3. CENTER FOR BUILDING TECHNOLOGY IN THE 70s

3.1 BACKGROUND FOR 1975

Fiscal year 1975 began on July 1, 1975, which serves as a convenient starting point for coverage of building research in this history. The prior history [1] covers building research from 1968 through 1974. The sections of this chapter are organized by years, approximately fiscal years, which through fiscal year 1976, began on July 1 of the prior calendar year, and thereafter began on October 1.

The Nation was in political turmoil with President Nixon nearing his resignation of August 6, 1974. The industries of construction were depressed (volume in constant dollars down 11 percent) because of higher interest rates imposed to curb inflation caused by increases in energy prices. However, CBT's building research was growing because of increased funding for research for energy conservation and solar energy. The National Bureau of Standards (NBS) had a dynamic young director, Richard Roberts, who had been director only since February, 1973, and emphasized closeness of NBS programs to their customers and effective representation of NBS work to policy makers and the public.

NBS's Institute for Applied Technology (IAT) was the parent unit for CBT and the home for most of the other engineering programs of NBS. IAT's director was F. Karl Willenbrock, an electrical engineer and physicist, who had led IAT since 1970. Willenbrock was passionate and inspiring for the potential of engineering research to improve quality of life, and for strengthening engineering programs at NBS in both their technical quality and their influence on practices and public policy. James Wright, chemist and founding director of CBT, since February 1974, had been deputy director of IAT. He complemented Willenbrock's leadership with his own enthusiasm for more effective programs and strong leadership in improving management practices in the Institute. Willenbrock focused much of his efforts on external representation of the Institute to develop collaborations with leaders in government and industry, but maintained active interest in good technical ideas within the institute. Wright concentrated on addressing organizational and management problems within the

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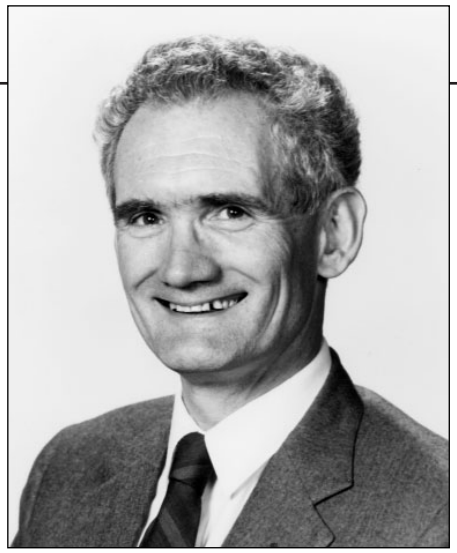
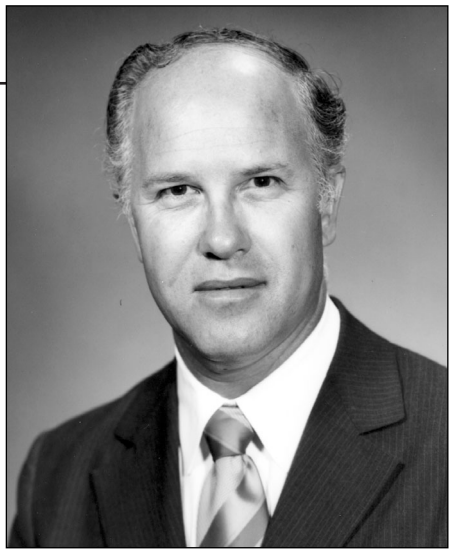


Richard N. Wright, director CBT and BFRL 1974-1999.



James Wright, founding director of CBT 1972-74 and chief of Building Research Division 1967-72 (former CBT); in 1975 he became deputy director, Institute of Applied Technology.

Institute and improving its working relations within NBS, continued a founder's interest in the development of CBT, and remained active in leadership of the International Union of Testing and Research Laboratories for Materials and Structures (RILEM).

At its founding in 1972, the mission of CBT was expressed as:
The Center for Building Technology shall consult with industry, government agencies, professional associations, labor organizations, consumers, and such organizations as the National Conference of States on Building Codes and Standards in developing test methods for evaluating the performance of buildings, including their materials and components, the support and stability characteristics of their elements and systems, the effects of new design strategies, their fire safety and environmental characteristics, and their service and communication systems; shall formulate performance criteria for building design and urban systems; and shall perform research (including research on safety factors) in the systems approach to building design and construction, improving construction and management efficiency, in building materials characteristics, in structural behavior, and in building environmental systems.

The Center was organized by divisions, which conducted the laboratory work, and offices, which provided program management and some technical work. These units and their leaders were:

- Headquarters was led until February 1974 by James Wright, with Deputy Director Harry Thompson. Wright's enthusiasm for effective programs and leadership in improving management practices contributed strongly to CBT and all other units of IAT. Thompson, an architectural engineer, had fifteen years of experience in federal design and construction programs and six years in the Bureau of the Budget dealing with public buildings. Thompson's warmth and kindness built rapport within the Center, Bureau and among other agencies.

- In June, 1974, Richard Wright became the director of the Center. Wright, a civil/structural engineer, had been professor of civil engineering at the University of Illinois at Urbana-Champaign, and had experience at NBS as chief of the Structures Section from June 1971 to July 1972, and deputy director-technical of the Center from July 1972 to August 1973. He was drawn to CBT by its potential for interdisciplinary problem solving and research addressing the functionality, safety and economy of constructed facilities.

