important studies and urges the Institute to continue to carry out more prospective and retrospective economic studies to help validate NIST's role in emerging technologies and to guide strategic planning.

Board on Assessment of NIST Programs — The National Research Council Board on Assessment of NIST Programs serves as another evaluation tool for NIST by providing qualitative peer review of NIST laboratory programs. It was customary for the Board to report its findings and recommendations to the VCAT each year. However, the Board began a new biennial review process in FY 2004 and their latest report was not available to share with the VCAT in FY 2005. The Committee is looking forward to a briefing on the Board's technical report as soon as possible.

ORGANIZATIONAL EXCELLENCE

NIST's capability to provide the nation with the technical infrastructure needed for economic growth and homeland security is supported by world-class talent, highly specialized facilities and equipment, and the continued pursuit of organizational excellence, as illustrated by numerous technical achievements. The VCAT commends NIST for continuing to address facility improvement needs, increase safety awareness, explore Baldrige processes for NIST, and respond to staff concerns as a way to further increase NIST's effectiveness.

Facilities

NIST must have modern and highly specialized facilities for its scientists and technical staff to remain at the forefront of measurement science, standards, and technology to meet the needs of the 21st century and to advance the U.S. technological competitiveness. To meet these needs, NIST developed a long-range Facilities Improvement Plan in February 1998 that was updated in June 2004 and February 2005 (addendum). NIST is making progress against this plan and is addressing the major construction, renovation and maintenance needs associated with the aging and deteriorated buildings in Gaithersburg and Boulder. No additional support was provided for safety, capacity, maintenance and major repairs (SCMMR) in FY 2005, but the VCAT is hopeful that increased support for the maintenance of the older buildings as well as preventive maintenance for the sophisticated AML will be available as requested in the FY 2006 President's budget request. Major construction of Boulder's Central Utility Plan (CUP) received

Courtesy HDR Architecture, Inc./Steve Hall © Hedrich Blessing

In a clean room located in the AML, NIST researchers develop metrology tools for nanoparticle manipulation and for studying atomic and molecular frictional forces. The research results will help improve the durability of micro- and nano-devices (such as tiny motors, positioning devices or encoders) as well as the assembly of nanoparticles to form new materials.

additional funding in FY 2005 which will complete phase 1 of this project, and the FY 2006 President's budget request includes funding to complete the CUP that will supply heating, chilled water, and compressed air to all of the lab buildings on the Boulder site. Also, Boulder's Primary Electrical Service project is now complete and has helped to significantly reduce power problems. On the Gaithersburg campus, a major asbestos removal project has been underway in one of the older General Purpose Laboratories. Once this project is completed, the staff from the NIST North campus, located across the street from the main campus, will move to this building.

The unique AML was awarded the distinction of "high honors" in *R&D Magazine's* 2005 Lab of the Year Competition. Regarded as the most technologically advanced research facility of its kind in the world, the AML was judged by representatives from the architectural, scientific and laboratory equipment communities, as well as the magazine's editors. The VCAT had the opportunity to tour several state-of-the-art research facilities in the AML that demonstrated vast improvements in measurement capabilities made possible by its unique features. These tours and unique facilities are described in Appendix B, Examples of Technical Excellence. The AML is already contributing to the emerging nanotechnology industry. NIST should continue to seek strategic partnerships that can help leverage this unique national facility.

The NIST Center for Neutron Research (NCNR), the nation's premier neutron facility, received an increase of $6 million in FY 2005 for capability improvements as well as increased operating costs. These improvements will help to significantly expand the NCNR's collaboration with industrial, government, and academic researchers in materials science, biotechnology, chemistry, engineering, and physics.

NIST should continue to evaluate its facility improvements based on the Institute's current and future research and staffing needs. The VCAT encourages NIST to develop new business cases to help justify and prioritize the needed renovations and repairs in program areas that tie to its Strategic Plan. This analysis should cover all of NIST's facilities, including the Advanced Chemical Sciences Laboratory and the newly constructed AML.

