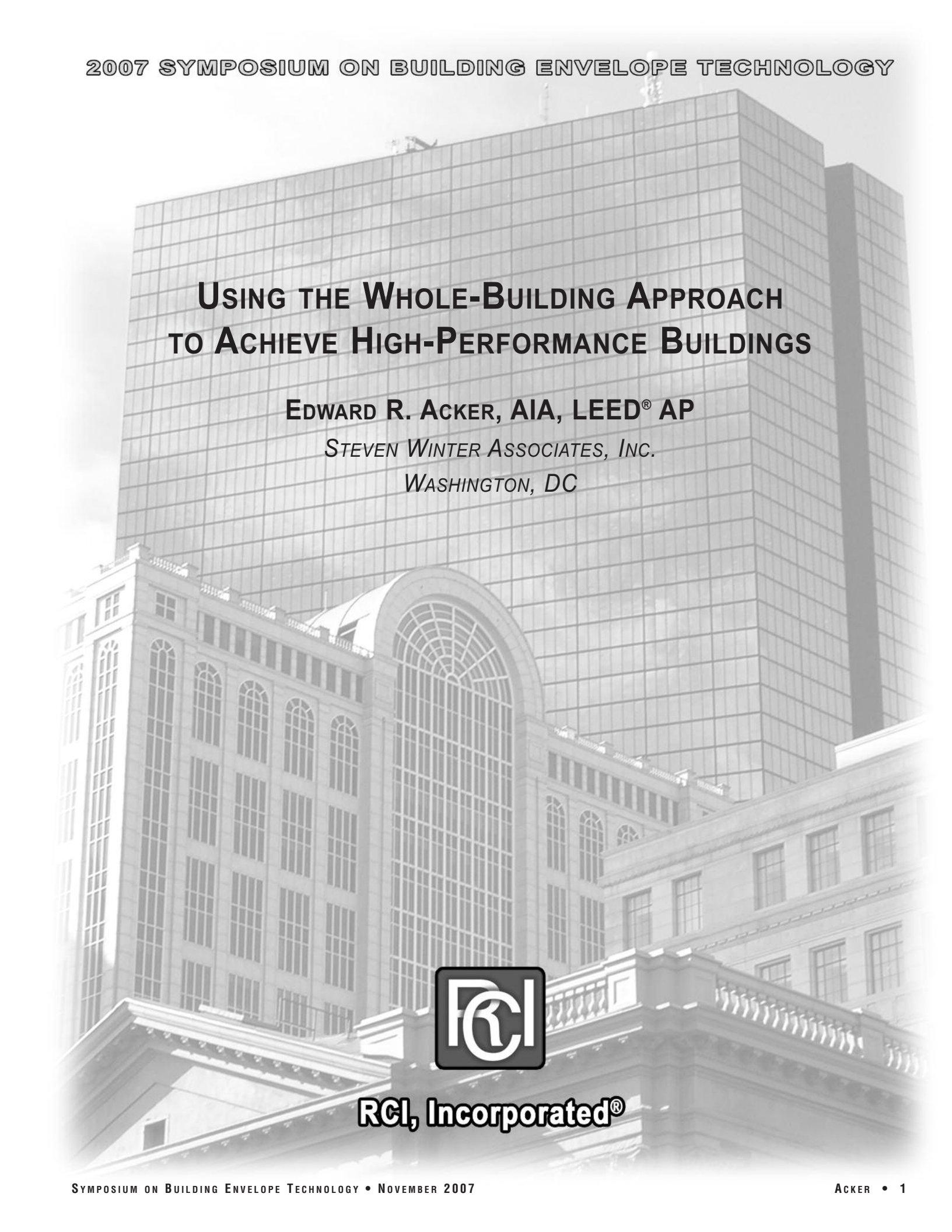
2007 SYMPOSIUM ON BUILDING ENVELOPE TECHNOLOGY



# USING THE WHOLE-BUILDING APPROACH TO ACHIEVE HIGH-PERFORMANCE BUILDINGS

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## ABSTRACT

It is critically important to utilize the whole-building approach (WBA) to address all aspects of design and program objectives during the concept stage and to understand the interactions of key building systems in order to assure the design results in a well-balanced, high-performance building. It is not sufficient to optimize each of the building's subsystems separately.

