CHAPTER FIVE

THE NATIONAL BUREAU OF STANDARDS BECOMES THE NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY: PUBLIC LAW 100-418, AUGUST 23, 1988

A NEW MISSION AND A NEW NAME

Although he did not realize it, Luigi Crovini, chief of the thermometry program at the Italian national standards laboratory, spoke for many metrologists when he asked in 1988, "Is it true that the National Bureau of Standards is changing its name? This is a very strange thing, to discard a name that is known throughout the world as designating the best metrology laboratory."[1] The change puzzled many staff members at NBS, too.

However, the change should have come as no surprise. It was rooted in the growing awareness in Congress that the American enterprise was faltering in international competition. Many in Congress knew that foreign governments—far from worrying about the niceties of anti-trust legislation as the United States government had done for decades—joined wholeheartedly in the industrial programs of their countries, smoothing the way to success in international trade. Even members of Congress who decried the excesses of "big government"—an attitude long associated with the Republican party—became willing to marshal the resources of the Federal establishment for the benefit of U.S. industry.

Given the increased emphasis on international competitiveness, technology transfer, and industrial productivity in the dialog between NBS and Congress during the 1980s, new legislation to re-define the mission of the Bureau was almost a certainty. The change in the name of the agency—in the view of the Congress—merely served to underscore its new role within the Department of Commerce.

Following the Congressional elections of 1986, the Senate Commerce Committee—under its new chairman, Ernest Hollings of South Carolina—was determined to give additional responsibilities to NBS as one of several initiatives to improve American competitiveness in world-wide markets. As it happened, there were many members of both houses of Congress who had similar feelings about American agencies and practices. Considering activities as varied as educational methods, Patent Office regulations, and international fiscal policy, Senators and Representatives debated ways to cure the ills of the American economy.

[1] Luigi Crovini, Head of Thermometry, Istituto di Metrologia "G. Colonetti," Torino, Italy; private conversation with the author.

Months of effort—both in the Senate and in the House—to accomplish these multiple goals resulted in the *Omnibus Trade and Competitiveness Act of 1988,* Public Law 100-418.[2] Ten Titles covered a range of trade-related topics in more than 460 pages of text, representing an amalgamation of ideas from throughout Congress. The titles convey the breadth of the Act's intended reach:

- Title I. Trade, Customs, and Tariffs.
- Title II. Export Enhancement.
- Title III. International Financial Policy.
- Title IV. Agricultural Trade.
- Title V. Foreign Corrupt Practices Amendments, Investments, and Technology.
- Title VI. Education and Training for American Competitiveness.
- Title VII. Buy American Act of 1988.
- Title VIII. Small Business.
- Title IX. Patents.
- Title X. Ocean and Air Transportation.

For Bureau employees and their colleagues in the world's national metrological laboratories, the most significant of the provisions of Public Law 100-418 were to be found deep within Title V. Mimicking the Act itself, Title V addressed a mixture of ideas:

- Subtitle A. Foreign Corrupt Practices Act Amendments, Review of Certain Acquisitions.
- Subtitle B. Technology.
- Subtitle C. Competitiveness Policy Council Act.
- Subtitle D. Federal Budget Competitiveness Impact Statement.
- Subtitle E. Trade Data, Impact, and Studies.

The line that caught the attention of NBS employees was lodged in *Subtitle B. Technology* of Title V's disparate collection. *Subpart A of Part I, Subtitle B, Title V, PL 100-418* carried the heading "National Institute of Standards and Technology." Just like that, the "National Bureau of Standards" was no more.

An indication of congressional faith that NBS could play a significant role in a resurgent American presence in world trade can be found in a few lines of the text of Subpart A:

[2] 102 STAT. 1107, Public Law 100-418. Its 10 titles occupy 467 pages in the U.S. Statutes At Large. Title V, amending the NBS Organic Act, fills 26 pages.

> The National Bureau of Standards since its establishment has served as the Federal focal point in developing basic measurement standards and related technologies, has taken a lead role in stimulating cooperative work among private industrial organizations in efforts to surmount technological hurdles, and otherwise has been responsible for assisting in the improvement of industrial technology. It is the purpose of this Act to rename the National Bureau of Standards as the National Institute of Standards and Technology and to modernize and restructure that agency to augment its unique ability to enhance the competitiveness of American industry while maintaining its traditional function as lead national laboratory for providing the measurements, calibrations, and quality assurance techniques which underpin United States commerce, technological progress, improved product reliability and manufacturing processes, and public safety.

It was clear from the quoted text that Congress intended to add substantial new responsibilities to the NBS mission. There was no indication that the new assignments should replace existing ones.

When the announcement came, the great majority of NBS staff members were offended that Congress would change the name of the Bureau. Only a few read the text of PL 100-418. Some employees counseled Director Ernest Ambler to retain NBS as a title, as if it were his option. Others simply shook their heads at the apparent ease with which Congress cast aside nearly a century of tradition.

Foreign colleagues such as Luigi Crovini were thunderstruck that such a valued American "trademark" would be discarded. For them, "National Bureau of Standards" identified the ultimate in objectivity and accurate measurements.

Because of the widespread surprise caused by passage of Public Law 100-418, it is worthwhile to document the signs of its coming.

Signs of Impending Change at NBS

The *Omnibus Trade and Competitiveness Act of 1988* came as a shock to most NBS employees. For those who would see, however, the portents of change had been visible for years.

A Growing National Need

A key ingredient in the mandate for change—not simply in name, but in the Federal role for the Bureau as well—was the existence of a pressing National need. A pressing National need there was indeed, and it was a need of long standing. American industry had been out-sold for years by foreign competitors. Consumer goods led the list—automobiles, television sets, radios, audio and video players, electronic toys, clothing, and a raft of other items. The steel products, heavy tractor-based equipment, and many other construction items used by Americans quite often were manufactured outside the United States. By 1983, the balance of international trade had shifted dramatically away from America.[3] The following table comparing trade balances for several nations during the decade of the 1980s illustrates the magnitude of the shift.

Current Trade Balances (in billions of U.S. dollars)

Country	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
United States	6	–7	–44	–104	–113	–133	–144	–127	–106	–92
West Germany	–3	5	5	10	17	40	46	50	55	44
United Kingdom	15	8	6	3	5	16	–7	–27	–34	–24
Japan	5	7	21	35	49	86	87	80	57	36

Source: International Monetary Fund, quoted by Lester Thurow, *Head to Head: the Coming Economic Battle Among Japan, Europe, and America* (New York: William Morrow and Company, Inc. 1992) p. 231.

The Congress, with advice from many quarters, perceived the problem underlying the debilitating trade balance as one of declining American technology. A committee of the National Academy of Engineering (NAE) issued in the spring of 1988 a comprehensive report on the role of technological issues in American competitiveness.[4] In its report, the NAE committee—which included among its members John W. Lyons, then director of the NBS National Engineering Laboratory—urged the Federal government to:

> Use its diverse capabilities to broadly encourage the technological developments that are critical to sustaining the competitive interests of the nation. Efforts need to be focused through a designated entity that can effectively respond to industry initiatives and interact with non-government groups, including industry.

It was not difficult for members of Congress to envision the National Bureau of Standards fulfilling the role of such a "designated entity," given the well-earned and well-known bond between the Bureau and the technology sector of American industry.

What's in a Name?