Technical Excellence

NIST continues to be a high-performing organization with outstanding achievements in ground-breaking scientific research, key contributions to major building and fire safety investigations, and rapid responsiveness to congressionally-mandated programs and presidential directives in FY 2005. For example, NIST is home to three Nobel Laureates, including John Hall, a scientist emeritus in NIST and the University of Colorado, who shares the 2005 Nobel Prize in Physics for "contributions to the development of laser-based precision spectroscopy." Other achievements include the development of a leading new experimental method for defining the

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NIST researchers (left to right) Steven Jefferts, Elizabeth Donley, and Tom Heavner with NIST F1, the world's best clock (as of Sept. 2005). The clock uses a fountain-like movement of cesium atoms to determine the length of the second so accurately that--if it were to run continuously--it would neither lose nor gain one second in 60 million years.

kilogram, the improvement of the NIST Atomic Fountain Clock, and the design of chip-scale refrigerators. NIST's significant research contributions in the building and fire safety investigation of the World Trade Center (WTC) disaster clearly demonstrate that NIST is a world leader in structural and fire analysis. A summary of NIST's building and fire safety investigations of the WTC disaster as well as the deadly Rhode Island nightclub fire of 2003 is provided in Appendix A. As an example of NIST's responsiveness to congressionally-mandated programs, the Institute reached a major milestone in May 2005 by submitting the first draft of the voluntary voting system guidelines to the Election Assistance Commission within nine months as required by HAVA.

As these and many other examples indicate, NIST has renowned scientists and engineers as well as some of the world's most specialized measurement facilities. With these assets, NIST is well-positioned to remain at the forefront of advancing measurement science, standards, and technology to enhance economic security and improve the quality of life for all Americans (see Appendix B for additional illustrative examples of NIST's technical excellence.)

Baldrige at NIST

The VCAT is extremely pleased to learn that NIST is beginning to embrace the Baldrige process more systematically. To help the organization become more familiar with quality and performance excellence issues, NIST established a Baldrige at NIST study group comprised of the next generation of NIST leaders. With guidance from Harry Hertz, the Director of the National Baldrige Quality Program, this group developed a draft Organizational Profile, a first step in the Baldrige process. In addition, Technology Services, one of NIST's major OUs, has begun implementing the Baldrige process to improve their wide-range of services. The Committee is eagerly looking forward to NIST's progress in implementing Baldrige which should help the Institute achieve an even higher level of organizational excellence.

People

NIST senior management recognizes the importance of responding to the concerns raised in the 2004 Employee Survey. Focus groups comprised of NIST staff reviewed the survey results and helped prioritize specific areas for the NIST management response. Based on this feedback, NIST developed and began to implement an action plan to improve operations and management.

The VCAT encourages NIST to continue to provide employees with immediate feedback and updates on the action plan. In addition, NIST should develop specific performance metrics to measure the success of these important efforts, as outlined in the Baldrige process.

Safety

NIST is continuing to embark on new safety practices and awareness activities to help improve its safety record. As reported in the 2004 Employee Survey, the NIST staff considered safety an important issue and provided high scores to NIST as a safe workplace. NIST's increased safety-related activities should help to continue this trend. For example, NIST finalized the Personal Protective Equipment policy, created a new office safety manual, developed a new safety training module for new employees, provided blood-borne pathogen awareness training to the staff in the Plant Division, offered new safety training classes under contract with HHS, and improved building evacuation practices. As a further demonstration of NIST's commitment to improving safety, the leadership encouraged all employees to participate in a NIST Safety Day held in Boulder and Gaithersburg with many activities involving safety awareness in and out of the workplace.

NIST has an impressive safety record in comparison to the Department of Energy (DOE) laboratories and other government agencies. In FY 2004, NIST's total case rate and lost workday incident frequency rate (LWIFR) compared favorably to its peers at the DOE laboratories, as shown in Table 4. Although NIST's total number of recordable safety incidents in FY 2005 is expected to increase slightly over FY 2004, this number should be lower than FY 2000 through FY 2003. NIST's total lost workdays also is expected to increase over FY 2004 as a result of three cases with an unusual high number of lost work days totaling 220. These three cases involved a police officer, a carpenter's helper, and a computer scientist. The VCAT encourages NIST to continue discussions with other research laboratories to identify additional safety practices that could help NIST further improve its safety record.

OUTREACH

NIST is continuing to expand its external outreach activities more strategically to key stakeholders to increase their awareness, appreciation, and support of the Institute. For FY 2005, NIST developed a comprehensive outreach plan that included a specific set of priority activities aimed at Congress, industry associations, partners, the Administration, the media, and the public. In addition, NIST identified a set of priorities for the use of new and more effective communication tools. To help evaluate its progress in carrying out the new outreach plan, NIST should refine its initial set of performance measures used in FY 2004.