Current emphasis on greening facilities and the predominance of the LEED® rating system have significantly increased awareness of sustainable design. But all key design objectives and how they interact in concert with each other, including sustainability, must be considered.

Incorporate the whole-building approach with an initial project-planning charrette with all project team members participating – owners, users, designers, contractors, and operations and management personnel – and continue WBA throughout the design and construction process. Having the entire building team evaluate optimization of building envelope and systems is essential for achievement of high-performance buildings.

The author will demonstrate how users, from beginners to those with advanced experience levels, can utilize the *Building Envelope Design Guide* (*BEDG*) (www.wbdg.org/design/envelope.php), and the *Whole-Building Design Guide* (*WBDG*) (www.wbdg.org) as reference tools to achieve balanced optimization of design objectives, as well as how the whole-building approach can bring value to the building development.


## SPEAKER


*EDWARD R. ACKER, AIA, LEED® AP — STEVEN WINTER ASSOCIATES, INC. - WASHINGTON, DC*


EDWARD R. ACKER received his bachelor's degree in architecture from Cooper Union and is a LEED® Accredited Professional and senior architect with Steven Winter Associates, Inc., Washington, DC. He has designed new office and industrial buildings and private residential projects. He is author of *WBDG, Building Types*, and *Warehouse, Archives and Record Storage Building*. In 2006, Acker received the Tucker Design Award from the Building Stone Institute with DiGeronimo, PA. His GSA training was with Whole-Building Design Guide/Design Disciplines Charrette, and he served as coordinator and co-facilitator for the NIBS/USACE Baltimore District USAMRIID Whole-Building Approach Workshop.

# Using the Whole-Building Approach to Achieve High-Performance Buildings

## THE CASE FOR WHOLE-BUILDING DESIGN

The green building movement is sweeping through both the public and private sectors, fueled by the desire to create buildings that are more responsive to the environment, use less energy, increase functionality, and boost occupant productivity.

There is a more holistic approach to buildings known as the "whole-building approach" (WBA) that enables designers to address these competing priorities. The WBA is growing as a movement within the federal government, the military, and the private sector. It will have a tremendous impact on the practice of architecture and related disciplines and on the future of America's buildings.

Facilities executives are only starting to understand that commercial office buildings can be more than just structures for conducting business. Facilities executives are learning how buildings interrelate with both their external and their internal environments. This growing awareness has shifted not only how people interact with buildings, but also how they design, create, and manage buildings. The green building movement has highlighted the importance of designing buildings that use resources efficiently and provide a healthy environment for their occupants. Since the passage of the Americans with Disabilities Act (ADA), a building must be accessible to serve the needs of an increasingly diverse population while providing a workspace that fosters health and productivity. And since 9/11, building security has been more prominently considered.

These important factors are often considered separately or sometimes not at all. Recently, a more holistic approach to building design, construction, and operations and maintenance has emerged. With a whole-building approach, it is not enough to simply design a sustainable, secure, or accessible building. Rather, by understanding how these separate goals are related to each other and can be integrated, it is possible to create a truly high-performance building, integrating all of the desired design objectives.

## THE CONCEPT OF WHOLES

The concept of "wholes" is not new. In 1926, Jan Smuts, a statesman, philosopher, and twice prime minister of South Africa, coined the term "holism." He believed that there are no individual parts in nature, only patterns and arrangements that contribute to the whole.