Besides wanting a Federal champion for American industry, it is likely that certain members of Congress also recalled the words of Allen Astin, testifying before a House Appropriations subcommittee in 1971:[5]

> Part of the difficulty in some of the lack of appreciation of the range of the Bureau programs and services is the name—The National Bureau of Standards. Some Secretaries of Commerce, on learning of the scope and importance of the

[3] See, for example, the description of "stagflation" by James MacGregor Burns, "The Crosswinds of Freedom," (New York: Vintage Books, 1990) pp. 557-559.

[4] "The technological dimensions of international competitiveness," *National Academy of Engineering*, Washington, DC, April 1988.

[5] See Oversight Hearings Testimony, Chapt. 2.

Bureau activities, have suggested that we devise a new and more descriptive name. I have viewed such suggestions with mixed thoughts. I can definitely see several advantages to a broader name. On the other hand, the present name is held in high regard by the Bureau's specialized clients and there is danger of losing some of this with a new name. I would want to retain the word "standards" in any new title. However, our counterpart laboratories in England and Germany have the names National Physical Laboratory and Physikalisch-Technische Bundesanstalt, respectively, and the word "standards" does not appear.

The National Bureau of Standards had never been represented by a more devoted champion than Allen Astin. Yet it was clear that Astin himself had considered its name to be a mixed blessing. On the one hand, it provided a well-known mark of excellence in research and rigor in objectivity. On the other, it offered a delimiting title that identified only part of the multi-faceted entity that was the Bureau.

"New Activities in Technology"

In tracking the path of Congress towards its designation of NBS for a key role in improving America's position in international competition, it is also well to remember the words of Lewis Branscomb. Branscomb, during his brief but intense tenure as NBS Director, saw Bureau involvement in industrial technology as neither new nor frightening. In his first address to the NBS staff, Branscomb noted the plethora of new responsibilities given NBS by the Congress, many of them ranging far beyond traditional research on measurements and scientific standards. But he urged the staff not to shrink from assigned tasks in applied science:[6]

> I have been aware of the widespread view that the new activities in technology introduce an alien, and some would say incompatible, dimension into NBS—a set of programs essentially different in character from those that have gone before. But the more I look into the problem of fostering innovation—or, if you prefer, encouraging engineering creativity in the solution of practical problems —the more I find that the cure calls for the science of measurement once again, and often at a high level of sophistication.

Branscomb backed up his words with action throughout his short reign, modifying even the style in which NBS programs were presented to Congress during budget hearings. From a listing that emphasized scientific disciplines, Branscomb changed the description to one that portrayed NBS as an agency that addressed national problems:[7]

- Providing the basis for the Nation's physical measurement system.
- Providing scientific and technological services for industry and government.
- Providing the technical basis for equity in trade.

[6] See Assessing Branscomb's Directorship, Chapt. 2.

[7] Budget hearings, *House Subcommittee on Departments of State, Justice, and Commerce, the Judiciary, and Related Agencies,* 92nd Congress, First Session, April 20, 1971, p. 1118.

- Providing technical services to promote public safety.
- Providing technical information services.
- Providing one-of-a-kind facilities for use by NBS and visiting scientists.

It is worth noting that Congress responded favorably to Branscomb's activist language, voting to raise the NBS appropriation by some 30 % for Fiscal Year 1972.

"Industrial Innovation and Productivity"

Early in his tenure as director, Ernest Ambler developed the view that NBS could prosper as a more active partner in American industrial progress. Observing the positive response to Bureau research in the areas of energy, environment, safety, and health, Ambler noted in 1980 the "needs for improved industrial innovation and productivity."[8] Throughout his term, he continually pressed the idea that NBS should become more directly involved with industry in solving technological problems.

Ambler took to heart suggestions in the 1982 Packard Report calling for a sharper definition of agency mission and for closer ties to outside organizations. Under his leadership, Bureau relations with industry expanded vigorously.

"Automated Manufacturing" Shows the Way

The success of the Automated Manufacturing Research Facility might have convinced the last skeptics that NBS could work directly with industrial engineers to enhance their use of technology.[9]

The basis for the Bureau's automated manufacturing project was research in dimensional metrology under the leadership of John A. Simpson and Robert J. Hocken. Taking as one challenge the accurate measurement of large container volumes, Hocken, Simpson, Bruce R. Borchardt, John W. Lazar, Charles P. Reeve, and Philip G. Stein by 1977 had developed new methods for accurate measurements in three dimensions. Their work was based on the use of a classical measuring machine fitted with laser interferometers. The machine and the interferometers were controlled by a dedicated minicomputer to determine the position of a single reference point, from which a machine-independent set of measurements could be created.[10] By 1979, Hocken and Borchardt had evaluated axis non-orthogonality errors associated with the technique.[11]

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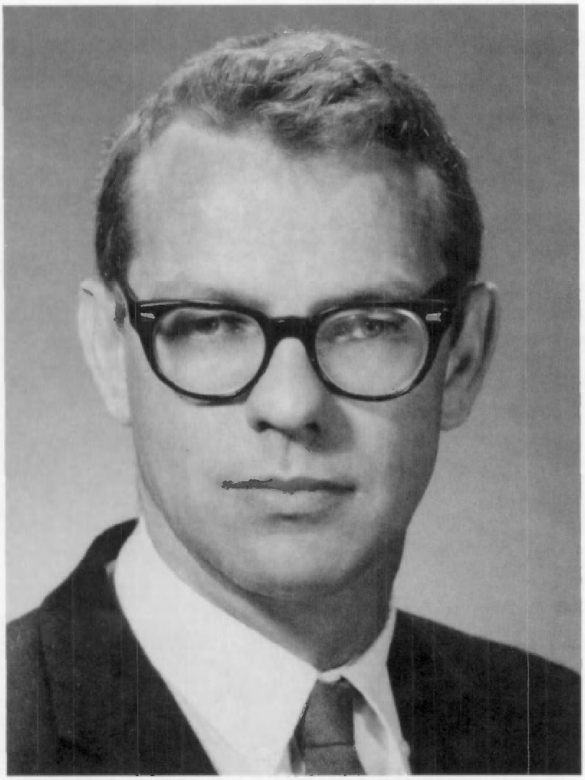
[8] E. Ambler, Preface to *"NBS 1980," NBS Special Publication 600,* January 1981, 40 pp.

[9] Much of the information in this section was kindly supplied by Dennis A. Swyt. See also *The Beginning of "Technology Transfer,"* Chapt. 4.

[10] R. Hocken, J. A. Simpson, B. Borchardt, J. Lazar, C. Reeve, and P. Stein, "Three dimensional metrology," *Ann. Int. Inst. Prod. Eng. Res.* **26**, No. 2, 403-408 (1977).

[11] R. J. Hocken and B. R. Borchardt, "On characterizing measuring machine geometry," *NBSIR 79-1752,* June 1979, 25 pp.



John A. Simpson, an expert in electron physics, worked at NBS/NIST from 1948 to 1993. He received many awards for the excellence of his scientific studies and his management achievements. His vision was of the greatest importance to the creation of the Automated Manufacturing Research Facility.

Within another 2 years, a group including Hocken, Borchardt, Reeve, William C. Haight, Clarence L. Carroll, Ronald G. Hartsock, Fredric E. Scire, and Ralph C. Veale had demonstrated the ability to measure the capacity of ship cargo tanks designed for the transport of liquefied natural gas (LNG) with an uncertainty of only +0.05 % of the total volume. They measured 18 such tanks using the laser-based dimensional metrology, providing calibration reports that specified the tank volumes as functions of their liquid levels.[12]

The measurements presented a challenging problem: each tank held about 5 million gallons of LNG; each tank was made from 10 flat planes which—when assembled—could enclose an eight-story building; and the temperature of the tanks in use dropped to −160 °C, engendering significant volume changes as a result of thermal expansion. The actual volume of the tanks was a critical issue in the pricing of LNG shipments, since no accurate cryogenic flowmeter then existed.