Over the past year, NIST outreach activities have increased significantly. For example, the NIST Director and the Acting Director have held numerous meetings with members of Congress and their staff, hosted several Congressional visits to the Gaithersburg and Boulder laboratories, and provided briefings and testimony on NIST's key investigative reports, such as the collapse of the WTC and progress on HAVA-related activities. As a more strategic approach for outreach to industry, NIST recently established a "key customer" outreach program that targeted specific companies and contacts in fourteen industry segments for NIST senior managers to develop a one-on-one relationship. As part of this program, the

Table 4. Benchmarks vs DOE Labs

Total Case Rate and Lost Workday Rate for FY 2004

Agency	Total Case Rate*	LWIFR
NIST	0.80	0.20
DOE	2.73	0.73
Argonne East	0.90	0.90
Argonne West	0.90	0.00
Lawrence Livermore	1.80	0.40
Los Alamos	2.50	0.80
Sandia	3.20	0.90
Fermilab	1.10	0.80

*Includes medical treatment and lost workday incidents

Source: NIST Director presentation to the VCAT, September 14, 2005

senior leadership has had key engagements with high-level executives in such companies as Boeing, Ford Motor Company, Fluke, and Agilent to understand their current and future needs and to educate them about NIST and its impact on their organization. In addition, the NIST Director has been conducting outreach with major manufacturers, customers of NIST services, and other federal agencies responsible for addressing national priorities to identify possible areas for collaborations and partnerships. The VCAT is pleased that NIST is becoming more strategic and more proactive in its outreach efforts with senior executives in industry.

While increasing its face-to-face interactions with key customers and stakeholders, the Institute needs to place a greater emphasis on developing new communication tools that clearly demonstrate the value of NIST. The VCAT commends NIST for its commitment to refine the NIST message for use in its outreach activities and looks forward to seeing this message in a new set of outreach material that provides examples of program impacts by industry segments. Program impacts also should highlight how the capabilities of the world-class AML have helped to increase NIST's contributions to the nation's standards and measurement infrastructure as a way to attract more interest in this national resource. The Committee also was impressed with the initial revision of the NIST Overview presentation for outreach activities and provided several suggestions for further improvement, including the development of customized versions for specific audiences.

As emphasized in the presentations by Michael Holland from OSTP and Kei Koizumi from the American Association for the Advancement of Science (AAAS), federal agencies need to communicate clearly the value of their programs and their priority setting process to policy officials as a way to gain more support from the Administration and Congress. The VCAT is hopeful that NIST will continue to focus on the development of improved communication tools as a high priority to increase the Institute's visibility even further.

BUDGET

NIST Laboratories

Increased funding for the NIST laboratories in FY 2005 and the President's FY 2006 budget request is a welcome return to a positive change in NIST resources that will help support strategic initiatives and strengthen NIST core competencies needed to increase our nation's innovation and competitiveness. However, the amount of funding available for core metrology programs in the NIST laboratories has been eroding over the past several years as the Institute has had to compensate for huge new responsibilities in response to a series of unfunded congressionally-mandated programs, such as projects related to the National Earthquake Hazards Reduction Program and the National Construction Safety Team Act, presidential directives, inadequate adjustments-to-base, and unfunded salary increases. Based on the extremely tight budget projections for non-security discretionary spending in the next few years, NIST must invest its resources in areas of high national needs where the Institute can have a significant impact on the growth opportunities for U.S. industry. This will likely involve the redeployment of existing resources to new and higher-value added contribution areas.

The VCAT appreciated the opportunity to learn more about the Administration's priority-setting process for the federal R&D portfolio as well as R&D funding trends in the federal government as described by representatives from OSTP and AAAS. Both of these speakers provided an excellent context for understanding the complexities of the budget process and the challenges associated with reducing the budget deficit while addressing the President's priorities.

