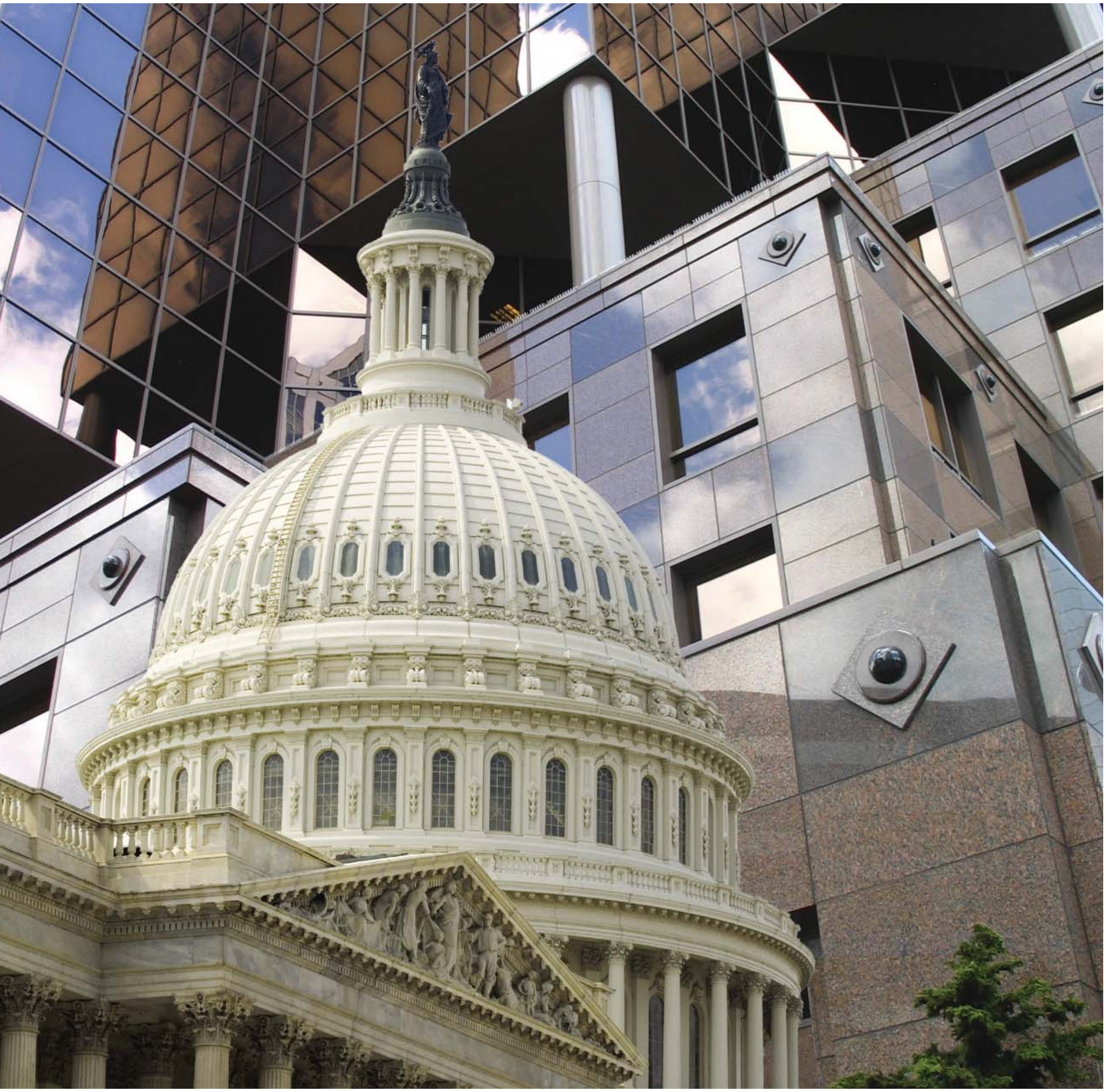
National Institute of
BUILDING SCIENCES

Assessment to the US Congress and US Department of Energy on HIGH PERFORMANCE BUILDINGS



An Authoritative Source of Innovative Solutions for the Built Environment

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BUILDING SCIENCES

Assessment to the US Congress and
US Department of Energy on
HIGH PERFORMANCE BUILDINGS

In Repsonse to Section 914 of the Energy Policy Act of 2005 (Public Law 109-058)

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FOREWORD

The U.S. Congress drafted Section 914 of the Energy Policy Act of 2005 to address not just more energy efficient or “green” buildings but rather high performance buildings that combine the objectives of reducing resource energy consumption while improving the environmental impact, functionality, human comfort and productivity of the building.