[12] W. C. Haight, R. J. Hocken, B. R. Borchardt, C. L. Carroll, R. G. Hartsock, C. P. Reeve, F. E. Scire, and R. C. Veale, "Estimated accuracy of calibration of some membrane-type LNG transport tanks," *NBSIR 80-2141* January 1981, 83 pp. See also Robert J. Hocken and Philip Nanzetta, "Dimensional metrology at the National Bureau of Standards," *The Physics Teacher* **21**, No. 8, 506-513 (1983).

In 1978, NBS scientist Robert J. Hocken explained the NBS three-dimensional measuring machine to a group of visitors from the National Science Foundation (NSF). From left to right were NBS Director Ernest Ambler, NSF Senior Science Associate Robert Rabin, NSF Director Richard C. Atkinson, Robert J. Hocken, and NSF Assistant Director for Astronomical, Atmospheric, Earth, and Ocean Sciences John B. Slaughter.

The group, then part of the Automated Production Technology Division, also developed methods for the accurate positioning of a numerically controlled milling machine, transforming it into a three-dimensional coordinate-measuring machine by replacing the cutting tool with a sensing probe. Again, the Bureau team broke new ground in the measurement technique, defining and minimizing positional errors endemic to the machine—one of which, for example, resulted from thermal expansion of its parts.

Because accurate measurements directly affected industry's "bottom line," the new Bureau capability was immediately recognized by major portions of America's manufacturing industry as extremely valuable.

John Simpson, Robert Hocken, and William Haight shared the NBS Applied Research Award in 1980 for the development and implementation of the automated, self-correcting, three-axis coordinate-measuring machine.

By 1983, the dimensional-metrology effort had become a mainstay of an Automated Manufacturing Research Facility at NBS. M. J. Mitchell and Edward J. Barkmeyer, Jr. described one of its outstanding problems—the development of a dictionary system for use in integrating existing databases into control processes.[13]

[13] M. J. Mitchell and E. J. Barkmeyer, "Data distribution in the NBS Automated Manufacturing Research Facility," *Proc IPAD II, Advances in Distributed Data Base Management for CAD/CAM, Denver, Colorado, 17-19 April, 1984*, pp. 211-227.

A natural collaboration between researchers working on dimensional metrology and a robotics team from the Institute for Computer Sciences and Technology was fostered by the NBS reorganization of 1978.

James S. Albus, an electrical engineer who left the National Aeronautics and Space Administration in 1973 to study sensors and computer control technology at NBS, led a team that created a variety of robotic devices at the Bureau. These found uses in many military and industrial settings. In one project, NBS prepared specifications for the Navy to use in competitive procurement of robots.

Led by Albus and including Anthony J. Barbera, Mary L. Fitzgerald, and Marilyn Nashman, the NBS robotics team focused its early efforts on some eight features of robots:[14]

- Accuracy of position.
- Dynamics of manipulation.
- Sensors.
- Control systems.
- World modeling.
- Development of software.
- Standards for interfaces.
- Mobility.

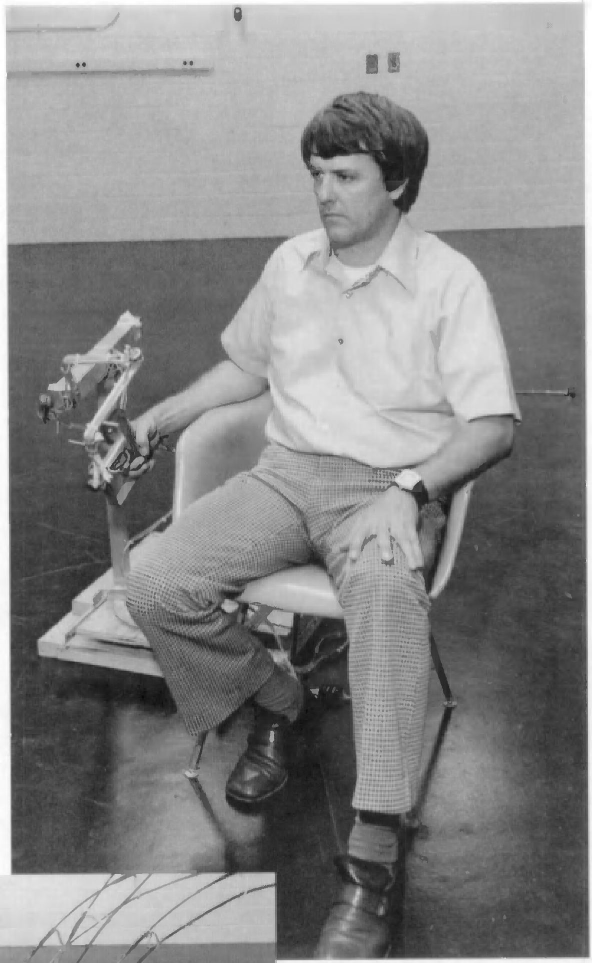
The idea to create an Automated Manufacturing Research Laboratory was born in 1979 as NBS scientists realized the significance to American industry of a factory in which every part could be made automatically, with no rejects and little scrap. The concept had several components: careful analysis of the manufacturing process to reduce errors in materials treatment to acceptable levels; generation of manufacturing protocols involving robotics and humans within a generic system; and development of interfacing methods to permit the use of optimum efficiency in the choice of equipment, control computers, and software.[15]

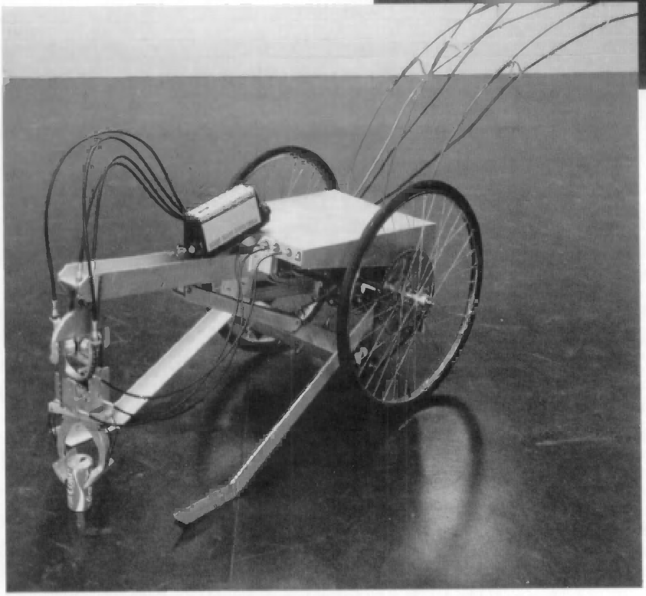
The AMRF received congressional funding as a new NBS initiative in 1981, and it received financial support from a U.S. Navy program in Manufacturing Technology at the same time. Taken together, these funds allowed construction of the facility as an adjunct to the NBS Instrument Shop.