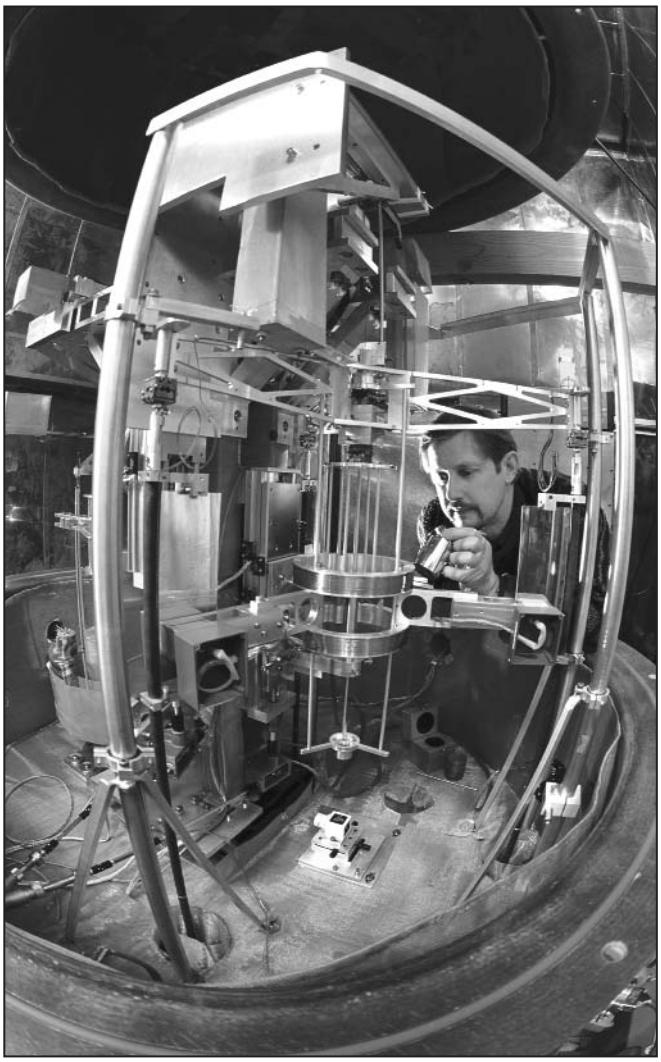
Facilities

NIST's facilities continue to require additional funding to help shape NIST's capabilities and productivity well into the 21st century. Additional investments are needed to overcome remaining problems associated with deteriorated and obsolete laboratory facilities in Gaithersburg

and Boulder and to support necessary preventive maintenance for the AML, as described under the "Summary of Operations, Organizational Excellence, Facilities" section of this report (page 13).

ATP and Hollings MEP

The funding uncertainty for the ATP and the Hollings MEP continued in FY 2005 and FY 2006 and must be resolved. The VCAT is concerned that the continuing debate between the Administration and Congress over funding these programs versus the laboratories is having a negative impact on NIST's long-term strategic planning process.



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NIST physicist Richard Steiner adjusts the electronic kilogram, an experimental apparatus for defining mass in terms of the basic properties of nature. The advance may move the scientific community closer to redefining the kilogram, the only one of the seven basic units of the international measurement system still defined by a physical artifact.

Appendix A: Examples of Technical Excellence: Major Building and Fire Safety Investigations

World Trade Center Investigation

In June 2005, Shyam Sunder, the WTC lead investigator, provided a fascinating and detailed presentation of NIST's response to the WTC disaster, including background information and a summary of the draft report and recommendations released for public comment on June 23, 2005. His overview included results from elaborate computer modeling, photographs, and videos in support of the analysis of the WTC collapse sequence. An unprecedented amount of data collection was required for reconstructing the exact sequence of events beginning with the impact of the aircraft, to the fire dynamics, to progression of local failures that initiated the building collapse. NIST intends to continue to work closely with the building and fire safety communities to ensure that the recommendations are given proper consideration. The Committee commends NIST for its extensive and excellent efforts in the building and fire safety investigation of the WTC disaster. In particular, NIST's ability to overcome the many challenges of the investigation, including leading and managing a team of over 225 individuals from NIST and other organizations and coordinating efforts with the 9/11 Commission and local authorities is admirable.

The final WTC towers report was released on October 26, 2005. The report called on the organizations that develop building and fire safety codes, standards, and practices- and the state and local agencies that adopt them- to give immediate and serious consideration to implementing the recommendations from NIST's investigation of the fires and collapses of the WTC. Based on the findings of the most detailed examination of a building failure ever conducted, the report features 30 recommendations designed to improve the safety of tall buildings, their occupants and first responders. The NIST recommendations are contained within 43 separate reports totaling some 10,000 pages that cover: specific improvements to building standards, codes and practices; changes to, or the establishment of, evacuation and emergency response procedures; and research and other appropriate actions needed to help prevent future building failures. A web-based system with information on the status of the WTC recommendations will be established for the public to track their implementation. NIST's investigation of the WTC towers fires and collapses was conducted under the National Construction Safety Team Act. Additional information about this investigation is available at http://wtc.nist.gov.

In 2005, NIST completed a three-year building and fire safety investigation of the probable causes for the post-impact collapse of World Trade Center Towers 1 and 2 following the terrorist attacks of Sept. 11. As part of the investigation, NIST structural experts examined about 250 pieces of steel recovered from the site. NIST researchers Stephen Banovic (left) and Frank Davis take inventory.