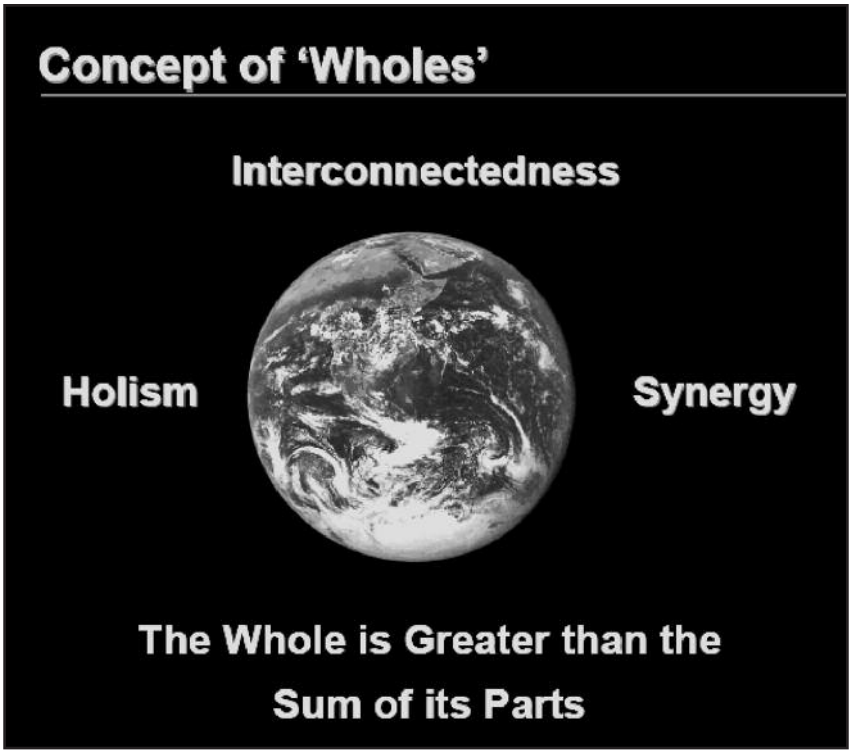


*Figure 1*

Buckminster Fuller, in 1969, said, "Synergy is the only word in our language that means behavior of whole systems, unpredicted by the separately observed behaviors of the system's parts or any subassembly of the system's parts."

It's a perfect example of the whole being greater than the sum of its parts. We view the building as a set of systems that interact and affect one another – through design and construction and in facility operation and maintenance over the life of the building (*Figure 1*). We continue to learn much about the interconnectedness of everything in nature, and buildings certainly play an important part in life on the planet. In fact, the role of buildings is constantly changing. Buildings today are life support systems, communication and data terminals, centers of education, justice, and community, and so much more. They are incredibly expensive to build and maintain and must constantly be adjusted to function effectively. The economics of building has become as complex as its design.

## ENERGY AND THE ENVIRONMENT

Buildings also annually consume over 40 percent of the energy in the U.S. Most of these buildings depend primarily on energy produced from nonrenewable, fossil fuel sources – coal, oil, and natural gas – extracted from the earth and burned to produce electricity. Through this process, buildings are responsible for more than a third of greenhouse gas emissions. The build-up is intensifying the atmosphere and changing climate in ways that may affect weather patterns, sea level, and the land masses that support life. Buildings often contribute to health problems such as asthma and allergies through poor indoor environmental quality. And this is only part of the story (*Figure 2*.)

In a post-9/11 world, we are acutely

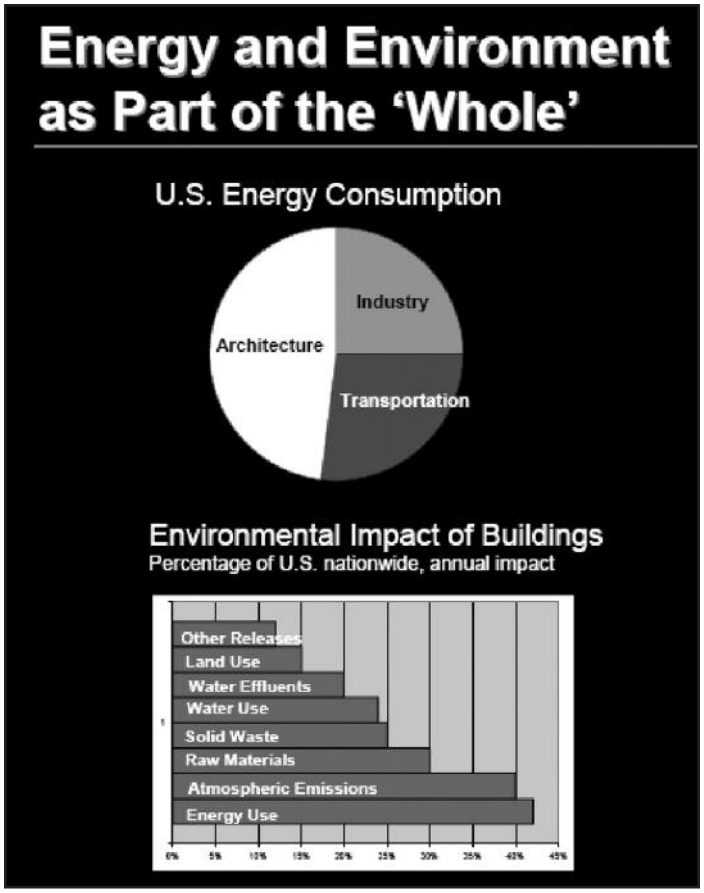


*Figure 2*

Understanding the whole-buildings approach will help consultants think and practice in an integrated fashion to meet these demands and create high-performance buildings.