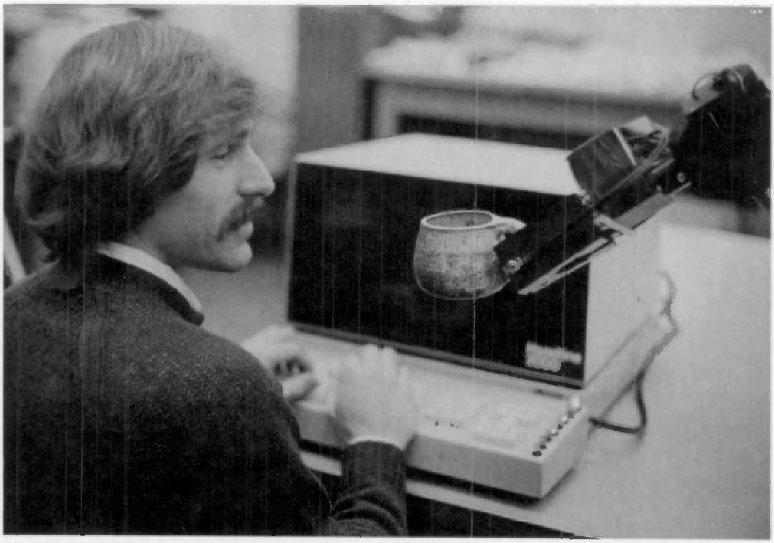
[14] James S. Albus, "Industrial robot technology and productivity improvement," *Exploratory Workshop on the Social Impacts of Robots: Summary and Issues*, February 1982, pp. 62-89. See also J. S. Albus, A. J. Barbera, M. L. Fitzgerald, and M. Nashman, "Sensory interactive robots," *Ann. CIRP* **30**, No. 2, pp. 559-562 (1981).

[15] J. A. Simpson, R. J. Hocken, and J. S. Albus, "The Automated Manufacturing Research Facility of the National Bureau of Standards," *J. Manufacturing Systems* **1**, pp. 17-31 (1982). See also John A. Simpson, "Mechanical measurement and manufacturing," *Control and Dynamic Systems* **45**, pp. 17-30, 1991. See also Philip Nanzetta, "Technology transfer from the Automated Manufacturing Research Program at the National Bureau of Standards," *ibid* pp. 307-331, 1991.

James S. Albus (right) utilized a low-cost, mobile robot (left) to pick up a small object. The robot was built circa 1974 by NBS for the Department of the Navy to prove the feasibility of using low-cost, readily available components in robot construction.







In 1977, a computer-controlled manipulator, used in research that developed sensor control systems for industrial robots, handed NBS electronics engineer Anthony J. Barbera a cup of tea.

Within a few years, the facility had achieved spectacular success. More than 40 companies had sent Industrial Research Associates to work on its projects, and equipment worth more than $12 million had been donated or lent by participating organizations. By the time NBS became NIST, the facility boasted a horizontal turning center, a vertical turning center, a cleaning and deburring center, and a final inspection center. Each center was served by a robot, robotic materials transport, and an automated storage and retrieval system. A *Hierarchical Control System,* developed in concert with hundreds of private companies and other government agencies, operated the facility's equipment.

The AMRF was an operating model of technology transfer, industrial productivity, and industrial competitiveness. Its projects benefitted the U.S. military effort in many ways as well.

So it was that one could easily find reasons for inclusion of NBS in Public Law 100-418, legislation intended to rescue American industry from the ravages of foreign competition. Congress readily saw the Bureau as an effective weapon to be used in the battle. And if its name were to be changed to emphasize its expanded role in the fight, well, Astin himself had not discouraged such a step.

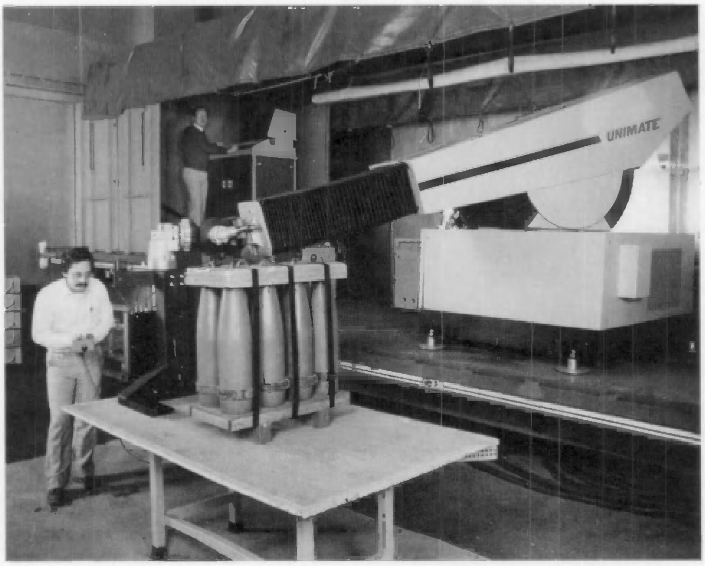
NBS engineering technician Michael Huff (seated) and project manager Kang Lee monitored the Mare Island Flexible Workstation at the Bureau's Automated Manufacturing Research Facility (AMRF). This workstation was developed by NBS for the U.S. Navy's Mare Island Naval Shipyard in the first large-scale transfer of flexible automation technology from the AMRF to a production facility.

Planning for Change

Most aware of all the Bureau staff regarding impending changes in the NBS charter were three of its leading managers in 1987—Director Ambler and two of his major laboratory directors, Donald R. Johnson, director of the National Measurement Laboratory and John W. Lyons, director of the National Engineering Laboratory. By the time PL 100-418 became law, Johnson had been involved for nearly a year in the extensive planning necessary to prepare the massive text, and Lyons had been involved even longer, though unofficially.

On September 30, 1987, Director Ambler sent to Johnson a memo assigning him to lead the planning effort for the Technology Competitiveness Act:[16]

[16] Memo, "Preparing for the Technology Competitiveness Act Assignments," Ernest Ambler to Donald R. Johnson, September 30, 1987.



In 1985, NBS engineers Azizollah Abrishamian (foreground) and Roger Kilmer began examination of a laboratory testbed for robotic sensor/controllers. The installation was built to study logistics for a U.S. Army human engineering project. The scientists sought to integrate proximity, vision, and other sensors into the NBS-developed real-time robot control system.

In the days just before the unveiling of the NBS Automated Manufacturing Research Facility in November 1983, (left to right) Anthony J. Barbera, Mary Lynn Fitzgerald, Len Haynes, Steve Leake, and Kathleen Strouse worked to solve last-minute problems with the facility's control systems.

> It seems prudent to commit ourselves to a full planning effort in order to prepare for the assignments to the Bureau contained in the House and Senate drafts of the Technology Competitiveness Act.
> Effective October 6, 1987, I would like for you to head the planning effort on a full-time basis. While you are on detail from your present assignment as Director of the National Measurement Laboratory, Dr. Helmut Hellwig will act for you.
> In addition to leading the planning effort, you will take primary responsibility for working with all the interested parties external to the Bureau. Ray Kammer will assist you in assuming these responsibilities.

Johnson's planning assignment lasted until the following June. During that time he led the effort that resulted in a workable plan for an *Advanced Technology Program, Regional Centers for the Transfer of Manufacturing Technology, State Technology Extension Services, a Non-Energy-Related Inventions* project, and—perhaps of necessity—a change in the venerable name of the National Bureau of Standards. It was a busy time for the manager, but one that he recalled as challenging.[17]

Even before Donald Johnson was operating as the Bureau's designated planner for PL 100-418, John Lyons was involved in discussions with staff members of the Senate Committee on Commerce, Science, and Transportation.[18] Lyons was sought out for his views because Bureau programs such as the Automated Manufacturing Research Facility were located within the National Engineering Laboratory (NEL). Director Ambler encouraged Lyons to provide members of Congress and their staffs with information on the successes of industrially oriented NEL programs. Lyons also provided information obtained by him during visits to "technology centers" in Japan. These were governmental bodies that funded selected industrial research and development initiatives in Japan.