- Office of Building Standards and Codes Services led by Gene Rowland a mechanical engineer who had joined NBS after leading the formation of the National

James Gross, leader in service to the standards and codes community

Samuel Kramer, expert in working with federal agencies and Congress.

Paul Reece Achenbach, Chief of the Building Environment Division.

Conference of States on Building Codes and Standards as the building official for the State of Wisconsin. Rowland's enthusiasm, wit and energy focused on improving the Nation's building regulatory system.

- Office of Housing Technology led by James Gross an architectural engineer who had joined NBS after being director of engineering and research for Precast Systems, Inc,. and director of engineering and technology for the Structural Clay Products Institute. Gross pressed for quality and responsiveness to sponsors in the Center's work and usefulness in practice of the Center's results, and expressed continued affection for masonry systems.

- Office of Federal Building Technology led by Samuel Kramer a civil engineer who had joined NBS after four years as an examiner with the Bureau of the Budget and ten years working on design criteria, design and construction with the Corps of Engineers. Kramer's intellectual curiosity, analytical skills, and interest in people extended to all of CBT's programs, and eventually to all of NBS/NIST as he was promoted to deputy director of the National Engineering Laboratory and subsequently to deputy director of NIST.

- Structures, Materials and Safety Division led by Edward Pfrang a civil engineer who joined NBS after faculty appointments at the universities of Nevada and Delaware, to lead the Structures section and then organize the Office of Housing Technology and develop major programs with the Department of Housing and Urban Development. Pfrang was outstanding for his imagination, forcefulness and comfort with conflict where he showed extraordinary ability to think on his feet.

- Building Environment Division led by Paul Reece Achenbach a mechanical engineer who had joined NBS in 1937. Achenbach worked tirelessly with quiet passion to gain knowledge to improve building environmental systems and extended his leadership to the American Society of Heating Refrigerating and Air-Conditioning Engineers.

- Technical Evaluation and Application Division led by Porter Driscoll an architect with extensive experience in private practice, government and industry before joining NBS in 1973. Driscoll was eager to make the Center's work relevant and useful to architects.

For 1974 the Center's funding was $9.2 million, $3.4 million directly appropriated and $5.8 million for sponsored research, and its staffing was 231. Sponsored research funding and staffing had increased substantially over 1973 driven by needs for research on energy conservation.

One major accomplishment of 1974 merits mention to set the stage for this

history. In the spring of 1973, the National Conference of States on Building Codes and Standards (NCSBCS) requested CBT to develop a technical basis for effective, nationally applicable building code requirements for energy conservation in buildings of all types. (Note the major role that CBT's predecessor, the Building Research Division of NBS, had played in the founding of NCSBCS [2].) CBT drew upon its long-term research expertise in the prediction and measurement of building thermal performance and lighting to formulate a technically and economically effective approach to the design of energy conserving buildings. Shortly after the oil embargo in December 1973, the NBS report was available for use.

In January 1974, NCSBCS requested the American Society for Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) to process the NBS report as a national consensus standard. ASHRAE established an extraordinary effort to analyze and refine the NBS report and develop a national consensus standard, which became ASHRAE 90-75 and the basis for the energy conservation building codes of the U.S. A thorough description of this effort may be found in the NBS/NIST Centennial Publication [3]. In summary, it showed how effectively CBT could work with the building community to meet critical national needs.

Major influence on the visions of Karl Willenbrock, James Wright, John Lyons and Richard Wright for building and fire research in the United States had been and continued to be provided by consultant William Allen. Allen, a British architect, was born and educated in Canada, and joined the British Building Research Station (BRS) in 1937 where he became a disciple of Robert Fitzmaurice, principal author of the seminal *Principles of Modern Building*, which was published in 1938.

Their views were that building practices can and should be based on science, a real understanding of the physical and human environments and behaviors that influence the usefulness, safety and economy of constructed facilities. Professional judgment, creativity and aesthetics are celebrated, too, but supported increasingly in improved knowledge from research. Another important perspective was that building and fire research laboratories should be closely linked to leaders in practice, including design, construction, product development and manufacturing. To be successful and supported, a laboratory should be and should be perceived to be valuable to industry. It should anticipate and be responsive to industry's greatest needs for knowledge, deliver this knowledge in useful form to decision makers, and assist in resolution of technical policy issues such as standards, regulations, education, and research priorities.

Allen, in turn, as Chief Architect of BRS was mentor to U.S. architect Ezra Ehrenkrantz, who worked under Allen, prior to returning to the U.S. and leading in introduction of systems building. After NBS's Institute for Applied Technology was created in 1964, its director Donald Schon and deputy director John Eberhard, himself an innovative architect, sought Allen as consultant for NBS's Division of Building Research. Allen had left the Building Research Station in 1961 to become Principal of the Architectural Association School and to form Bickerdike, Allen and Partners, which became a leading architectural practice in London. The relationship with NBS/NIST lasted almost thirty years.

Another, related legacy from the 1960s had profound influence on management's vision for building research at NBS in the 70s. Under the leadership of John Eberhard, as deputy director and director of the Institute for Applied Technology, and James Wright, director of the Building Research Division, building and fire research activities in the late 60s were energized and focused on providing criteria, and measurement, test and evaluation methods for the performance approach in building to building standards and codes [4].