Congress turned to the National Institute of Building Sciences, long recognized as an authoritative source of knowledge, to provide a sense of direction for this undertaking.

The Institute formed an ad hoc High-Performance Building Council consisting of representatives of approximately 100 private sector and governmental organizations to advance this mission. This report is the first result of that effort.

The Institute is indebted to the many volunteers who served on the Council representing the participating organizations listed in this report. In addition, we sincerely appreciate the outstanding contributions by the Sustainable Buildings Industry Council (SBIC), which served as secretariat to the Council.

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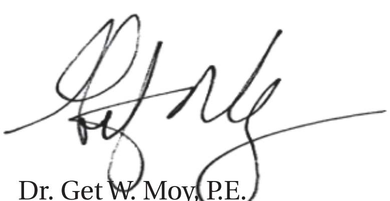

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INTRODUCTION

BACKGROUND

The United States enjoys one of the highest standards of living in the world. One contributing component of this standard of living is the supporting array of buildings and infrastructure. According to the Environmental Protection Agency this building stock constitutes approximately 40 percent of the total yearly energy expenditure of the nation, and accounts for 12 percent of total water consumption, 68 percent of total electricity consumption and 38% of total carbon dioxide emissions into our atmosphere.

The Energy Policy Act of 2005 and the Energy Independence and Security Act of 2007 seek to reduce building-related energy consumption and our dependence on foreign energy sources. Title IX, Subtitle A, Section 914 of the 2005 Act specifically directs the National Institute of Building Sciences (NIBS) to explore the potential for accelerating and supporting the development of consensus-based voluntary standards for producing more energy-efficient, less resource-intensive, "high-performance buildings."

Energy Policy Act of 2005 (Public Law 109-058)

Section 914. Building Standards.

(a) Definition of High Performance Building – In this section, the term "high performance building" means a building that integrates and optimizes all major high-performance building attributes, including energy efficiency, durability, life-cycle performance, and occupant productivity.

(b) Assessment – Not later than 120 days after the date of enactment of this Act, the Secretary shall enter into an agreement with the National institute of Building Sciences to –

(1) conduct an assessment (in cooperation with industry, standards development organizations, and other entities, as appropriate) of whether the current voluntary consensus standards and rating systems for high performance buildings are consistent with the current technological state of the art, including relevant results from the research, development and demonstration activities of the Department;

(2) determine if additional research is required, based on the findings of the assessment; and

(3) recommend steps for the Secretary to accelerate the development of voluntary consensus-based standards for high performance buildings that are based on the findings of the assessment.

(c) Grant and Technical Assistance Program – Consistent with subsection (b) and section 12 (d) of the National Technology Transfer and Advancement Act of 1995 (15 U.S.C. 272 note), the Secretary shall establish a grant and technical assistance program to support the development of voluntary consensus-based standards for high performance buildings.

NIBS was created in 1974 by the U.S. Congress through Public Law 93-383 which authorized its establishment as a single authoritative national source to make findings and to advise both the public and private sectors with respect to the use of building science and technology in achieving national goals and benefits.

The intent of Section 914 is described in the House Science Committee's report, Section 303(c):

> Standardization report and program. The National Institute of Building Sciences (NIBS) maintains a web site called the Whole Building Design Guide (WBDG) that is an invaluable source of information on high performance buildings and makes that information available to all in a user-friendly manner. Much of the information contained on this site has resulted from the research and development activities of the Department of Energy and other agencies. However, to encourage the use of this knowledge, high performance building standards and procedures must be developed before this knowledge is used in new and renovated buildings on a routine basis. In an effort to stimulate the formulation of voluntary consensus standards, the Committee directs the Department to enter into an arrangement with NIBS to assess how well current private sector standards match state-of-the-art knowledge on the design, construction, operation, repair, and renovation of high-performance buildings as represented by the WBDG. NIBS, working with the appropriate industry groups and standards development organizations, is to make recommendations on steps the Secretary can take to accelerate the development of procedures, including voluntary consensus standards, encompassing on a life cycle basis, all major high-performance building attributes. These high-performance building standards shall include energy efficiency, environmental quality, sustainability, safety and security, and accessibility. Once this assessment is complete, the Secretary, in cooperation with NIBS as appropriate, is directed to establish a program of technical assistance and grants to bring about, on an accelerated timetable, the promulgation of a comprehensive set of high performance building procedures and related standards, for both new construction and renovation. The Secretary and the National Laboratories are both asked to encourage participation of their employees with relevant expertise in the work of the standards development organizations under this section.