It was the opinion of Lyons that the accomplishments and future plans for the AMRF figured heavily in the eventual "technology transfer" content of PL 100-418.

For both Johnson and Lyons, the new legislation simply reflected a crystallization in Congress of long-felt needs to find some way to stanch the hemorrhage of dollars from a disastrously negative U.S. balance of payments. Lyons—a veteran of two decades of employment in industry—was particularly attuned to reorganization as a frequent response by corporate management to changing conditions. He saw the Congress as a sort of "Board of Directors" for government agencies; unwieldy because of numbers and variation in views held by individual members, but all-powerful nonetheless.[19]

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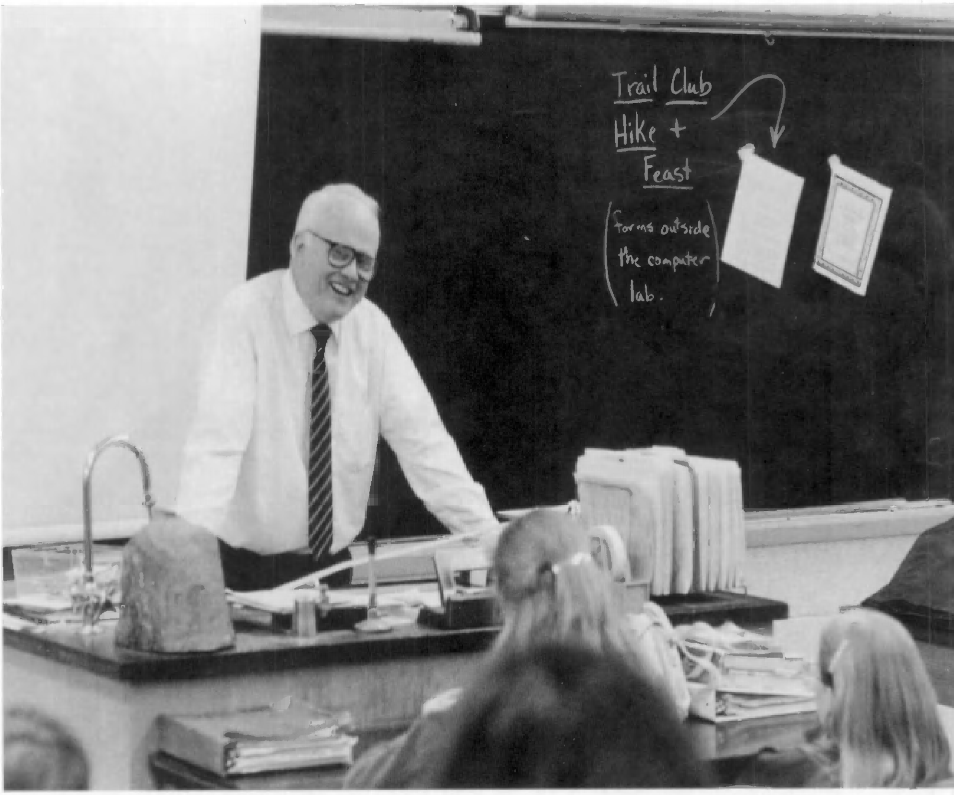
[17] Donald R. Johnson, Oral History, September 8, 1998.

[18] John W. Lyons, Oral History, June 1, 1993, and June 9, 1993.

[19] John W. Lyons, Oral History, June 1, 1993.

In 1987, Donald R. Johnson (right), director of the NBS National Measurement Laboratory, showed Maryland Senator Paul Sarbanes (center) and a member of Sarbanes' staff several examples of NBS Standard Reference Materials.



In February 1991, John W. Lyons taught classes at a Gaithersburg, Maryland, school as part of an annual National Engineers Week "teach-in."

PUBLIC LAW 100-418

The *Omnibus Trade and Competitiveness Act* received a sympathetic hearing by the 100th Congress, primarily because control of the Congress had passed to the Democratic Party in the 1986 elections. In the minority during the previous years of President Reagan's administration, Senator Hollings and his colleagues on the Commerce, Science, and Transportation Committee favored governmental intervention in the plight of America's industry in international trade. Hollings visited the NBS Automated Manufacturing Research Facility (AMRF) during efforts to bring to his home state a new technology center. In the course of that visit, Hollings recognized the significance of the AMRF program for developing and commercializing new technology. He became a leading proponent of an expanded role for NBS in the National competitiveness effort.

Congressional plans to enhance U.S. competitiveness had surfaced in several draft bills over a period of years. Many of these plans were made part of PL 100-418 to add technological strength to the legislation. Although issues involving international trade dominated congressional discussion of the bill, the future of NBS was bound tightly to its technical provisions.

Many Republican members still agreed with the President that less government was better government, but their numbers were dwindling. By the time Congressional Republicans returned to power in 1995, support of PL 100-418 was moot; the value to U.S. industry of the new programs had been well established.

A New Organic Act

The 26 pages of text of PL 100-418 that referred to NBS was identified as the *Technology Competitiveness Act.* This Act-within-an-Act made few substantive changes in the duties assigned to NBS/NIST, but changed drastically the emphasis on those duties and the level of detail with which they were prescribed. Gone was the simplicity of the two-page legislation approved by the 56th Congress in 1901, with its few lines instructing the Bureau to develop and maintain standards, offer calibration services, provide needed data, and solve technical problems. In its place, Congress sent forth an intricate set of instructions that left no doubt of its intent.[20]

The contrast in length between the Bureau's founding legislation and PL 100-418 is so striking as to merit explanation. In simple terms, the difference in detail between the two acts is less surprising when measured against the gradual lengthening of amendments to the 1901 legislation over the better part of a century.

Appendix A lists more than 70 pieces of legislation affecting the National Bureau of Standards during the period 1901-1993. One of these, the *Solar Heating and Cooling Demonstration Act of 1974,* PL 93-409, exemplifies the trend toward more and more lengthy instructions for all agencies with the passage of time. Some eight sections of the Solar Act pertain to NBS. Descriptions of such matters as definitions of solar heating and cooling, development and demonstration of solar systems to be used in residential and commercial buildings, monitoring of projects, and dissemination of information thus produced more text than had been used to establish the Bureau in 1901. Viewed in this light, the length of PL 100-418 is more understandable.

The *Technology Competitiveness Act*—the portion of the Omnibus Trade and Competitiveness Act that created NIST—consisted of Subparts A through F. The headings for these subparts were:

- Subpart A—National Institute of Standards and Technology.
- Subpart B—Technology Extension Activities and Clearinghouse on State and Local Initiatives.
- Subpart C—Advanced Technology Program.
- Subpart D—Technology Reviews.
- Subpart E—Authorization of appropriations.
- Subpart F—Miscellaneous Technology and Commerce Provisions.

In the following paragraphs, we note significant features of each subpart.

[20] The text of *Subtitle B, Part I* is reproduced in full in Appendix A. So is the NBS founding legislation, PL 56-177.

Subpart A—A New Name for NBS

Section 1 of the original organic act (Public Law 56-177, 3 March 1901) consisted of a single sentence: "Be it enacted that the Office of Standard Weights and Measures shall hereafter be known as the National Bureau of Standards." This sentence was replaced in the new legislation by a page of declarations and intentions rooted in the traditional responsibilities for precise measurements and calibrations, but stressing heavily the importance of providing assistance to American industry in acquiring new basic technologies, including automated manufacturing processes.