"A high-performance building is more than just a green building," says Helen English, executive director of the Sustainable Buildings Industry Council (SBIC). "A high-performance building is durable, safe and secure, and environmentally responsible. It is attractive and accommodating to people who are going to lease it, has good indoor environmental quality, and is acoustically, visually, and thermally comfortable."

## THE ELEMENTS OF THE WHOLE-BUILDING APPROACH

Whole-Building Design is an integrated design approach and team process (*Figure 3*). In order to apply the concepts to a project, one must first understand the concepts and then utilize the tools. *The Whole-Building Design Guide* (*WBDG*) is a comprehensive, Web-based portal supported by government agencies, industry, academia, and the private sectors responsible for developing buildings. The *WBDG* provides timely, relevant, up-to-date information and guidance on all facets of the whole-building approach through a whole-buildings perspective.

The eight design objectives that should be considered and optimized for a high-performance building are:

1. Accessibility
2. Aesthetics
3. Cost-Effectiveness
4. Functionality
5. Historic Preservation
6. Productivity/Health
7. Security/Safety
8. Sustainability

aware that safety is paramount in our buildings. A 2003 Building Owners and Managers Association (BOMA) report indicated security-related expenditures were one of the fastest rising expenses, with the government showing a 29 percent increase and private-sector properties showing a 14.3 percent increase.

The federal government has responded to these challenges by putting into place executive orders and mandates. Programs like the U.S. Green Building Council's (USGBC) LEED® rating system have an impact on the time, energy, and resources of consultants' practices and businesses. LEED continues to be refined and expanded in scope and is becoming a regulatory- and/or market-driven requirement for new construction projects. The private sector and industry have also responded by creating more environmentally friendly, energy-efficient products and systems. So, in fact, we are developing an expanding base of knowledge, materials, building systems, energy, and carbon-related financial systems to solve these energy problems as well as to make a positive impact on the environment and on the quality of life of building occupants.