All disciplines of the Building Research Division were involved in a major program, cosponsored by NBS and the Department of Housing and Urban Development (HUD) to explore the hypothesis that, if adequate performance standards for low-income housing could be developed, and if they were

The performance approach demands a statement of performance in terms of function. Since buildings serve people, function is defined by the attributes necessary to serve human requirements. The means of delivering an attribute is left open. It is in this way that the builder or supplier of a building component is invited to innovate. Indeed, the encouragement of innovation is sometimes cited as the reason for the performance approach. In any event, the philosophy of performance begins and ends with - and puts its principal emphasis on - the satisfaction of human needs.

broadly used, an important and fundamental way would be opened to accommodate the introduction of cost-reducing innovations into the design of housing for low income families. The success of this work [5] encouraged the HUD to proceed with Operation Breakthrough to encourage manufactured housing systems to improve housing quality and reduce costs.

CBT staff were greatly involved in Operation Breakthrough in support of HUD in developing performance criteria for the acceptance of innovative housing systems [6], assessing the compliance of the systems through analysis and testing, and performing longer range research to improve the criteria. The rigorous and systematic approach developed for the expression and application of performance criteria set the stage for the national and international move to performance based design in the late 20th century. The performance criteria and the responses of housing systems manufacturers advanced practices in residential smoke detectors, design to avoid progressive structural collapse, thermal insulation, acoustics, plumbing systems and durability. CBT and CFR researchers developed a strong orientation towards improved performance in meeting users' needs for safety, functionality, and durability. While HUD's support for Operation Breakthrough was not sustained sufficiently to greatly increase the U.S. market for industrialized building systems, it did achieve significant and continuing improvements in housing technology.

Simultaneously, the Building Research Division worked with the Public Building Service (PBS) of the General Services Administration to apply the performance concept in the procurement of better performing and more economical government office buildings. These were developed for and applied in the procurement of Social Security Administration payment centers for San Francisco, Philadelphia, and Chicago [7].

The focus of CBT on the performance concept continued after these projects for HUD and PBS were completed. The vision of Karl Willenbrock, James Wright, and Richard Wright for CBT was for it to be the leading laboratory supplying the performance prediction, measurement, test and evaluation methods needed by designers, builders, regulators, manufacturers, owners and occupants to achieve the performance (usefulness, safety and economy) for the buildings or building products and services with which they were concerned.

3.2. 1975

The energy crisis of 1973-1974 resulted in several legislative mandates for CBT:

- PL 93-409, Solar Heating and Cooling Demonstration Act of 1974, which became law on September 3, 1974, directed NBS to assist in determining performance criteria for solar heating and cooling systems, establishing test procedures and evaluating performance of systems demonstrated.
- PL 94-163, Energy Policy and Conservation Act directed NBS to develop test procedures for estimating annual operating costs and measures of energy consumption of energy consuming building equipment.
- PL 94-385, Energy Conservation and Production Act directed NBS to develop efficiency improvement targets for household heating and air-conditioning equipment, and to assist in the development of energy conservation performance standards for new commercial and residential buildings.

Another act influencing the CBT program was P.L. 93-382, The Housing and Community Development Act of 1974, which charged HUD to develop the Federal Mobile Home Construction and Safety Standards. HUD called upon CBT for substantial technical support. The Act also authorized the creation of the non-governmental National Institute of Building Sciences (NIBS) to improve the building regulatory environment, facilitate the introduction of new and existing products and technology into the building process, and disseminate nationally recognized technical and regulatory information. NIBS and NBS/NIST have generally found their roles complementary with NIBS suited

to convening all elements of the building community to seek consensus on technical policy issues, and NBS/NIST having the research and laboratory capability to address needs for performance prediction, measurement, test and evaluation methods.

An immediate response was to reorganize CBT to respond effectively to these mandates that drew broadly upon the technical competences in the divisions. In September 1974 the "office" (program management) structure was revised to:

- Create the Office of Energy Conservation led by Jack Snell. Snell, an aeronautical and civil engineer, had joined NBS from a faculty position at Princeton University in 1971, and served successively as chief of the Building Service Systems Section and deputy chief of the Building Environment Division. Snell's personal energy, enthusiasm, broad technical competence and rapport with both policy and technical people qualified him well for this assignment (and many more to come in this history of building and fire research).
- Continue the Office of Building Standards and Codes Services under the leadership of James Gross. Gene Rowland had been called to the parent Institute for Applied Technology to lead its Standards Application and Analysis Division. Thomas Faison became acting chief of the Office of Housing Technology. Faison, who joined NBS as an undergraduate student trainee in 1957, was outstandingly efficient and congenial in dealing with sponsors and researchers to meet commitments on time, on target and within budget.
- Assign Samuel Kramer as acting deputy director with Harry Thompson becoming acting chief of the Office of Federal Building Technology.

The Solar Heating and Cooling Demonstration Act gave CBT 120 days to develop interim performance criteria for heating systems and the dwellings themselves. The criteria, needed as the basis for selecting the systems to be demonstrated, were drafted by November 1, 1974, reviewed in an open meeting at NBS on November 20, 1974, and provided to HUD for use in the demonstration program by the scheduled date of January 1, 1975. Work was planned and initiated to produce Intermediate Minimum Property Standards for Solar Heating and Domestic Hot Water Systems, as a supplement to HUD's Minimum Property Standards, to allow federally insured mortgages for dwellings with solar systems.