Photo Credit: NIST

Investigation of The Station Nightclub Fire

On June 29, 2005, NIST released a report that called for some significant changes to further strengthen the model building and fire safety codes based on the findings from its investigation of The Station nightclub fire in West Warwick, Rhode Island, that killed 100 people on February 20, 2003. The report contains

ten recommendations for increased occupant safety in nightclubs based on the investigation and comments received from the draft report. These recommendations reinforce the current model codes and propose additional changes that will make them even more effective. NIST will work with major organizations representing state and local officials to encourage them to seriously consider these recommendations. A special web site will be established for NIST to track progress in adopting its recommendations. NIST conducted its investigation of The Station nightclub fire under the National Construction Safety Team Act.

At a robotic sample preparation station, NIST staff members John Butler and Susan Ballou discuss a NIST project for improving forensic analysis of human DNA. Butler developed a concept for reducing the size of DNA fragments needed for a definitive identification, which has proven useful in analyzing damaged or degraded DNA. Methods based on the concept were used to help identify victims of the World Trade Center collapse on Sept. 11.

Appendix B. Examples of Technical Excellence: Lab Reviews Conducted by the VCAT in FY 2005

Technical excellence is evident in many of NIST's programs as reflected by the increasing number of prestigious awards bestowed upon the technical staff for outstanding accomplishments; NIST's responsiveness to congressionally-mandated programs and presidential directives in high visibility areas; NIST's technical accomplishments that are featured in the scientific media; and the high quality research presented to the VCAT members during selected laboratory tours.

Examples of prestigious external awards that recognize NIST accomplishments include *Scientific American's* "Research Leader of the Year" to Deborah Jin for the creation of a new state of matter; the Presidential Rank Award for Distinguished Senior Professional to David Wineland; and the Arthur S. Flemming Awards to four NIST researchers. In addition, William Phillips was appointed to the Pontifical Academy of Sciences. Scientific journals and other news media also have highlighted NIST technical achievements.

At each meeting, the VCAT members tour selected NIST laboratories to gain an appreciation of the high quality technical work and staff expertise. These tours also provide the Committee with an excellent opportunity to examine how the technical programs support the NIST Strategic Plan. Due to a schedule change, the Committee did not visit the Boulder campus in FY 2005, but will resume these annual visits in December 2005. Provided below is a brief summary of the FY 2005 tours that illustrate the technical excellence of NIST's programs, their impact to the nation, and their relationship to the NIST Strategic Plan. In addition, the Committee was extremely impressed with each of the researchers' depth of knowledge and enthusiasm as they described their exciting projects.

Homeland Security

Weapons and Protective Systems for Law Enforcement – The Office of Law Enforcement Standards (OLES) serves the interests of the criminal justice and public safety communities (state and local law enforcement, corrections, fire service, other first responders, and courts) by developing performance standards for equipment; methods for examining evidentiary materials; users guides; and Standard Reference Materials, as well as performing other scientific and engineering research.

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With funding from the National Institute of Justice, NIST's Office of Law Enforcement Standards develops test methods and standards to ensure the performance of equipment used by police, corrections officers, and first responders. Nathaniel Waters, a NIST engineering technician, examines a bullet-resistant vest being tested. NIST recently upgraded its ballistics facility used for such research.

OLES has six program areas: weapons and protective systems; detection, inspection, and enforcement technologies; chemical systems and materials; forensic sciences; public safety communication standards; and critical incident technologies. The VCAT witnessed a very interesting body armor ballistic test.

The Weapons and Protective Systems area provides ongoing technical support and research for the National Institute of Justice (NIJ) standards for ballistic-resistant body armor (bullet-resistant vests), which OLES first developed for NIJ in 1972. The body armor program is part of NIJ's successful Law Enforcement and Corrections Standards and Testing Program, through which companies may have their products voluntarily certified as compliant with the standard. Ballistic-resistant body armor has been credited with saving more than 2,500 lives, and the program's evaluations of new materials and ballistic threats and its revisions of the standard help ensure the continued effectiveness of this technology. This project area also develops and supports other equipment performance standards vital to the safety of law enforcement and corrections personnel, including stab-resistant body armor; ballistic helmets; riot helmets and face shields; bomb suits; metallic handcuffs; and firearms.