The high-performance procedures and standards envisioned by the legislation would enable designers, developers and owners to produce buildings that significantly exceed the minimum requirements of current codes and specifications. High-performance buildings will not only use much less energy; they have the potential to improve the health, comfort, and productivity of their occupants.

Most of the thousands of codes, standards and guidelines used by the Nation's building community are produced by hundreds of standards development organizations, probably more than 300. While there are a few large organizations, most write only a handful of codes and standards. Typically, these standards are written under consensus procedures established by the American National Standards Institute (ANSI), although not all standards developers do so. In the United States, codes and standards usually set minimum prescriptive and performance requirements that can be met by a substantial portion of the design, construction and manufacturing community. Codes and standards provide a degree of standardization or uniformity to a complex and sometimes fragmented industry. The authority they enjoy is derived from their adoption by reference or reference by text in model codes as minimum requirements. When these model codes are adopted by local jurisdictions, they become enforceable regulations providing for the public safety, health and welfare. When referenced in master or guide specifications (private or public) they impact the complete design of the building including the levels of quality and performance for the selection and procurement of building materials, products and systems under contractual agreements.

Although energy efficiency and sustainability are core issues addressed in the legislation, Sections 914 and 401 acknowledge that energy and environmental attributes cannot be separated from other important building performance attributes:

> **Energy Policy Act, Section 914. Building Standards.** (a) Definition of High Performance Building – In this section, the term “high performance building” means a building that integrates and optimizes all major high-performance building attributes, including energy efficiency, durability, life-cycle performance, and occupant productivity.

> **Energy Independence and Security Act of 2007, Title IV, Energy Savings in Buildings and Industry, Section 401, Definitions.** (12) HIGH-PERFORMANCE BUILDING- The term `high-performance building’ means a building that integrates and optimizes on a life cycle basis all major high performance attributes, including energy conservation, environment, safety, security, durability, accessibility, cost-benefit, productivity, sustainability, functionality, and operational considerations

These definitions hint at one of the major conclusions of this study: Optimizing the attributes of a high-performance building does not mean maximizing each building attribute. Attributes are often in conflict, making clear solutions elusive. New criteria, therefore, are needed to optimize each attribute for maximum performance. Owners in both the public and private sectors seeking a higher level of building performance have lacked this criteria upon which to base the kind of optimization that will create and maintain greater building performance and long-term value. Perhaps more importantly, they have typically had no compelling reasons to request designs or features that exceeded the minimum performance levels found in most U.S. codes and standards.

This value, whether derived from reduced energy and operating costs, lowered maintenance costs, improved functionality or productivity, continued operational capability after a catastrophic event, enhanced environmental conditions, sustainability, or building durability has the potential to offer building owners dramatically greater returns on their investments. This impact is a “business” decision to be made voluntarily based on optional improvements to the building’s performance well above the minimums required by local codes and federal regulations.

The first task for NIBS’ High-Performance Building Council, formed to conduct this study, was to perform an initial assessment of the current state of knowledge in this area with the help of standards development organizations, professional societies, governmental agencies and major trade associations. Representatives of these organizations examined hundreds of existing standards to begin the process of identifying these existing standards and to judge their relevance to a high-performance building. In addition, NIBS was charged with determining what was needed to accelerate the development of voluntary, consensus-based standards for high-performance buildings. As this Report demonstrates, there are a vast number of current standards, guidelines, and recommended practices that remain in individual silos without the requisite communication among disciplines or parties.

HIGH-PERFORMANCE BUILDING COUNCIL

The High-Performance Building Council was formed in April 2007 and held three meetings during that year. They were attended by representatives from most of the major codes and standards writing organizations, associations, and federal government entities involved with the built environment. Council committees were created to research and examine the eight attributes identified in NIBS' *Whole Building Design Guide:* cost-effectiveness, sustainability, security and safety, accessibility, productivity, functionality, historic preservation, and aesthetics. The WBDG attributes were selected because the Council recognized that the Section 914 definition stressed that a high-performance building ". . . integrates and optimizes all major high-performance building attributes . . . ." and because the WBDG is the nation's most widely recognized and comprehensive source of building design and construction information (Science Committee legislative committee report language on Section 914 and text of Section 401).

The Council then set about identifying, from the thousands of current standards, those that appeared to promote the design and construction of high performance buildings. It found that a large number are in individual "silos' that prevent them from working together to contribute to high performance goals.

Section 914 recognizes that the building industry is regulated by codes and standards designed to achieve acceptable levels of health, life safety, building usability, and public welfare. They do not provide a coordinated means for optimizing the most appropriate mix of building attributes and resources.