In response to the strong national concern for energy conservation, NBS and the Department of Commerce worked to obtain a legislative mandate and directly appropriated funding for energy conservation research. Betsy Ancker-Johnson, Assistant Secretary of Commerce for Science and Technology, Richard Roberts, director of NBS, and Karl Willenbrock, director of IAT, led the efforts in planning and testifying and were supported by Jack Snell and Reece Achenbach of CBT. However, the momentum in the Administration and Congress was to develop the Nation's programs in the Federal Energy Administration and the Energy Research and Development Administration. Increased directly appropriated funding for NBS was rejected in the White House Office of Management and Budget citing the rule that the lead agency would request the funding for NBS's supporting work.

Snell, Achenbach and colleagues worked extensively in support of planning of the Federal Energy Administration and the Energy Research and Development Administration to assist these new agencies address their responsibilities for energy conservation in buildings and industry. The first major output was achieved for the program for energy conservation in industry: the Energy Conservation Program Guide for Industry and Commerce [8].

The CBT Advisory Committee initially was chartered by the Secretary of Commerce for a two-year period (January 1973 to January 1975) to help identify current and emerging issues in building design, construction and materials for study by the Center. Its members represented materials manufacture, design, construction, finance and consumer interests, and the Committee was chaired by Karl Willenbrock.

Jack Snell, founder of the Office of Energy Conservation, possessed energy, enthusiasm, broad technical competence, and rapport with technical and policy leaders that led to success in this assignment and to future leadership of CFR and BFRL.

This guidance was clear endorsement for comprehensive, performance-oriented planning for the Center's program.

The Building Economics section, the Building Environment Division and NBS Public Affairs collaborated to investigate the energy savings potentials and life cycle costs of improvements in housing, and express the results in a form usable to homeowners (9). NBS director Roberts cited *Making the Most of Your Energy Dollars in Home Heating and Cooling* as the Bureau's most significant publication of 1975. However, the publication created some friction with CBT's sponsors in HUD who had commissioned a document of similar purpose but lesser scope. Neither agency had informed the other of its intent until the two documents were published.

Noel Raufaste took on responsibilities for preparing outreach publications for the Center - publications that would inform the building community and others interested in the Center's work what it was doing and producing. A general overview [10], project summaries [11] and publications listing [12] were produced to begin series that would continue through the 90s.

CBT received strong recognition in Department of Commerce Medal Awards. Paul Reece Achenbach received the Gold metal for the study that provided the basis for national standards for energy conservation in buildings. Jack Snell received the Silver Metal for his leadership of NBS's energy conservation program. James Clifton and Robert Mathey received a Silver Metal for their study of coatings to prevent corrosion of reinforcing bars in concretes exposed to deicing salts that led to creation of the epoxy coated reinforcing bar industry.

Richard Roberts resigned as director of NBS at the end of FY 1975. Ernest Ambler, veteran NBS physicist who had been Robert's deputy, became acting director and remained "acting" until confirmed under President Carter in 1977. Ambler was dedicated to hard physical science, a firm and decisive director for internal affairs, and uncomfortable with personal external representation of the Bureau's interests.

The principal recommendations in its June 17, 1975 report were:

- That CBT work toward a systematic understanding of the working of the Nation's building regulatory system;
- That CBT explore the socio-economic impacts of research output;
- That CBT continue to endorse national consensus energy standards based on performance of the building as a whole;
- That CBT identify generally significant environmental factors related to buildings and their uses, and relate intensities of environmental factors to associated human responses;
- That CBT prepare a state-of-the-art report dealing with applications and requirements for further development and research for guidance on future construction community activities in support of the performance concept.

3.3 1976

P.L. 94-168, The Metric Conversion Act of 1975, became law on December 23, 1975. CBT focused substantial efforts on learning from experiences in the metrication of the British Commonwealth to provide technical bases for metrication in U.S. building practices, standards and codes. Hans Milton, who had led in Australia's metrication of building, came to work at CBT to show the U.S. how to benefit from the Commonwealth's experience. The extensive results contributed to ASTM standards and the work of the U.S. Metric Council. CBT also

investigated methods to respond to the one-time opportunities for dimensional coordination (effective and efficient families of product sizes) that would arise from "hard" metric conversion (to sizes such as 100, 200 and 500 millimeters rather than 101.6, 203.2 and 508.0 millimeters which correspond to 4, 8, and 20 inches, respectively). Formal catalog optimization approaches looked very interesting, but were not pursued when it became evident that there was not broad enthusiasm in U.S. industry or society for metric conversion. The recommendations of the Advisory Committee, re-chartered for 1975 to 1977, were decisive in not pursuing work in dimensional coordination.

The Advisory Committee's efforts from 1975 to 1977 focused principally on the programs of the Center for Fire Research.

The Center and Institute were much concerned to develop an effective architectural research effort. For guidance, the Center co-sponsored the Architectural Research Roundtable in September 1975, with the American Institute of Architects, the Association of Collegiate Schools of Architecture and the AIA Research Corporation [13]. The Roundtable addressed:

- The opportunities, problems and benefits of architectural research;
- The strategies and methods of architectural research;
- The resources needed to perform architectural research;
- The delivery and application of architectural research.

Another benefit was the associations developed between the Institute's and Center's management and 40 leaders in architectural practice and education, and in industry.