As noted earlier, most Bureau employees were startled at the change in the name of the institution from the National Bureau of Standards to the National Institute of Standards and Technology. Few were aware that, save for the unfortunate definition of the acronym NIT ("nit, n. —The egg of a louse or other parasitic insect"[21]), the new name might have become National Institutes of Technology, in analogy with the National Institutes of Health, an organization long respected for its effectiveness in advancing the quality of U.S. health care.[22]

New Functions and New Activities

The language of Section 2 of the 1901 Act, a nine-line paragraph describing the functions of NBS, was given much greater detail in 1950 by Public Law 81-619. That act provided the first complete restatement of NBS functions since its founding. Although the legislation was entirely consistent with the original Organic Act, it enumerated in detail some six functions and 19 activities for the Bureau.

The 1988 *Omnibus Trade Act* further expanded Section 2 to three pages in the U.S. Statutes. By placing it first, the Act emphasized the importance of the following task:

> (1) To assist industry in the development of technology and procedures needed to improve quality, to modernize manufacturing processes, to ensure product reliability, manufacturability, functionality, and cost-effectiveness, and to facilitate the more rapid commercialization, especially by small- and medium-sized companies throughout the United States, of products based on new scientific discoveries in fields such as automation, electronics, advanced materials, biotechnology, and optical technologies.

The new text followed the first instruction with more than 30 detailed provisions that were mostly consistent with ongoing Bureau projects.

In the 1901 legislation, the Bureau had been instructed to exercise its functions for the benefit of "firms and corporations." Within the limits of then-current antitrust legislation, NBS scientists had often followed that instruction, assisting industry in solving its measurements and standards problems. In the new legislation, relations between NIST and industrial firms were spelled out in considerable detail to make it clear that the old antitrust fears limiting contact between NBS researchers and industrial researchers were to be eased considerably.

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[21] Webster's New International Dictionary, 2nd Ed.

[22] John W. Lyons, Oral History, June 9, 1993.

NIST Director's Organization Plan

Subpart A also required the NIST Director, within 120 days, to present to the House Committee on Science, Space, and Technology and the Senate Committee on Commerce, Science, and Transportation a detailed organization plan for NIST. The plan had to satisfy several requirements:

- Establish the major operating units of NIST.
- Assign each of the required functions of NIST to one or another of these units.
- Provide details of a 2-year program for NIST, including an *Advanced Technology Program.*
- Provide details indicating how NIST would expand and fund a *Non-energy-related Inventions Program.*
- Make no changes in the Center for Building Technology or the Center for Fire Research.

Creating a plan for reorganizing NBS into NIST so quickly was a challenging task, though it was made easier by the preliminary planning carried out by Johnson and Lyons. Foretelling a useful, expanded role for NIST in technology transfer was itself problematic, since only the first steps in that direction had been taken. Forecasting the likely interests of a new presidential administration—to be elected and installed just as the plan was due to be submitted—presented similar uncertainties. Another problem was that Ernest Ambler was about to retire from government service after 14 years as the agency director—he might have felt it wise to leave some or all of the transition decisions to his successor.

As matters would turn out, Ernest Ambler and his deputy director, Raymond G. Kammer, Jr., would share the responsibility for submitting the required organization plan to Congress.

Subpart B—Technology Extension Activities

Technology Extension Activities, the subject of Subpart B of Title V, were created in the image of the extension centers of the Department of Agriculture. The agricultural centers had been powerful forces in disseminating up-to-date information on farming practices throughout America in an earlier time, and they still served U.S. agriculture well in 1988.

Regional Technology Centers

As part of the extension services, PL 100-418 mandated the establishment of Regional Centers for the Transfer of Manufacturing Technology. These centers, to be "affiliated with any United States-based nonprofit institution or organization that applies for and is awarded financial assistance under this section," were intended to become technological resources for U.S. manufacturing companies.

Activities of the new centers were to consist of demonstrating "automated manufacturing systems and other advanced production technologies" to industry, especially the small- and medium-sized firms that could ill afford to send research associates to NIST. Along with relevant information, the centers would be authorized to lend equipment to firms with fewer than 100 employees.

Each Regional Center was to be funded at least 50 % by its sponsoring organization. The maximum duration of support for any center was set at six years.

Authorization for the appropriation of earmarked funds—$40 million for fiscal years 1989 and 1990—was given for the Regional Centers program. However, the size of the program clearly would be determined by the amount of funds actually appropriated for it.

State Technology Programs

In addition to the Regional Centers, the new Act directed NIST to provide technical assistance to individual State technology programs through a variety of other activities.

The assistance was to begin with a national survey—to be completed within 120 days—of technical help currently provided by the states to manufacturing firms within their boundaries. On the basis of the information so acquired, NIST was to suggest ways by which it could make the state extension services more effective.

The legislation specified that information and advice, workshops for state personnel, and cooperative agreements between NIST and individual state governments should be used to implement the NIST activity. Appropriations to support the state extension program were authorized to the extent of $2 million per year over the following 3 fiscal years.

Non-Energy Inventions

Another paragraph of the new legislation directed the establishment of a program for the evaluation of inventions that were not energy-related (the NBS program which evaluated energy-related inventions was not to be impacted by this activity).

Subpart C—Advanced Technology Program

Subpart C of the Technology Competitiveness section of the new act addressed the establishment of an *Advanced Technology Program,* to be created at NIST.

The stated intent of the ATP was to help American businesses to:

- Rapidly commercialize new, economically significant scientific discoveries.
- Refine manufacturing technologies.

The clear motivation of the ATP was to enhance the competitive positions of U.S. manufacturing enterprises. Joint ventures among NIST, universities, and independent research organizations were encouraged, with the transfer of funds to individual companies in support of new, generic technical plans. It was hoped that such a step would "avoid providing undue advantage to specific companies."

The text suggested that joint ventures might consist of start-up funding for demonstration projects involving development and testing of equipment and process prototypes. It also encouraged emphasis on areas of NIST technical strength, and suggested that the collaborations make use of the provisions of the *1980 Stevenson-Wydler Technology Act* where appropriate.

The merit review process was to be used in choosing joint-venture collaborators. Corporate intellectual property was to be protected at all times.

Visiting Committee on Advanced Technology

The statutory Visiting Committee, which had advised the Secretary of Commerce on the state of NBS since its founding, was replaced in the new legislation by a Visiting Committee on Advanced Technology (VCAT). The new entity was to consist of nine members, appointed by the NIST Director. At least five of these were to come from U.S. industry, with the rest coming from academia. No one was to represent the Federal Government. The VCAT was to meet quarterly or more frequently. An annual report was to be transmitted to the Secretary of Commerce with reference to the new responsibilities of NIST.

Subpart D—Technology Reviews

Subpart D placed reporting tasks in the hands of the President. He was required to include in his 1990 budget request statements of policy and budget proposals in four research areas; semiconductors and semiconductor manufacturing technology, fiber optics and optoelectronic technology, superconductivity, and advanced technology for manufacturing. There would be plenty of work for NIST staff members in preparing these reports!

Subpart E—Authorization of Appropriations

The new act authorized about $145 million for technology activities at NIST for Fiscal 1988. The total was distributed among the following activities:

- Measurement Research and Technology, $41.9 M.
- Engineering Measurements and Manufacturing, $40.3 M.
- Materials Science and Engineering, $23.5 M.
- Computer Science and Technology, $7.9 M.
- Research Support, $19.6 M.
- Cold Neutron Facility, $6.5 M.
- Technology Extension Activities, $5 M.