Nanotechnology

Mechanics, Adhesion and Friction at Nanoscale – Tomorrow's micro- and nano-scale devices and materials will be the engine for our nation's economic growth, permeating every industrial sector. As the sizes of these devices shrink, surface forces become dominant, governing how tiny device components interact with each other, as well as how nanoparticles can be assembled to form new materials. Understanding and control of these forces are critical to successful development of competitive industries in the United States. NIST pioneers precise measurements of mechanical properties, friction, and surface forces using unique instrumentation.

Located in a clean room in the AML, with tight temperature and vibration control, the laboratory allows researchers to view surfaces, probe material mechanical properties, and measure the interaction forces accurately. Collaborating with U.S. instrument-makers, NIST researchers have developed an integrated system of micro- and nano-scale instruments that include a custom-built three-dimensional sensor for friction measurement, ultra-high-vacuum scanning probe microscopes, and new adhesion and surface force measurement capabilities, as well as applying and disseminating NIST force metrology to ensure the accuracy of the test results.

Manufacturing

NIST Dimensional Metrology: Ultra-High Accuracy Coordinate Measuring Machine (CMM) – Arguably the most accurate instrument of its type in the world, this NIST-enhanced ultra-high-accuracy Moore 48 CMM housed in the AML is key to NIST calibrations and research that help U.S. manufacturers of all sizes to meet ever more demanding dimensional requirements and to reliably machine and assemble parts with increasingly complex features. Ensuring proper performance of CMMs is fundamental to manufacturing performance at nearly every level of supply chains. NIST dimensional calibrations and a series of innovative measurement references provide the nation's manufacturers with compelling evidence (technically termed "traceability") that their parts and final products are of uniformly high quality, satisfying customer specifications and, as warranted, regulatory requirements. With this customized CMM, NIST provides its customers, many of whom are smaller manufacturers and private-sector calibration service companies, with access to state-of-the-art capabilities that are beyond their budgets, yet critical to their quality assurance systems, and thus those of their customers. In addition, NIST researchers actively participate and often lead efforts to develop international standards regarding the use and performance of CMMs, the primary inspection tool in many manufacturing sectors.

Competence: Nanotechnology

Microforce Realization and Measurements – This project is another outstanding example of how NIST competence funds have been successfully used in an

intra-laboratory collaboration to carry out core measurement research that is at the heart of the NIST mission. Competence funding was first provided to this project in FY 2000 to develop competence in specialized instrument design appropriate for the realization, measurement, and repeatable dissemination of microforces that begins to address the emergent force metrology needs of a growing class of nanotechnologies. This competence, enabled by a new laboratory in the AML, has formed the basis of a metrological infrastructure for instruments, such as atomic force microscopes, nanoindenters, and micro-electromechanical systems (MEMS) that operate in force regions between nanonewtons and millinewtons.

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NIST physicist Ray Simmonds holds a protective box containing "artificial atoms" that might be used in quantum computers. Next to him is a cryogenic refrigerator that cools the box to temperatures near absolute zero.

Competence: Measurement Science

NIST Combinatorial Methods Center (NCMC) – The NCMC, established in 2001 with competence funding, specializes in developing combinatorial and high-throughput metrologies for polymer materials science. Originally applied to drug discovery, combinatorial and high-throughput methods are now exploited for catalysis, coatings, and materials science. With an open source, non-proprietary, model, the NCMC established a new type of consortium that now includes 21 industrial, academic, and government members. Current research activities include microfluidic technologies for the analysis of complex multiphase formulations, gradient library methods for nanomaterials and nanometrology development, and rapid quantitative analysis of adhesion and mechanical properties of coatings and films.

Measurement Science and Standards

Large Fire Metrology Laboratory – NIST maintains a world-class large fire laboratory to improve fire metrology capabilities for the country, conduct model validation/verification tests in intermediate and large scale settings, and set standards for fire testing. This laboratory is equipped with three separate calorimeters rated at 1 megawatt, 3 megatwatts and 10 megawatts heat release rates, respectively. The VCAT witnessed a spectacular test of a residential bed mattress under the 3 megawatts calorimeter. NIST worked to understand how bed fires proceed from the ignition of bedclothes to the full involvement of the bed and its foundation and developed a novel infrared technique for measuring the intensity of heat transfer from the bedclothes. Recognizing that routine testing of mattresses could not depend on a standard set of bedclothes, NIST used the data to develop a unique double burner that accurately simulates the threat from such a fire to both the top and sides of the mattress and its foundation. In addition to developing the test methodology, NIST also determined

the relationship between the size of the fire and the heat release rate that would lead to flashover, i.e., where the full room bursts into flame and starts the fire spreading rapidly to the rest of the building. This led directly to the acceptable levels of heat release rate for the mattresses.