The Institute launched a second effort in the summer of 1976 to identify the knowledge-based problems of those responsible for building design, and to suggest areas in which the Institute should focus its present and future efforts in order to improve building [14]. Francis Ventre, an architectural engineer whose thesis studied the effects of the building regulatory system on innovations, and who was on detail from the Center to the Institute, staffed the study for the Institute. The study was conducted by Ehrenkrantz and Associates with involvement by William Allen, Professor John Habraken of MIT, and Richard Wright, Porter Driscoll, Robert Wehrli and Robert Hastings of CBT. The study's main recommendation was for "the conscious design of a system of inquiry that will better enable CBT to serve the needs of building designers and other members of the building team."

At the request of the Institute for Applied Technology's director, Karl Willenbrock, following several years of initiative by the Institute's deputy director, James Wright, CBT management undertook a substantial effort in organizational development. CBT managers studied Grid Organizational Development for each to gain understanding of team dynamics and the influence of one's own behavior on the quality of a team's work. It seemed that each person had been trained in school, including graduate school, to work alone and be rewarded only for one's own ideas. Such orientation is detrimental to finding and exploiting the best ideas of the team.

The organizational development was facilitated by Paul Buchanan, an ingratiating management psychologist who had taught James Wright at the Federal Executive Institute. Offsite meetings were held on September 3-5, 1975, October 14-16, 1975, and December 11-13, 1975. The first two involved the Management Council (headquarters executives and division and office chiefs) to define our problems and a process to resolve them. The latter involved the Management Group (Management Council plus section chiefs from divisions and program managers from offices).

At the first offsite, the Management Council agreed to merge the offices of Housing Technology and Federal Building Technology into a single Office of Housing and Building Technology with Harry Thompson as acting director. Samuel Kramer continued as acting deputy director of the center.

The Management Council identified 42 "itches" to be dealt with in the organizational development.

The general effect of the organizational development was to generate conscious attention to teamwork in the Management Council and in the conduct of multi-unit projects. CBT also

developed a Policy, Procedures and Operating Guide to cover predictable needs for collaboration.

As part of this process, CBT made more concise its mission statement: "To advance the Nation's building technology and facilitate its implementation for the public benefit."

In August 1976, IAT decided to move energy program management to the Institute. Jack Snell transferred to the Institute to lead the Institute-wide program, the CBT Office of Energy Conservation was abolished, and the program managers concerned with energy conservation and solar energy in buildings transferred to the Office of Housing and Building Technology.

In February 1976, Reece Achenbach announced his plans to retire in about three years and his desire that the Center proceed to replace him as Chief of the Building Environment Division. A search committee was appointed to identify the best available successor recognizing that his leadership of the division and profession would be difficult to match.

In September 1976, Karl Willenbrock announced that he would become Dean of Engineering at Southern Methodist University on October 1. His enthusiasm for technical excellence and for beneficial influence on building practices, while generally difficult to satisfy, had been inspiring to CBT.

James Hill received the Department of Commerce Silver Medal for his research to provide consistent test methods for solar collectors. Stephen Petersen received the Silver Medal for his guidance to homeowners on cost effective investments in energy conserving measures in Making the Most of Your Energy Dollars.

NBS felt staffing and budget pressures as part of the Ford administration's efforts to deal with inflation. CBT successfully defended its directly appropriated funding for fiscal year 1977 in August 1975, received a staff ceiling cut of 11 positions in October 1975, and was assigned a $500,000 cut in its directly appropriated funding for fiscal year 1978 in September 1976.

3.4 1977

Earthquake hazard reduction had long been seen as an important area for CBT research. Edward Pfrang organized the U.S./Japan Panel on Wind and Seismic Effects in 1968. In 1971, he led a significant investigation of the San Fernando Earthquake, which showed the value of prompt reporting of structural performance and identification of important opportunities for research and improvement of practices.

Richard Wright in 1971 began collaborations with the National Science Foundation, the Department of Housing and Urban Development and the White House to develop a multi-agency program on building practices for disaster mitigation. Charles Thiel of NSF had the initiative and financial resources to be "first among equals" in the collaborations.

Charles Culver in 1972 joined CBT from a faculty position at Carnegie Mellon University to become disaster research coordinator and the manager for the joint NSF/NBS project to work with leaders in research and practice to synthesize nationally applicable seismic design and construction provisions from available knowledge. Culver's energy, efficiency and experience in laboratory and analytical research helped advance this work. In 1977, Congress developed the Earthquake Hazards Reduction Act, and in August 1977 Culver represented NBS on the team developing the Act's implementation plan in the White House Office of Science and Technology Policy.

Led by Jack Snell, NBS had been working with the Energy Research and Development Agency (ERDA) in the planning and conduct of energy conservation research. Snell, Achenbach, and Frank Powell prepared a National

The main concerns seemed to be:

- Lack of trust, respect, commitment and responsiveness
- Poor communications, from overload to lack of feedback
- Unclear priorities, policies, and strategies

Program Plan for Energy Conservation that was used by ERDA and its successor, the Department of Energy, as a resource in program planning. Development of major programs in the National Laboratories required NBS to clarify its role as it became just one of the laboratories in an area in which it had been predominant. The role selected by NBS and recognized by headquarters of ERDA (though never by the National Laboratories) was performance criteria, and evaluation, test and measurement methods. CBT had proposed a systematic approach, using formal optimization techniques, to developing the Congressionally mandated energy budget performance standards for buildings. It was dismissed as too complex and the assignment given to HUD using the AIA Research Corporation in April 1977. Their eventual results were not implemented since opponents could show the lack of sound basis for the recommendations. The basis for the Nation's energy conservation performance standards remained the component performance approach developed by CBT in 1973 and standardized by the American Society of Heating, Refrigerating and Air Conditioning Engineers.