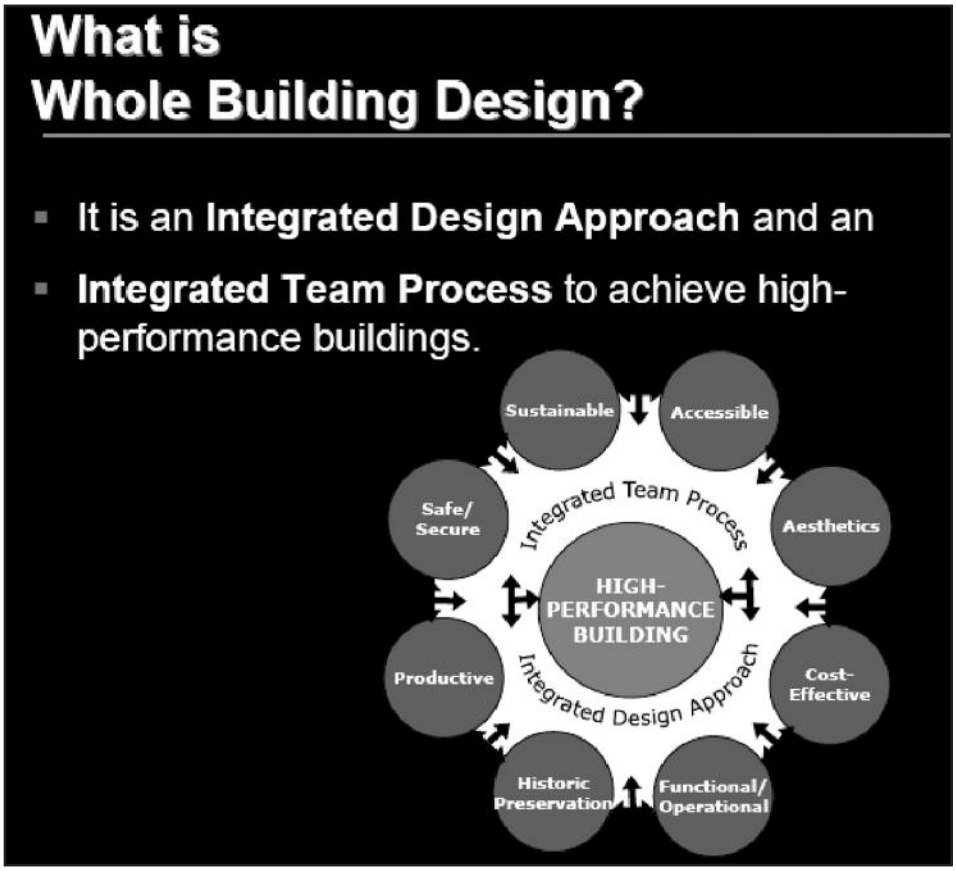


*Figure 3*

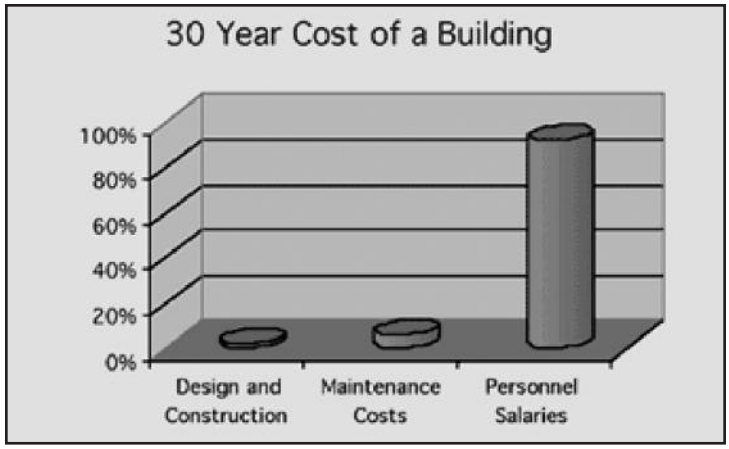


***Figure 4 – Viewed over a 30-year period, initial building costs account for just 2 percent of the total, while operations and maintenance costs equal 6 percent, and personnel costs equal 92 percent. Source:*** **Sustainable Building Technical Manual.**

No one aspect takes precedence over any other. The goals for each building are identified by the project team and will determine how each design consideration is balanced against the others. The key to creating a high-performance building is an integrated approach that, early in the process, brings together all those who have a hand in designing, constructing, operating, and maintaining the building.

Every project is unique, so the relative importance of each of those design objectives will vary for each situation. But one design element should never become the overriding or sole driving force behind a project, or it will fail to meet its "holistic" objectives in the short-term and over the facility's life cycle.

The whole-building approach provides the strategies to achieve high-performance, low-energy, sustainable, and secure buildings. The fundamental challenge of whole-building design is to understand that all building systems are interdependent. The integrated approach considers building components and subsystems collectively, along with their potential interactions, to achieve efficiencies. The business case for high-performance buildings is made when one considers all the costs over the life of a building (*Figure 4*).

## THE INTEGRATED TEAM PROCESS

Whole-building design in practice requires the design team and all affected stakeholders to work together throughout the project phases and to evaluate the design for cost, quality of life, future flexibility, efficiency, overall environmental impact, productivity, creativity, and how the occupants will be enlivened. This approach deviates from the typical planning and design process of relying on the expertise of specialists who work somewhat isolated from one another.

The process draws from the knowledge pool of all the stakeholders across the life cycle of the project, from defining the need for a building through planning, design, construction, building occupancy, and operations. The charrette process as a vehicle for the whole-building approach accelerates the education and design process, allowing for buy-in of major decisions, while all-important and complex issues are addressed and explored (*Figure 5*).

The whole-building approach is a departure from the typical planning process in which all parties concentrate only on their own areas of expertise, staying in their own silos, and emerging only at certain milestone meetings. It is important for all stakeholders to communicate their goals for the project and to understand and be receptive to others' goals and ideas.

Because facilities executives usually have the best idea of the types of space that will be required and of the overall purpose of the building – and because they have the largest stake in the building's outcome – they should take a leading role in establishing these goals. However, it is important to try to get a bottom-up view of space requirements from employee representatives who will be using the spaces. Likewise, team members must consider what the operations and maintenance needs of the building will be and be sure the views of operations and management personnel are integrated into the planning process. It is the face-to-face "brainstorming" aspect of these early exercises that produce more realistic and comprehensive goals.