Bed fires in homes cost the nation nearly 500 lives, over 2000 serious injuries, and $250 million in property loss every year. Safety standards now adopted by the California Bureau of Home Furnishings are based on the testing methods and hazard analysis developed in this laboratory. NIST is now working with the Consumer Product Safety Commission who is considering adopting a modified version of these standards, which is estimated to cut national losses from bed fires in half.

Cryptographic Algorithm Validation Program (CAVP) – The CAVP demonstrations provided an overview of NIST's highly successful algorithm testing program and live testing of cryptographic algorithm implementations through the Cryptographic Algorithm Validation System (CAVS). The validation test tools exercise an algorithm implementation to provide assurance that the algorithm has been used correctly based on the specifications given in the associated cryptographic standard. Statistics show that 25 percent of the algorithm implementations submitted for testing and perceived to be ready to go to market were found to be incorrect. The CAVS allows these errors to be quickly isolated and corrected before the products are used by industry and federal agencies. Testing is required to validate a cryptographic-based product against NIST's Federal Information Processing Standard (FIPS) 140-2: Security Requirements for Cryptographic Modules. In addition to use in the federal sector, validation through NIST's Cryptographic Module Validation Program (CMVP) is recognized worldwide by ISO standardization and international industry acceptance. Both Canada and the United Kingdom specify FIPS 140-2 validation for use within their federal structure and the CMVP serves as a model for programs in other countries. NIST validated algorithms and modules can be found in use on every continent to help protect information, secure electronic transactions, and even protect communications with the International Space Station.

Measurement Science

Immersive Visualization Interacting with Data in Three Dimensions – Computational and laboratory experiments are generating increasing amounts of scientific data. Often, the complexity of the data makes it difficult to devise a priori methods for its analysis, or the data is from new landscapes, such as the nano-world, where scientists have limited experience. NIST is developing immersive visualization capabilities that allow scientists to interact with data objects in a three-dimensional landscape rather than simply viewing pictures of them. The VCAT witnessed three demonstrations with applications for cement and concrete flow, tissue engineering, and the behavior of smart gels used in the drug and food industry. By permitting such visual exploration, scientists can more easily perceive complex relationships in their data, quickly ascertaining whether the results match expectations.

Appendix C. NIST Response to FY 2004 VCAT Annual Report Recommendations

At the September 2005 VCAT meeting, the NIST Director provided a status report on how the Institute is addressing each of the twelve recommendations from the FY 2004 VCAT Annual Report (see Table 5). Beginning in FY 2004, NIST committed to provide detailed progress reports to the Committee on these and other VCAT recommendations. This reporting system is intended to close the loop between the VCAT's observations, recommendations, and NIST's response. By engaging in extended discussions with the NIST leadership on a variety of topics presented over the course of the meetings, the VCAT is better able to advise the Institute on its policies, organization, budget, and programs to help NIST best support the nation's scientific and technical needs.

Table 5. NIST Response to FY 2004 VCAT Annual Report Recommendations

VCAT Recommendations	NIST Status
Budget	
Immediately increase NIST budget to fund strategic initiatives and to compensate for unfunded Congressional mandates, inadequate adjustments to base, and unfunded salary increases.	The President's budget request for FY 2006 supports this objective while balancing other national priorities including cutting the budget deficit. Final budget for FY 2006 awaiting Congressional appropriations.
Continue to invest in core competencies required to provide measurement and standards capabilities for the future.	Strategic planning is a key focus area for the new Director. A list of top level NIST core competencies and newly funded competence projects was provided in the September NIST Update presentation. Clearer alignment between critical areas and investment decisions will be made.
Obtain budget increases to equip the AML, improve the NCNR, and modernize Boulder labs.	Plans are being developed for the N^3F and AML to maximize usage and impact on the nation. This may include increasing their priorities within existing budgets. The FY 2005 budget included $6.9M CRF to fund the current phase of the Boulder Central Utility Plant (CUP) upgrade. The FY 2006 Presidential budget request includes: • $9.4M CRF to complete CUP upgrade • $6.5M CRF for Boulder Building 1 design • $4M CRF for Boulder Building 4 design & renovation • $8.1M increase to SCMMR base
Stabilize funding for MEP and ATP.	This is an ongoing issue and is subject to FY 2006 Congressional appropriations.