The initial direct influence of the Carter administration on NBS was the requirement to do Zero Base Budgeting - prioritize all activities and eliminate or justify those lowest in priority. The process consumed much time and energy and CBT defended successfully its activities.

The organizational development program of the Institute for Applied Technology reached the stage of teamwork among its units to solve an important mutual problem. Given that limitations on numbers of personnel were inhibiting the hiring of engineers and scientists to conduct available work, the team decided to reduce clerical staffing where it was deemed excessive. CBT was identified to exceed Institute norms for clerical staffing and required to make reductions. This was accomplished by organizing a word processing center to make more efficient the production of reports and other voluminous documents. The process was painful, clerical staff were valued members of their units, but the resulting word processing center was seen as a model for NBS.

Preston McNall was recruited from his position as Director of Engineering for Johnson Controls to replace Reece Achenbach as Chief of the Building Environment Division. McNall's leadership in ASHRAE and expertise in mechanical systems and human comfort qualified him well to match Achenbach's stature. Porter Driscoll was reassigned to manage a new Design and Construction Technology Applications Program to exploit his passion for making knowledge available in useful form to designers. Robert Kapsch, a scholarly and productive civil engineer, became acting chief of the Technical Evaluation and Application Division. At the request of IAT, which had not processed the re-assignments, Harry Thompson resumed the position of deputy director of CBT and Samuel Kramer the position of chief of the Office of Housing and Building Technology.

In September 1977, NBS director Ernest Ambler assigned John Lyons, director of the Center for Fire Research to head the team planning the National Engineering Laboratory that would replace the Institute for Applied Technology. Lyons decided that NEL would not use matrix management so CBT was reorganized to four divisions: Structures and Materials led by Edward Pfrang, Building Thermal and Service Systems led by Preston McNall, Environmental Design Research with Thomas Faison acting director, and Building Economics and Regulatory Technology led by James Gross. Program management responsibilities were divided appropriately among division chiefs; the tension between offices and divisions was ended.

Department of Commerce Silver Medals were received by: Charles Culver for management of the development of tentative provisions for the development of seismic regulations for new buildings, Rosalie Ruegg for development of life cycle cost analysis methods for solar energy systems, and James Pielert and James Gross for analyzing the performance of mobile homes and recommending improvements in mobile home standards.

3.5 1978

Public Law 95-124, The Earthquake Hazards Reduction Act of 1977 was approved on October 7, 1977, to authorize the National Earthquake Hazards Reduction Program (NEHRP). NBS was listed as one of the participating agencies. In April 1978, the White House requested NBS to budget for its role in the program. In the Implementation Plan issued by the President on June 22, 1978, NBS was assigned to assist in continuing the development, testing and improvement of model seismic design and construction provisions suitable for incorporation in local codes, standards, and practices, and research on performance criteria and supporting measurement technology for earthquake resistant construction. However, NBS did not give priority to seeking funding for NEHRP in its fiscal year 1980 budget request. CBT, with NBS approval, reprogrammed funds from building regulatory technology to provide research and technical support for the National Earthquake Hazard Reduction Program.

The Interagency Committee on Seismic Safety in Construction (ICSSC) was established in 1978 to assist the Federal departments and agencies involved in construction to develop and incorporate earthquake hazard reduction measures in their ongoing programs. Richard Wright served as Department of Commerce representative to ICSSC and served on its Steering Committee. CBT provided the technical secretariat, which led by E.V. Leyendecker of the Structures and Materials Division, began work on the assignment to develop seismic design and construction standards for consideration and subsequent application in Federal construction by 1980.

A cooperative research program was developed with the Public Buildings Service of the General Services Administration to address its principal needs for improved building practices. David Dibner, Assistant Commissioner for Construction Management, was the champion for PBS and Noel Raufaste was the coordinator of research for CBT.

A number of management changes resulted from the formation of the National Engineering Laboratory. The name of the Technical Evaluation and Application Division (an epitome of bureaucratic meaninglessness fortunately matched by several divisions at the U.S. Army's Construction Engineering Research Laboratory) was changed to Environmental Design Research Division and Francis Ventre was selected as its chief. However, there is reason in bureaucracy. The clear name made it a target for those who felt NBS should be limited to physical science and hard engineering research. Robert Kapsch went on to a Congressional Fellowship. Samuel Kramer became deputy director for programs of the National Engineering Laboratory.

NBS director, Earnest Ambler, initiated the NBS Competence Building Program to provide multi-year research support to small teams of investigators to develop world leadership in technical areas that would be vital to the future of NBS. Individual investigators initiated proposals, the center and laboratory expressed their priorities, and the Director made his selections. CBT was interested in many competence areas, including behavioral science. Its priority proposal in geotechnical engineering test methods was not successful.

CBT conducted a thorough long range planning process including:

- Assessing societal problems and trends requiring building research;
- Assessing technical problems and trends to identify the technologies needed and the role, considering other organizations, appropriate for CBT;
- Defining goals and objectives for CBT's work over five years.