Once goals have been established for the project, all the stakeholders come together for a structured brainstorming session to review and refine the preliminary design. This is known as a design charrette, and it provides an opportunity for stakeholders to discuss face-to-face how the previously established goals for the building will be carried out.

Budget restrictions, building schedules, and material selection are all issues that can be discussed and agreed upon during the charrette. Key people to include, if possible, are mechanical, structural, electrical, and construction engineers; the facilities' executive, operations, and maintenance staff; architects, cost-management experts, owners, occupants, and building consultants. Although it may be difficult to include contractors this early in the process, the more people at the table, the more integrated the design can be. Facilities executives can assume a leadership role in this process by maintaining focus on the big picture.

Following the planning and design stages of a high-performance building project, an integrated team approach is

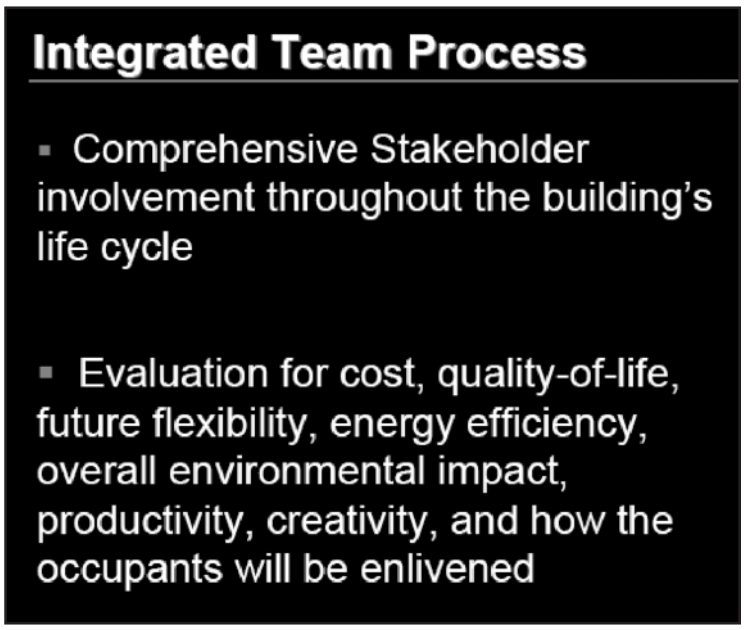


***Figure 5***

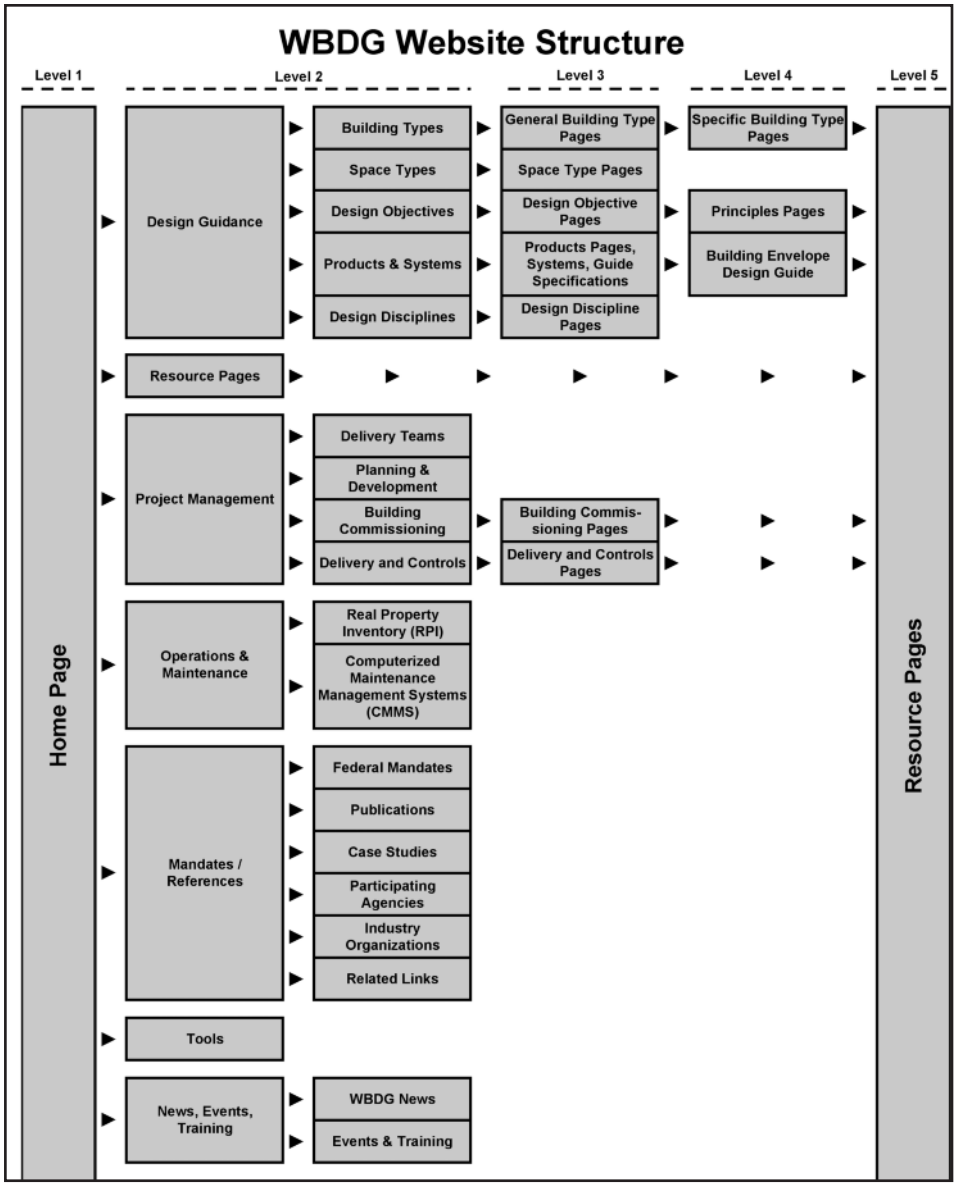


*Figure 6*

required throughout the construction process to ensure that all parties continue to communicate with each other. Project management software can make it easier for the entire team to share information and track the sometimes intricate changes. Ideally, total building commissioning is performed throughout the process and tracks all design goals, considering the envelope, mechanical and electrical systems, controls, etc. Total building commissioning helps ensure the agreed-upon design intent is fulfilled – that the design objectives are being optimized in the total building systems.

### *THE WHOLE-BUILDING DESIGN GUIDE*

The ultimate goal of the *WBDG* is to assist the design community with integrating government criteria, non-government standards and criteria, vendor data, and expert knowledge into a whole-building performance perspective.