Outreach	
Develop a longer-term comprehensive plan for marketing capabilities to key customers and stakeholders.	NIST is working on refining a common "NIST message" to use in outreach activities. NIST SMB has established a "key customer" outreach program. The Director has been reaching out to major manufacturers, customers of NIST services, and agencies responsible for addressing national priorities. Examples include Boeing, Ford, and USCAR. OU Directors have been charged with doing the same, by sector.
VCAT will continue to advise NIST's stakeholders on the strategic direction and value of NIST.	Thank you for your commitment and success in advising NIST's stakeholders. Your work to advise NIST's stakeholders including DOC, OMB, OSTP, and Congress is very much appreciated.
Strategic Direction and Performance	
Develop specific short-term and long-term metrics and other quantitative data consistent with the Baldrige Framework. Reflect this in the 2005 Balanced Scorecard.	The "Building the Next Generation Leaders" leader program established a Baldrige at NIST study group that is working with Harry Hertz. They have developed a draft Organizational Profile, the first step in the Baldrige process. Technology Services has also begun implementing the Baldrige process to improve their services. David Spong gave a talk to NIST staff about Baldrige. The FY05 Balanced Scorecard (provided to the VCAT in June) was improved with the addition of a new section on programs based on your recommendations and aligned with OMB and Commerce metrics. The *NIST Performance Measurement and Evaluation System* overview was distributed at this meeting.
Expand efforts in the Strategic Focus Areas. In particular, closely examine NIST's role in biosciences and the pharmaceutical industries.	The Nano and Bio SWG has been tasked with developing a list of high priority options to consider for budget initiatives.

	NIST has carefully cataloged its research activities related to Biosystems and Health. NIST has developed a fact sheet to inform the pharmaceutical industry about NIST's research and services.
Continue to explore opportunities for extensive collaborations and partnerships to take advantage of expertise outside of NIST. Update the strategic plan to include strategies for identifying where partnerships should be appropriate, targeting specific partnerships, and achieving these partnerships.	NIST is developing an internal document to enunciate our strategy and to guide our strategic planning on partnerships. We are evaluating strategies for using MOUs as part of this effort. An example of the kind of successful partnership relationship NIST plans to develop is USCAR.
Integrate the analysis of NIST's role in the National Measurement System into the next version of the Strategic Plan.	USMS is one component of our strategic planning efforts for identifying national needs and NIST's role. The planned series of targeted workshops will provide critical outside input to our strategic planning process.
Organizational Excellence	
Continue to upgrade aging buildings and facilities.	The highest priority items for facilities are renovations in Boulder. Longer term priorities are renovations in Gaithersburg. Details from the FY 2006 budget request are presented in an earlier slide.
NIST's Safety Council should benchmark safety practices with other organizations and seek additional advice from VCAT members with expertise in this field.	This comparison data was presented in the NIST update presentation.

Appendix D. Abbreviations

AAAS	American Association for the Advancement of Science
AML	Advanced Measurement Laboratory
ANSI	American National Standards Institute
ASTM	ASTM International, originally known as the American Society for Testing and Materials
ATP	Advanced Technology Program
CAVS	Cryptographic Algorithm Validation System
CMVP	Cryptographic Module Validation Program
CMM	Coordinate Measuring Machine
CRF	Construction of Research Facilities
DHS	Department of Homeland Security
DoC	Department of Commerce
DOE	Department of Energy
FIPS	Federal Information Processing Standards
FY	Fiscal Year
HAVA	Help America Vote Act
HHS	Department of Health and Human Services
HS	Homeland Security
I/KM	Information and Knowledge Management
ISO	International Organization for Standardization
JILA	A joint research institute of NIST and the University of Colorado at Boulder
LWIFR	Lost Workday Incident Frequency Rate
MEP	Manufacturing Extension Partnership
MOU	Memorandum of Understanding
N^3F	National Nanomanufacturing and Nanometrology Facility
NCMC	NIST Combinatorial Methods Center
NCNR	NIST Center for Neutron Research
NIJ	National Institute of Justice
NIST	National Institute of Standards and Technology
NSTC	National Science and Technology Council
NNI	National Nanotechnology Initiative
OA	Other Agency
OLES	Office of Law Enforcement Standards
OMB	Office of Management and Budget
OSTP	Office of Science Policy and Technology
OU	Operating Unit
RFID	Radio Frequency Identification
SCMMR	Safety, Capacity, Maintenance and Major Repairs
SMB	Senior Management Board
STRS	Scientific Technical Research and Services
SWG	Strategic Working Group
US-VISIT	United States Visitor and Immigrant Status Indicator Technology Program
USMS	U.S. Measurement System
VCAT	Visiting Committee on Advanced Technology
WTC	World Trade Center

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