The goals selected were:

1. Energy Conservation in Buildings;
2. Safety in Construction and Use of Buildings;
3. More Useful and Economical Buildings.

The Plan expressed the mission of CBT as:
to increase the usefulness, safety and economy of buildings through the advancement of building technology and its application to the improvement of building practices.

Needs to obtain the majority of funding from external sponsors and to conduct the work jointly with other organizations complicated the planning and implementation, but the Plan was valuable in focusing CBT's work.

Zero-based budgeting defenses continued to consume much management time. NBS offered to the White House cuts in CBT work in acoustics, materials, and standards and codes.

George Kelly received the Department of Commerce Silver Medal for his research on test methods for energy labeling of heat pumps and air-conditioners.

3.6 1979

The recommendations of the Advisory Committee on Building Technology for its 1977 to 1979 term were supportive of CBT's engineering research, but not of behavioral research or strengthened funding. In light of the desire of the Administration to reduce numbers of advisory committees and the availability of the National Academies, the National Institute of Building Sciences and other sources for program guidance from the private sector, the Advisory Committee was not re-chartered.

Thomas Dillon, deputy director of NBS, discussed informally with Richard Wright the prospects for NBS's support of CBT's long range plan. He doubted that CBT's plan would be supported by NBS. In view of several years of reductions and reprogramming in the CBT program, NBS management decided to assess the program to aid in consideration of further budget actions such as termination, continuation or augmentation.

In April 1979, 50 letters were mailed to building community leaders by NBS Director Ambler, and three letters were sent by Assistant Secretary of Commerce for Science and Technology Jordan Baruch to his counterparts in the Departments of Housing and Urban Development and Energy and in the Occupational Safety and Health Administration. Forty-six responses were received, which in summary stated:

1. The mission and role of CBT are appropriate to NBS and for the building community.
2. The CBT program is well oriented, but materials, regulatory technology, metrication, and building performance criteria issues need attention.
3. The Program's delivery system is well-oriented toward meeting standards, codes and industry needs; but better mechanisms are needed to reach designers and builders.
4. The NBS/DoC should provide a larger proportion of directly-appropriated funding to provide a healthier environment for the program.

National Engineering Laboratory Director John Lyons addressed the issue of whether the Laboratory should develop a world-class competence in behavioral research to support its programs in building technology, fire research, consumer product technology and manufacturing engineering. He did not want NEL to be pursuing programs with which NBS was uncomfortable. A panel of eminent scientists reviewed the relevant NEL programs and program plans and recommended that NEL develop and maintain competence in behavioral research. These recommendations were reviewed with the NBS Executive Board and Assistant Secretary Jordan Baruch. Their decision was that NEL and NBS would not seek to measure fitness to human use without a new and specific mandate in legislation. Behavioral research should be only an incidental part of NBS programs that should not be global, soft or unbounded.

The National Earthquake Hazards Reduction Program, with full involvement of CBT management and in consultation with private sector leaders, decided to assign the role of developing and evaluating recommended seismic design and construction provisions for buildings to the Building Seismic Safety Council operating under the auspices of the National Institute of Building Sciences. This would assure that federal influence on the provisions would not be, or perceived to be, dominant. CBT's role was to participate appropriately in the Council's technical committees and link the Council's work to that of the federal agencies as secretariat of the Interagency Committee on Seismic Safety in Construction. As the research community met to consider the earth-

quake research agenda, the primarily academic group preferred that engineering research be funded through the National Science Foundation rather than NBS. There was the same preference of NSF over the U.S. Geological Survey for earth science research, but USGS already had its appropriation for NEHRP. The White House Office of Science and Technology Policy requested NBS to budget for increased earthquake engineering research for fiscal year 1981, but again NBS did not give it priority.

The Federal Trade Commission (FTC) became concerned that thick insulations were not correctly labeled for insulating value and that customers might be inequitably treated. Standard test methods traceable to NBS were available only for thicknesses up to 25 mm; much greater thicknesses were in use for energy conservation. FTC, the insulation industry and NBS agreed that NBS would accelerate development of a device for direct measurement of insulating value of thick insulations and make calibration specimens available to industry as an improved basis for insulation labeling. The resulting technical work is described in Chapter 10.

The Senior Executive Service was implemented in 1979 with the Center's director, deputy director and division chiefs becoming members, and developing performance agreements as basis of pay for performance. Robert Dikkers received the Department of Commerce Silver Medal for his work in developing performance criteria for solar energy systems for buildings.

3.7 1980

In November 1979, representatives of the National Construction Industry Council, which was composed of 28 national trade associations and professional societies involved in all sectors of construction, met with Undersecretary of Commerce Luther Hodges to seek support in:

1. Leveling out extreme cycles in construction that increase costs,
2. Establishing and maintaining a comprehensive program of information for the construction community,
3. Technology for enhancing construction productivity,
4. Revision of government policies, such as regulatory delays, that inhibit productivity,
5. Adoption of a national energy policy sensitive to construction's needs, and
6. Encouraging construction and engineering exports.

Philip Klutznick, formerly a Chicago developer, had become Secretary of Commerce in 1979. He sought to be a builder in Commerce, too, and during 1980 in preparation for the fiscal year 1982 budget, encouraged NBS to propose challenging programs. CBT began by proposing a construction productivity initiative at a level of $3.5 million. The response of Secretary Klutznick was to request definition of a Construction Productivity Program at a level of $100 million annually.