The search engine has the ability to access the most likely useful sources for information. In effect, one has a librarian who can select the best books out of the entire library and then leave place markers at the most likely useful pages – all done instantly. How time-efficient is that!

Similar to an encyclopedia, the *WBDG* is reductive in nature. But unlike an encyclopedia, the *WBDG* allows access to more related information by directly linking the user to other resources available on the Internet with the click of a mouse. And the advantage of the Web-based format is that the many interrelated issues of whole-building design can be linked so that as one question arises, the answers and information are a simple hyperlink away.

The *WBDG* is organized into five levels (*Figure 6*):

- Level 1 – Home page, with hot links to topic areas and other levels, current topics of interest, and new postings to the *WBDG*.
- Level 2 – Category pages: Design Guidance, Project Management, Mandates/References, Tools and News, and Events and Training.
- Level 3 – Sub-categories under the Level 2 titles: General Building Information, General Building Types, Space Types, Design Objectives, Products, Systems, Guide Specifications, Design Disciplines, Building Commissioning, Delivery and Controls, and Operations and Maintenance.
- Level 4 – Specific building information pages: Specific Building Types, Design Guidance Principles, and the *Building Envelope Design Guide*.
- Level 5 – Resource pages: the deepest *WBDG* level, consisting of very specific and detailed building-related information on many different topics. The best way to review an index of resource pages and to access them directly by hyperlink, is by clicking on the Site Map tab located on the top right of any page where there is an alphabetically listed index with authorship information.

The *WBDG* will enable a user to link to information related to the topic under research. The user will always be made aware of important related issues and resources as he or she links through the levels of detail and across major topic areas.