The Council decided to concentrate on the relation of current standards to the eight WBDG attributes, draw conclusions, and provide recommendations that would further the goals of Sections 914 and 401.

The Council recognizes that developing high performance design and construction standards will be a complicated, long-term task, but a task that is necessary for improving energy efficiency, reducing operation and maintenance costs, decreasing property loss, and increasing functionality and productivity.

DEFINITION OF HIGH-PERFORMANCE BUILDING

The High-Performance Building Council adopted the following definition:

> High-performance buildings, which address human, environmental, economic and total societal impact, are the result of the application of the highest level design, construction, operation and maintenance principles—a paradigm change for the built environment.

This definition presupposes that buildings must be designed and built in the context of larger human, environmental, and economic concerns, and that high-performance building standards are the means for doing so. All the parts of the building need to be addressed in a cohesive, "whole building" approach, taking into account the ways in which the design, construction, operation, occupancy, repair, usability, extendibility, and retirement of buildings are interconnected throughout their whole life cycle.

The high-performance building concept comes at a time when the building community is being pulled in many directions and is in need of a framework for balancing competing interests. The increasing popularity of sustainable or "green" building, post-9/11 safety and security concerns, the new contractual and delivery methods available to builders, and the market mechanisms driving institutional investors to seek out energy and other efficiencies in building asset portfolios all confirm that this is the right time to begin the initiatives set forth in Sections 914 and 401. The last 30 years have seen substantial changes in the way buildings are delivered, and speculative design, design-build, and just-in-time materials delivery have affected scheduling, financing and risk management procedures for most types of construction. Computers and computer software have had an increasing impact on the delivery of buildings since the 1980s and now, coupled with the Internet, dominate construction scheduling, project management, building representation and drawing, accounting, and real-time video of construction progress accessible by internet anywhere in the world. Computer based platforms can even model the effects of wind and seismic activity, and cross platform programs allow intricate material fabrication to be controlled all the way from the designer's office to the fabrication facility. The most prominent and revolutionary of the new technologies, "building information modeling" (BIM), allows a complete, three dimensional, virtual model of the building to exist alongside real-time information and analysis tools for cost, constructability, fabrication details, scheduling, energy use, and many other parameters. When the high-performance building standards are inventoried, benchmarked, and modeled through BIM, building performance can be readily assessed and an array of design options considered with the goal of significantly increasing the performance measures that are eventually selected.

Codes and standards development organizations are also feeling the push of technological acceleration and are responding in various ways. In the past, some standards could take years to come to fruition. This is changing as the Internet reduces the time required for drafting, editing, and voting on standards and facilitates rapid communication among stakeholders. It may therefore be possible to develop an initial set of high-performance building standards and procedures within several years.

CONCLUSIONS

COST EFFECTIVENESS

The Cost Effectiveness Committee (CEC) considered the role of costs in the design and delivery of a high-performance building. The CEC concluded that cost is the common metric for all high-performance building features and goals. The CEC also concluded that first or capitalized costs alone could not and should not be the sole basis of decision-making for a high-performance building. Instead, it is necessary to engage in a rigorous cost/benefit analysis which accounts for the many tangible and intangible benefits of a high-performance building over its life-cycle.

Not easily understood cost metrics exist for most of the intangible benefits often sought in a high-performance building, including occupant productivity. Further research and benchmarking performance is needed to assess many of the intangible benefits in a quantifiable manner. A whole range of drivers including insurance, surety, legal, real estate and others must be investigated and the owner's acceptable economic risks need to be investigated in terms of their effect and consequences on high-performance buildings.

There can be significant differences between economic decisions in the public sector and certain areas of the private sector. Public funds may have different return rates for pursuing a high-performance building. Often enough this relates to the realities of the type of return and useful life cycle to be expected from a public compared to a private entity. Whole areas of business and economics deal with the problem of return on investment, internal rates of return, and many other mechanisms to assess the feasibility and desirability of investing in various types of assets, including buildings.

In most building projects, either public or private, the financing of the initial capital expenditure is often derived from a radically different source than the post-construction maintenance and operating budgets. This "color of money" problem plagues building procurement and results many times in looking solely at first costs in making decisions about building attributes and value. This fundamental dichotomy (often caused by parallel separations in internal management and accounting procedures) creates a serious misalignment between the goals of a high-performance building and achieving them. Making the full life-cycle costs of a project part of the cost/benefit analysis will provide a major step towards a unified approach for the construction of high-performance buildings.