Congressional *appropriations* of funds did not always match congressional *authorizations* (the numbers given above). In Fiscal 1988, for example, the authorization figures given above, totaling just under $145 M, did not materialize in the appropriation, which totaled a bit less than $138 M.[23]

[23] See Appendix I.

Subpart F—Other Provisions

Among provisions discussing, for example, continuity for the agency, user fees, and Stevenson-Wydler Act amendments, Subpart F of the new act contained one page of kind words for the Metric System, designating it as "preferred" for U.S. trade and commerce. Escape clauses were retained, however, in case metric measure was found "economically infeasible," "impractical," or "inefficient." In addition, use of traditional measurement systems was approved for non-business activities. The metric system still was obliged to make its own way through America's technical life.

A New Agency Begins Work

Resistance within the organization to the change in name from NBS to NIST died hard. Many staff members had exerted themselves greatly to ensure that the initials "NBS" on technical work denoted accuracy and objectivity. They were not happy that people who knew little of the organization could eradicate its name. Gradually, however, it became obvious to all that the deed was irreversible. It was time to begin new lives as employees of—could they say it?—NIST.

Ernest Ambler was still director when NIST began its life in August 1988, although he had announced his intention to retire from government service in April 1989. Within 4 months, however, Ambler had acceded to a request by Secretary of Commerce C. William Verity to serve temporarily as Under Secretary for Technology, a post created by Verity to enhance the role of technology in his department.

Along with two smaller agencies, the Under Secretary was responsible only for NIST, so that Ambler was able to participate—albeit at some distance—in the guidance of his home agency while on duty "downtown." Ambler returned to NIST in time to retire as its director.[24]

Raymond G. Kammer, Jr., Acting Director

Ambler's involvement with the office of Under Secretary for Technology left effective leadership of NIST to Deputy Director Raymond G. Kammer, Jr. Kammer, unique among those charged with direction of the agency, had no training as a scientist. His first position with NBS, in 1969, was as an analyst in the Office of Program Planning. In a series of assignments in budget and program analysis both at NBS and Commerce, however, Kammer became familiar with the management of Bureau technical projects. He quickly learned to evaluate the effectiveness of technical work despite his lack of formal training in technology. Ernest Ambler selected Kammer to be his deputy director in 1980. He served in that post until Ambler accepted the temporary position of Under Secretary of Commerce for Technology on December 2, 1988. At that time, Kammer became Acting Director of NIST; there he served until John Lyons was confirmed as Director on February 9, 1990.

[24] Ambler, *Special Publication 825*, pp. 39-40, 1991.

In 1977, NBS Director Ernest Ambler presented NBS senior program analyst Raymond G. Kammer, Jr. (center), with the William A. Jump Memorial Foundation Meritorious Award for Exemplary Achievement in Public Administration. Associate Director for Programs Howard F. Sorrows stood at Kammer's left.

NIST Reorganization Plan

In one of his first acts as NIST director, Ernest Ambler established an *Advanced Technology Program* (ATP). As mandated by PL 100-418, the program was made part of the office of the NIST director. Donald R. Johnson, who helped prepare the legislation describing the new program, was designated Acting Chief of the ATP.[25]

Another of Ambler's early acts as NIST director was to reassure the staff that, although the agency had been given new and ambitious marching orders, it would continue to embody high standards of scientific competence. Ambler accomplished this goal through an interview entitled "NBS has new name, expanded role," prepared by Michael Baum, a NIST Public Affairs Specialist. Discussing the new legislation, Ambler offered a prefatory statement:

> I believe the most significant part of this legislation is found right up front in the list of functions assigned to the agency. We now have a direct, unambiguous charge to work closely with industry on the development and use of the new technologies that U.S. companies need to stay competitive in the world marketplace.

[25] NIST Admin. Bull. 88-13, September 20, 1988.

The interview mentioned the Regional Centers for the Transfer of Manufacturing Technology, the Advanced Technology Program, the Technology Extension Program, and the Non-energy Inventions Program, all embodied in the Trade Act but unfamiliar to most of the NIST staff. While no details were given of the manner in which the new programs would be accomplished, Director Ambler expressed pleasure that Congress had shown faith in the traditional scientific capabilities of the Bureau:

> During the past 87 years as the National Bureau of Standards, this agency developed a reputation, of which we are all quite proud, for the highest standards of technical competence and objectivity. As the National Institute of Standards and Technology, we will continue to maintain the same high standards and to pursue excellence.[26]

In December 1988, Acting Director Kammer submitted to the Department of Commerce a proposed reorganization plan for NIST as required by PL 100-418. In the new plan, the four existing major units of NBS remained intact. This step was intentional. It minimized disruption of continuing programs which, after all, would be expected to provide the bulk of NIST accomplishments for the immediate future.

The most noticeable change from the structure of the old NBS was the addition of a new organizational unit identified as Industrial Technology Services (ITS), with Donald Johnson at its head. Comprising the new ITS were the following units:

- The Manufacturing Technology Program, headed by Philip N. Nanzetta.
- The Advanced Technology Program under George A. Uriano.
- The Office for Standards Services, led by Stanley I. Warshaw.
- The Office for Technology Commercialization, headed by David E. Edgerly.
- The Office for Industrial Extension Services under George P. Lewett.
- The Office for Measurement Services, with no chief named.

In addition to the new components, the reorganization plan included three traditional outreach programs—Standard Reference Materials, Standard Reference Data, and the calibration services—as parts of the Industrial Technology Services unit.

Kammer expected that the new structure might take effect by May 1989.[27]

An Associate Director for Quality Programs

In the context of NIST's mandate for increased emphasis on industrial productivity, the Malcolm Baldrige National Quality Award (see *The Malcolm Baldrige National Quality Award,* Chapt. 4) assumed new significance. First presented in November 1988, the award resonated immediately within American industry. The criteria used in judging award entries, circulated widely among manufacturing firms, seemed to provide both an incentive to excel and a recipe for excellence.

[26] "NIST Research Reports," *Special Publication 743,* October 1988.

[27] NIST Admin. Bull. 88-16, December 14, 1988.

In recognition of the high place deserved by the Baldrige award, Raymond Kammer created the post of Associate Director, NIST, for Quality Programs. Curt Reimann, who had generated the nation-wide program on short notice, was designated to act as director of the new office.

Regional Manufacturing Technology Centers

As directed by the provisions of the Trade Act, Philip Nanzetta, head of the Manufacturing Technology Centers program, quickly prepared and circulated application forms for use in choosing regional centers. Some 36 non-profit organizations applied for the designation despite the short notice.

The first Regional Manufacturing Technology Centers to be established were located at the Cuyahoga Community College in Cleveland (The Cleveland Advanced Manufacturing Program, a not-for-profit organization intended to emphasize research and development, technology applications, and training), Rensselaer Polytechnic Institute (RPI) in Troy, NY, and the University of South Carolina (USC) in Columbia.

At RPI, the funding provided by the program—approximately $1.5 million in matching funds per center—was expected to help establish the Northeast Manufacturing Technology Center, dedicated to applying advanced manufacturing technologies to material removal, assembly, and inspection of mechanical components for the automotive, consumer and electronics industries. The South Carolina Technology Transfer Cooperative, to be established at USC, would involve faculty members from nearby Clemson University to help transfer new manufacturing technology to small- and medium-sized metal-fabricating companies.

Kammer said of the choices, "We expect not only to monitor the progress of these centers but to work closely with them. NIST researchers will visit the centers, and we expect the centers' staffs to spend time at our laboratories."[28]

The major NIST organization expected to interact with the new Regional Centers was the Automated Manufacturing Research Facility (AMRF), known in some circles as the "factory of the future." The AMRF already had developed and implemented new manufacturing techniques in cooperation with industry, government and universities.