Planning of new work in construction productivity involved most of CBT management. They were assisted by John Eberhard who had joined CBT as a part time consultant after leaving the presidency of the AIA Research Corporation in late 1978 following termination of its project for HUD on Building Energy Performance Standards. CBT took a fresh look at research topics for impact on construction productivity:

Partial support for construction research centers at universities in the fifty states was proposed to assist in research and education, and demonstration programs were emphasized for technology transfer.

The basis in and growth beyond CBT's base program can be seen by comparing topics from its October 1979 long range plan:

Energy Use in Buildings
- Energy conservation in buildings
- Building thermal envelope systems and insulating materials
- Building solar systems technology

Safety in Construction and Use of Buildings
- Structures and foundations performance
- Earthquake hazards reduction
- Building safety

Building Productivity and Performance
- Building rehabilitation technology
- Building and community acoustics
- Building service systems performance
- Lighting technology
- Building economics

The drive for a Construction Productivity Program ended in the election of November, 1980, but the work with industry leaders on productivity needs and the research ideas developed had substantial effects on the evolution of CBT's program. Moreover, it had been transiently refreshing to plan for growth rather than defend against cuts. However, NEL assigned CBT cuts of 20 positions for fiscal year 1981 as part of a transition of NEL and CBT to focus on engineering measurements.

Harry Thompson retired as deputy director in February. Charles Culver rejoined CBT from assignments to the White House and NEL to become deputy director. The Building Thermal and Service Systems division was divided to form the Building Thermal Performance Division, headed by Preston McNall, and the Building Equipment Division, headed by James Hill. Hill, a calm, cheerful, efficient and insightful mechanical engineer had led CBT's solar systems performance research since the early 1970s.

The Merit Pay system including performance plans and pay for performance was implemented for NBS supervisors. Much work was required to develop appropriate performance plans, and the system functioned well.

William Cullen received the Gold Medal Award of the Department of Commerce for his research on performance standards for built up roofing systems. Tamami Kusuda received the Gold Medal Award for developing and verifying computer models for the dynamic thermal performance of buildings. Bruce Ellingwood received the Silver Medal Award of the Department of Commerce for leading research to formulate consistent, reliability-based load factors for structural systems using the principal structural materials (masonry, concrete, wood and steel). Steven Petersen, of the Building Economics Group, was selected for the Presidential Executive Exchange. He worked with the Carrier Corporation to develop techniques for evaluating the life cycle costs and benefits of innovative, energy-conserving appliances.

Construction Management Technologies
- Construction project information systems
- Evaluation system for computer-aided design and construction technologies
- Measurement systems for management for productivity
- Equivalency system for regulatory approvals

Construction Site Technologies
- Construction loading criteria
- Shoring and scaffolding systems
- Materials handling systems
- Excavation and soil stabilization
- Concreting operations
- Quality assurance

Performance of Facilities
- Roofing evaluation system
- Wall evaluation system
- Controls evaluation system
- Lighting evaluation system
- Sanitation evaluation system
- Accessibility evaluation system
- Facilities productivity evaluation

References

1. Neil Gallagher, editor, *Building Research at the National Bureau of Standards, 1968-1974*, BSS 75, National Bureau of Standards, 1979.
2. Neil Gallagher, editor, *Building Research at the National Bureau of Standards, 1968-1974*, BSS 75, National Bureau of Standards, p 23, 1976.
3. James L. Heldenbrand, "Design and Evaluation Criteria for Energy Conservation in New Buildings," *A Century of Excellence in Measurements, Standards and Technology*, SP 958, National Institute of Standards and Technology, pp 260-265, 2001.
4. James R. Wright, "Performance Criteria in Building," *Scientific American*, pp 16-25, March 1971.
5. John P. Eberhard, project director, *The Performance Concept: A Study of Its Application to Housing*, NBS Report 9849, National Bureau of Standards, 1968.
6. *Guide Criteria for the Evaluation of Operation BREAKTHROUGH Housing Systems*, NBS Report 10-200, National Bureau of Standards, 1970.
7. David B. Hattis and T. E. Ware, *The PBS Performance Specification for Office Buildings*,

James Hill, founding Chief of the Building Equipment Division.

NBS Report 10 527, National Bureau of Standards, 1971.

8. R. R. Gatts, R.G. Massey, and J.C. Robertson, *Energy Conservation Program Guide for Industry and Commerce*, Handbook 115, National Bureau of Standards, 1974.
9. Madeline Jacobs and Stephen Petersen, *Making the Most of Your Energy Dollars in Home Heating and Cooling*, Consumer Information Series 8, National Bureau of Standards, 1975.
10. Michael Olmert, *The Center for Building Technology: A Perspective*, SP 439 National Bureau of Standards, 1976.
11. Michael Olmert, *Building Technology Project Summaries*, SP 446, National Bureau of Standards, 1976.
12. Joanne R. Debelius, Steven G. Weber, and Kenneth N. DeCorte, *Building Technology Publications 1965-1975*, SP 457, National Bureau of Standards, 1976.
13. *The Architectural Research Roundtable*, AIA Research Corporation, 1976
14. *Beyond the Performance Concept*, Ezra D. Ehrenkrantz and Associates, P.C., NBS GCR 77-107, National Bureau of Standards, 1977.