SAFETY AND SECURITY

A high-performance building must maintain the safety and security of its occupants while considering the impact of building failure on the mission or function of the facility and on the wider community. The Safety and Security Committee (SSC) understood the value of providing a mechanism that allows owners to design and deliver buildings beyond minimum life safety standards to meet other specific mission, context, public welfare, property conservation or quality requirements. Preserving life safety and property takes into account natural disasters of all kinds; manmade disasters and failures of all kinds, both intentional and unintentional; health hazards from natural and manmade conditions; and even hazards related to building use such as falls, electrical shocks, or elevator failures. In addition to the overwhelming number of safety standards and codes currently in place, the requirements for building security have become much more complex and will require particular care in coordinating with the other high-performance building attributes.

A productive area to consider for providing for a higher level of operational capacity and performance after a catastrophic event is the development and use of performance-based codes for buildings and facilities. Building codes are established to provide for safety, health, building usability and public welfare of the general public. Most codes do not provide guidance for owners seeking to deliver safety and security beyond a minimal level, especially in terms of building operations performed after a disaster.

In a high-performance building, occupant safety and security will often preempt or reconfigure the capacity for maximizing the other attributes. Consequently, it is important to consider how the safety and security criteria are integrated with other attributes. The delivery of a safe and secure high-performance building will require the application or development of proper measurement and verification tools to assure the continued operational capacity and performance of a facility after a significant event.

SUSTAINABILITY

The Federal government has established Guiding Principles for Federal Leadership in High Performance and Sustainable Building per a Memorandum of Understanding signed by nineteen agencies in January 2006 and later in Executive Order 13423 (2007). These five Guiding Principles—covering integrated design principles, optimized energy performance, water conservation, enhanced indoor environmental quality, and reduced environmental impact of materials—have served to define the minimum requirements for federal buildings and are informing the development of standards for the private sector as well. Furthermore, in developing these requirements, Federal agencies began the process of identifying where existing standards could serve its needs and where there were needs for additional standards work. Building from these efforts, the Sustainability Committee (SC) set out to identify and assess the capacity of today's standards to support the market's transformation in high-performance buildings in terms of environmental, economic, and social sustainability.

In many ways sustainable building standards are at the forefront of the environmental movement: taking a holistic, systems approach to defining preferred performance; pushing the science of life cycle assessment; defining strategies for dramatically better energy efficiency and decreased aggregate energy usage; asking the tough questions about chemicals of concern; and, most importantly, balancing environmental, economic and social considerations. The leaders in sustainable building standards development are engaging stakeholders in an open, transparent process-demonstrating that consensus can bring real industry transformation.

To guide our identification and assessment of sustainable building-related standards, a range of performance indicators were identified within the areas of sites/smart growth, energy, atmosphere, water efficiency, occupant health and well-being, environmentally preferable materials, and social responsibility. Based on the initial assessment of the field, several priorities were identified for filling gaps in both process-oriented and performance-based standards for sustainability. First, it is clear that more attention needs to be paid to improve the environmental performance of the nation's existing building stock. In particular, tremendous opportunity exists to achieve higher performance in existing buildings by discouraging the practice of deferred maintenance and by vigorously encouraging practical service strategies for the building mechanical system. Prior decisions about operation and maintenance of systems based on the energy costs at the time must be constantly evaluated with respect to current and expected energy costs.

Another area in which there is clear agreement is the goal of healthy indoor environments; however, understanding what that means and how to make it happen are serious challenges. The indoor environment, like the outdoor environment, is made up of a variety of frequently fluctuating forces that interact in complex ways. These forces include: products and processes releasing contaminants into the indoor air; outdoor pollutants being sucked indoors; varying levels of temperature, humidity, ventilation, light and noise; the presence of moisture, mold and other biological contaminants; and the often unpredictable and changing variable of human behavior. This has made developing IEQ standards a tricky proposition and an area ripe for additional focus.

Finally, a significant priority for standards development is in the area of sustainable building product attributes. A race to respond to consumer demand for green products has lead to a plethora of marketing claims. There is a major need to assess and verify the sustainability of a building material, product, system or service. In particular there is a need for credible and widely accepted standards that address life cycle assessment, risk assessment, and health impacts of products over their entire life cycle.

At the heart of a high-performing building's sustainable attributes lies the fact that it should deliver dramatically better energy and water efficiency and decreased aggregate energy usage when compared with similarly benchmarked buildings. Reduced energy expenditure and increased energy and water efficiency are commonly recognized as crucial to delivering more sustainable buildings since they can lead to decreased use of fossil fuels.