New Appointments

As part of the effort to lay a solid foundation for NIST, Acting Director Kammer made several appointments to managerial positions during 1988-89:

- Dennis A. Swyt, an NBS/NIST staff physicist since the early 1970s, was assigned to head the Precision Engineering Division of the Center for Manufacturing Engineering. Swyt was an expert in optical surface and linewidth measurement.

- Richard H. F. Jackson, an applied mathematician, was named deputy director of the Center for Manufacturing Engineering.

[28] Matt Heyman, "New Centers to Aid Industry," NIST Research Reports, *NIST Special Publication 761*, March 1989, pp. 10-11.

- Hai S. Lew, veteran of earthquake investigations and other structural studies in the Center for Building Technology, was designated chief of its Structures Division. Barry I. Diamondstone, an analytical chemist, was named Deputy Director of the Center for Analytical Chemistry.
- Rance A. Velapoldi, former deputy director of the Center for Analytical Chemistry, was named chief of the Gas and Particulate Science Division.
- Frederick C. Johnson, former chief of the Mathematical Analysis Division, was assigned to the position of associate director of the Center for Computing and Applied Mathematics (CCAM).
- John A. Brown, former head of the Advanced Computing Environment group, was named assistant director for Boulder of the CCAM.
- Patsy B. Saunders was assigned as acting chief of the Information Systems Division in the CCAM.
- Two new divisions were created in the CCAM to replace the Mathematical Analysis and the Scientific Computing divisions. A Scientific Computing Environments Division was formed with Sally E. Howe as chief, and an Applied and Computational Mathematics Division was created with Paul T. Boggs at the helm.
- B. Stephen Carpenter, an expert in nuclear tracer techniques, was selected to head the Office of International Relations.
- J. Michael Rowe, veteran of years of research in solid state physics at the NBS reactor, was named chief of the Reactor Radiation Division.

Settling in at NIST

In June 1989, Kammer spoke before the Senate Committee on Commerce, Science and Transportation about the legislation passed the previous year. His comments included the following remarks:

> This past year has probably been one of the more eventful in our history as we made the transition from the National Bureau of Standards to the National Institute of Standards and Technology. Along with that name change, we saw the enhancement of our traditional measurement research and standards function to include a more general mandate to improve the competitiveness of U.S. industry.
>
> To my way of thinking, the NIST now has three major elements: measurement (providing the scientific data and standards that our economy needs to compete in the world market), technology (assisting U.S. industry to make world-class products), and technology transfer (accelerating the application and wide deployment of new technologies). World-class products have the following characteristics: highest quality, advantageous life-cycle cost, modern features, and prompt availability in the marketplace.

Kammer went on to describe NIST programs that contributed to the success of competitiveness effort. Product quality, he said, was enhanced by the Malcolm Baldrige National Quality Award, created by Congress to promote world-class product manufacture. As noted above, the Malcolm Baldrige Award competition was managed by NIST and quickly established a productive relationship between American industry and NIST in terms of making improved quality an industry goal.[29]

A second example given by Kammer was that of measurement science. The new NIST superconducting volt standard and the NIST scanning electron microscope with polarization analysis both provided world-leading advances to help entire industries to compete better in world markets.

Kammer described the NIST work in intelligent processing as an example of a new technology that could be communicated broadly, and he completed his report by noting the designation of Regional Manufacturing Technology Centers as a new means of technology transfer.

In an article in the newly renamed *Journal of Research of the National Institute of Standards and Technology,* Donald Johnson outlined the new directions that would accompany the transition to NIST, with emphasis on its new responsibilities:[30]

> The rapid loss of competitiveness of American industry in international markets is an extremely serious problem with wide-ranging consequences. Its causes are many, but among them certainly are the slow rate at which new technology is incorporated in commercial products and processes.
>
> As a nation, we have been slow to capitalize on new technology developed from America's own intellectual capability. Our government must now find ways to help companies meet the demand of global competition, when speed is of the utmost importance.
>
> NIST will maintain the traditional functions of NBS in support of U.S. industry and will continue to offer the full array of measurement and quality assurance services including calibration services, standard reference materials, standard reference data, and measurement assurance programs.

A Caution to Congress

The 1988 Visiting Committee on Advanced Technology, replacing the former NBS Visiting Committee upon the enactment of PL 100-418, was chaired by William D. Manly, a consultant to the Oak Ridge National Laboratories. Making up the balance of the committee were Arden L. Bement of TRW Corporation, John G. Bollinger of the University of Wisconsin, Nolen M. Ellison of the Cuyahoga Community College, Jeanette G. Grasselli of Ohio University, William G. Howard of the National Academy

[29] The award was established by the Malcolm Baldrige National Quality Improvement Act, August 1987. For a brief note on its early success, see John Makulowich, "Quest for Quality," NIST Research Reports, *NIST Special Publication 761,* March 1989, pp. 16-18.

[30] Donald R. Johnson, "New program and directions at the National Institute of Standards and Technology," *J. Res. NIST* **95**, No. 1, pp. 1-5 (1990).

of Engineering, John P. McTague of Ford Motor Company, William P. Schlichter of AT&T Bell Laboratories (retired), and William J. Spencer of Xerox Corporation. This group, representing considerable technical experience and a variety of viewpoints on science and technology, had strong words for the Secretary of Commerce and the Congress on the need for adequate resources for the new NIST:

> The Administration and Congress must work together to make Federal funding of civilian technology development a high priority. The Committee encourages the Federal Government to provide the resources NIST needs for real growth and for fulfilling its mandate under the Trade Act to provide leadership in developing technology that meets national needs. These resources are not now available. In fact, a shortfall in the 1989 NIST budget threatens the health of an agency that has just been given a lead role in promoting U.S. technological competitiveness. This will be interpreted as a lack of commitment by the Federal Government to continued U.S. leadership in science, technology, and international economic competition.

The committee report called attention to the potential damage to NIST programs from consistent underfunding of the agency. Key technical personnel left NIST during the previous year, noted the report, and more losses could be expected if support for research programs was not forthcoming. The committee went on to point out that $40 million was authorized for the Regional Centers for the Transfer of Manufacturing Technology for the 2-year period 1989-90, but only $7.5 million was actually appropriated for Fiscal 1989 to get the program going. Furthermore, no funding at all had been proposed for the centers in the 1990 budget.

In its 1989 report, the same committee observed that funding for NIST core science and engineering had failed to even keep up with inflation. In addition, no new work proposed in the 1990 budget was funded. The only alternative to dropping needed research at NIST was to seek financial support from other government agencies, a poor strategy in the best of times.

A caution sounded 10 years later in an editorial by Peggie J. Hollingsworth, president of Sigma Xi, The Scientific Research Society, eerily echoed NIST's situation in 1989. Hollingsworth warned that a trend to university-based "Technology Transfer"—the commercialization of research results—held danger in two areas for the scientific enterprise. First, the effort to create new wealth for the university through the commercialization of applied projects might well sap the energy—formerly given by the faculty to undirected research—that was essential for the transformation of students into imaginative scientists and engineers. Second, the traditional openness of academic scholarship might well suffer as faculty members suppressed publication of results until patent or other commercialization issues were resolved.[31] It was not difficult to see in Hollingsworth's words a warning that NIST's ability to preserve its scientific competence might suffer from an overemphasis on technology transfer.

[31] P. J. Hollingsworth, "Technology Transfer in Higher Education," *American Scientist* **87**, p. 482, 1999.