Beyond new construction, major renovations and retrofit, opportunity exists to achieve higher performance in buildings by discouraging the practice of deferred maintenance and by vigorously encouraging practical service strategies for the building mechanical system. Prior decisions about operation and maintenance of systems based on the energy costs at the time must be constantly evaluated with respect to current and expected energy costs.

ACCESSIBILITY

Accessibility, as currently understood and practiced, is achieved primarily by minimum standards applied through regulation. Owners wishing to provide a higher degree of accessibility for their current or future occupants or visitors have little or no guidance for either initial design or retrofits. The Accessibility Committee (AC) worked at identifying a more expansive concept of Universal Accessibility in high-performance buildings.

Most of the population can be considered “temporarily able-bodied” and that inevitably, whether through injury, disease or age, nearly all will find their physical abilities limited at some point in time. Thus, they will all be confronted with the limits that buildings pose to their ability to work, reside, and visit. Given the nation’s aging population, high-performance buildings that ignore the realities of accessibility will fail at a fundamental level of providing for higher performance levels of buildings.

Technological changes in all phases of the building process from design to operation and changes in the actual technological aids available for variously able-bodied persons force constant reconfigurations of the intersecting details that satisfy the various attributes. Universal accessibility will promote the technological advancement of controls and sensors that will compensate for the reduced sensory and mobility abilities of building occupants. Significant savings and productivity gains can be realized by accommodating the needs of workers with disabilities and for the similar needs of older citizens in order to reduce the requirement for dedicated assisted living environments.

FUNCTIONALITY

Functionality can be considered the primary building attribute. If a building does not meet the purposes and fulfill the functions required by the owner, it cannot be said to perform well.

Although functionality deals directly with the ability of a building to fulfill mission or the program for the building, it also addresses a facility’s fundamental abilities to meet the needs of occupants to navigate space and carry out basic activities. Serviceability refers to the usefulness of a building for its intended purposes; maintainability refers to the capacity of the building to be easily serviced in terms of the functional requirements. In other words, functionality establishes a building characteristic and maintainability indicates the capacity to maintain that function over time. Much work has already been done on maintainability of buildings but relatively little has been done on functionality. There are numerous maintainability standards and protocols and an emerging family of useful functionality standards, which are not yet widely used, although a few federal agencies and large corporations have made a start.

It is not hard to understand the gap between functionality and maintainability; an owner’s requirements can be very subjective both in the types of functions elaborated and the manner in which they are described. Addressing the maintainability of the functional choices after they are made is a far easier task.

There can be little doubt that no building can be considered a high-performance building if it does not fulfill its functional requirements throughout its service life. Re-engaging the most basic building attributes, such as functionality can provide valuable mechanisms towards the overall goal of high-performance.

PRODUCTIVITY

It has often been determined that the primary cost for any enterprise is personnel and that any increase in the productivity of the work force will translate into significant bottom-line benefits. Research, primarily based in the social sciences, on how to increase worker productivity has been extensive and well documented. Industrial and organizational psychology, organizational behavior, and other business or management related fields currently explore the intersection of the physical and social environment with worker productivity. Recently, the possibility that future building stock and renovated buildings can be created with an eye towards increasing worker productivity has caught the imagination of some designers and sustainability consultants.

The research community has found it difficult to verify any simple causal linkages to improved worker productivity. Limited success has been achieved in reworking industrial production processes that involve worker interaction, but no such increase of productive efficiency has been demonstrated for service workers. Even if current research provides only mixed outcomes or practical benefit, it is certainly true of high-performance buildings that the health and well-being of the occupants and occupant comfort can play a role in the success of the project for owners.

Productivity encompasses not just worker productivity, but also the capacity for the building to contribute to the overall productivity of the business or public enterprise through mediated costs or benefits such as flexibility.

It is recognized that the productivity of the American workforce is of significant importance to the general GDP, global competitiveness, and fundamental strength of the economy. Therefore, if the buildings in which the workforce spends its time can help increase workforce productivity in a meaningful manner, public policy and business strategy would dictate pursuing further research in this area. A building that could validly demonstrate increased occupant worker performance (especially for service workers) would be of genuine interest, and if easily repeatable, have a very real impact on the economic success of the country. Current studies, almost all of which are post-occupancy self-evaluation studies, do not provide this level of evidence, but as the research in this area becomes subject to stricter standards of scientific study, new opportunities for increased productivity will arise.

HISTORIC PRESERVATION

The cultural value imbedded in our historically important buildings should be considered in the prioritization of attributes for a high-performance building. The nation's historical building fabric provides a significant part of the physical basis for America's historic self-understanding. Too often, this physical fabric, which functions as the backdrop of all public and private activity in the country, is forgotten in the thick of economic redevelopment or other activity to the eventual detriment of the visual and physical continuity of the culture. Conversely, buildings are occasionally preserved just because they are old, rather than because they truly contribute positively to the cultural and historic fabric.

Although a number of guidance documents and numerous local ordinances exist, few standards exist for decision-making related to historic structures. Reuse of the building shell or productive adaptation, in whole or in part, significantly reduces resource expenditure. In effect, it is a form of building recycling and reuse which should be seriously considered early in the process on projects where this attribute applies. In addition to decreasing the overall cost for the building process, a culturally significant retrofit can bring important benefits in terms of community development and cultural continuity.

The preservation of historic buildings also provides benefits in terms of the durability of the building envelopes and building amenities that are no longer easily obtainable: solid stone walls, which could have significant energy usage advantages; roofing, flooring, and interior surfaces made from materials with durability measured in multiple decades; large thermal massing to aid in passive solar energy usage; visual amenities of many types no longer economically feasible; and visual harmony within the building's larger context. Of course the nature of the buildings that will be "historic" will change as the buildings of the 1950s and 1960s reach inclusion in preservationist ledgers. While these newer buildings may not provide some of the same benefits as the older structures, they will certainly provide new opportunities for potential reuse.

AESTHETICS

Aesthetics are considered an important performance attribute. However, subjective, rather than objective metrics comprise society's performance measurement of aesthetics in buildings. Currently no widely recognized objective metrics exist to serve as basis for aesthetic criteria. Without such objective metrics, the development of a widely accepted aesthetic measuring system for a high-performance building will remain an extremely difficult task. The methods employed in most building design competitions do not provide much confidence that any type of metric is being employed, let alone that it is being verified to determine aesthetic value.

Certainly, building aesthetics has a strong connection to historic preservation, the enjoyment of occupants and to the productivity of workers. A high-performance building is the result of a difficult set of prioritizations in a given context with a limited set of resources. Security, accessibility, aesthetics, and energy efficiency are all competing for these resources and must be properly prioritized given the context. Being cognizant of these parameters and trade-offs allows an owner to properly prioritize by becoming fully cognizant of the role that aesthetics may play in the particular building project at hand.

The relationship between a high-performance building and aesthetics leads to the conclusion that a new high-performance building paradigm must begin to explore seriously the state of architectural and building sciences education to support the high-performance building mission. BIM, new project delivery options, new legal contracting regimes, current job market shortages in the building industry, and the globalized market for architectural and engineering talent will radically change the current status quo. The inevitable changes on the horizon provide a real opportunity for this new high-performance building paradigm to take root and the meaningful relationship of aesthetics to the other attributes of a high performance building can be reinvigorated at the same time.

RECOMMENDATIONS

The current positive attention surrounding the linkages between the built environment and energy awareness, energy efficiency, sustainability, asset management, political capital, and technological feasibility should not be wasted. The emergence of the need for high-performance buildings provides a real opportunity to look deeply at some fundamental organizational, procurement, scientific, and technical possibilities. A general effort must be made to clarify and verify the information streams common to discussions about high-performance buildings.

In order to support new high-performance technology, appropriate education of design, construction, installation and service professionals as well as building occupants is essential. Part of the education process is an "unlearning" of commonly accepted practices such as first cost, simple payback and short term investment.

Some of the following recommendations will be easier to implement than others and will require less financial support. Nonetheless, all of the recommendations have a vital role to play in transforming the creation and operation of high-performance buildings. It is also important to recall that the recommendations are aimed at providing for a better understanding of appropriate metrics for meaningful, risk-adjusted, cost-effective increased building performance.

1. **Identify and establish new cost decision-making parameters for the planning, programming, budgeting, procurement and delivery of high-performance buildings.**

Fundamentally, first-costs drive budget and procurement decisions and will most often produce a less than high performing building. The life-cycle costs of a building are the true measure of the cost performance, but are disengaged from key decision-making during the procurement process. There is a significant need to re-examine the mechanisms for building procurement especially in the public sector.

Mechanisms for the accounting of both first costs and long-term operational costs at the earliest stages of the procurement process should be established. In addition cost standards need evaluation to insure consistency and proper benchmarking.

2. **Develop and establish performance metrics and verification methods for high-performance buildings, systems and products that provide sustainability.**

Without proper metrics to measure the performance of sustainable buildings, the true benefits that "green" attributes can contribute to a high-performance building are not well documented. The often competing and contradictory definitions of green building attributes can lead to both intentional and unintentional abuse in products and systems. The High-Performance Building Council's larger vision of the high-performance building as defined by Sections 914 and 401 will provide much-needed guidance to the general public and governmental policy-makers alike about green buildings and their relationship to high performance.

Energy efficiency should be a cornerstone of a high-performance building. All energy consuming systems and products should be designed to achieve the highest level of energy efficiency consistent with the other design attributes.

3. **Develop and establish performance metrics and verification methods for high-performance building beyond minimal life safety requirements to provide post-catastrophic operational capacity and resilience.**

   After man-made or natural catastrophic events, high-performance buildings should remain viable longer than conventional minimum code-compliant buildings. To assure this outcome, metrics and validation protocols must be established and coordinated with the other high-performance building attributes. Land development patterns, population increases and increased property losses in vulnerable locations all point to the need to coordinate life safety and operational viability for both maintaining services and activities within the community, providing critical and necessary services and reducing monumental insurance losses.

4. **Develop and establish performance metrics and verification methods for high-performance buildings that provide increased occupant productivity.**

   Worker productivity is a core attribute of economic success. Because of this importance, objective credible measurement and verification of any linkage between high-performance buildings and productivity needs to be established. Much research exists from other established disciplines regarding methodological protocols but little exists that properly applies this to building attributes. It is important to encourage this research simply to ascertain if such linkages are scientifically plausible. The movement from an industrial worker-dominated economy to a service worker economy lends further import to research in understanding, and possibly increasing, the productivity of this growing sector of the American workforce.

5. **Develop and establish performance metrics and verification methods for building serviceability, durability, and functionality.**

   Failure of serviceability or functionality can effectively destroy the durability of a building and thus its potential value to not only the owner but to society. Such a failure can affect a building's long-term value in public and private portfolios. Connecting and coordinating functionality and serviceability to the other attributes of a high-performance building requires the development of new metrics that respond to the individual or institutional owner's requirements. New standards for operation and maintenance of high performance buildings needed to be developed to provide for this functionality.

6. **Develop and establish performance metrics and verification methods for high-performance buildings that provide universal accessibility.**

   Our aging population makes the need for universally accessible buildings palpable. As the workforce ages, both the accessibility of buildings and the ergonomic concerns of the older worker's physical environment and physical limitations need to be actively addressed. Improving these attributes requires detailed research and metrics to maintain worker productivity and cover other areas of universal accessibility. Recognizing the importance providing for individuals with a range of disabilities as well as an aging workforce and population require that high-performance buildings must address the age-related realities of their occupants.

7. **Develop and establish a new set of self-diagnostic protocols for the prioritization and optimization of high-performance building attributes.**

   There are no guidelines for assessing which high-performance features can be sought given their particular contexts, and for developing a proper hierarchy among the various attributes for optimization. The optimization of several attributes rather than the maximization or minimization of individual attributes is the hallmark of a high-performance building. With the aid of standard setting bodies, guidance should be developed that can be used during the earliest stages of project planning. Such a document would at least proffer a coherent means for acknowledging the attributes of a high-performance building, and encourage the implementation of context-appropriate attributes.

8. **Establish two independent expert panels for technical and non-technical areas as a necessary filter for advancing viable policies on high-performance buildings.**

   The creation of independent expert panels that can act in a consultative capacity for technical and non-technical issues will allow better-informed policy decisions. Such panels are particularly important when working with a complex set of scientific, technical, industry, and business issues. These panels will provide authoritative guidance in the many difficult technical matters involved in achieving high-performance buildings and push the benchmark for analysis and objective information to higher levels. Without good information, prudent decision-making for the implementation of high-performance buildings becomes more difficult and subject to decisions based on headlines rather than substance.

   Non-technical areas such as insurance, surety, legal, real estate, and others are crucial to understanding the economic and risk regimes present in possible options for promulgating and establishing high-performance building attributes. Without the input of these non-technical but necessary sectors, any high-performance building strategy will have many hidden flaws.

The successful transition from the status quo to high-performance buildings optimized on a life-cycle basis will require the integrated expertise of a wide variety of disciplines including those who design, manufacture, construct, use, maintain, refurbish, finance and insure our built environment. The Institute's High-Performance Building Council has pulled together over 100 organizations, both public and private, to produce this report. The Council stands ready to assist in the implementation of these recommendations through existing and future legislative efforts.

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Acoustical Society of America
Air Conditioning Contractors of America
Air-Conditioning and Refrigeration Institute
Alliance to Save Energy
Associate Air Balance Council
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