### THE BUILDING ENVELOPE DESIGN GUIDE

*Figure 7* shows the *WBDG Building Envelope Design Guide* (*BEDG*) page. This page is consistent in format with all *WBDG* pages, which provide easy access to the *WBDG* levels structure as discussed above. From here, one can access a wealth of building envelope information and design guidance written from a whole-building perspective. Link to: www.wbdg.org/design/envelope.php.

- The comprehensive Introduction chapter contains an overview of the

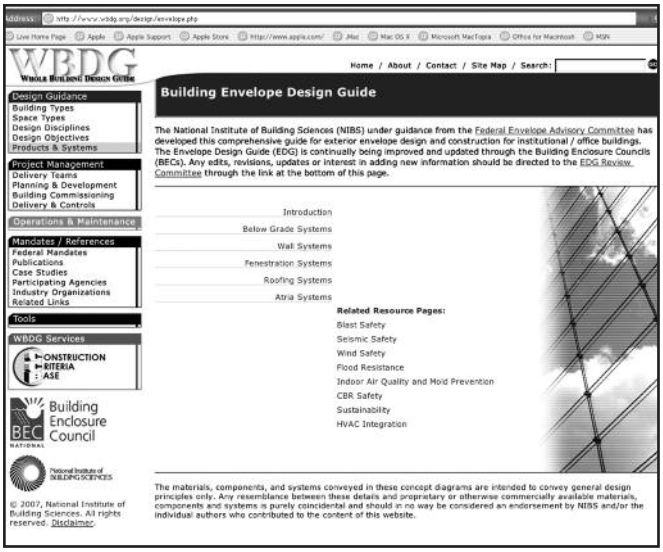


*Figure 7*

*BEDG* and general discussion of the building envelope; a description of the page structure and format used consistently throughout the *BEDG*; a section on the evolutionary development of building envelopes; a discussion of envelope function, performance, and cost criteria; and matrices showing building envelope components' performance interrelationships.

- Separate chapters are specific to the building envelope systems: Below Grade, Wall, Fenestration, Roofing, and Atria.
- There are detailed related resource pages on specialized topics: blast safety, seismic safety, wind safety, flood resistance, IAQ and mold prevention, CBR safety, sustainability, and HVAC integration.
- The Web-based nature of the *BEDG* allows one to quickly link to any other related information and criteria documents in the *WBDG*.
- Finally, there is a "Comment on this page" button in the lower right corner of every *WBDG* page, which permits user feedback, enabling constant update, refinement, and improvement of the Web site.

## ACHIEVING BALANCE AND SYNERGY

Security and sustainability are increasingly important issues in new construction. On a typical project, they are likely to be addressed separately. With an integrated design, however, sustainability and security goals can be balanced in a synergistic way to achieve a high-performance building. Using a whole-building approach, we can use technology to enhance and optimize a holistic design, not just to overcome the deficiencies of a poorly conceived design.

For example, when decisions are being made about how a building will be situated on site, access to the building is a security consideration. While this may traditionally be addressed with walls or fences, an integrated approach could use trees, berms, or constructed wetlands to restrict access–a solution that would contribute to the sustainability of the site by maintaining vegetation and natural habitat, controlling erosion, and providing a filtered stormwater management system. The position of the building on the land can also be considered from both security and sustainability perspectives, as this can affect both the energy performance of the building (for solar access, daylighting, passive cooling, etc.), as well as what access control methods will be possible.

Another example of synergy is when daylighting is optimized, with proper building orientation, shading, and glare control, allowing for a reduction in lighting fixtures, wattage, and heating and/or cooling loads. Such synergies can reduce–or at least not increase–estimated construction costs, and also contribute to great occupant comfort and a reduction in operations and maintenance costs.

## INFLUENCE ON COSTS AND FEES

While there are many compelling reasons to engage in whole-building design, the graph in *Figure 8* is one of the most telling.

Engaging early in the process ensures that the cost of constructing the building as well as maintaining it over its life cycle are reduced, for that is when the stakeholders can have the greatest influence.

This requires a change in the budgeting of A/E fees and time estimates. The whole-building approach process requires more A/E time assigned to higher-salaried project leaders at the front end, as they will be involved in project goal setting, design charrettes, and coordination of information with all stakeholders. It is anticipated that this added front-end effort "to get it right" will

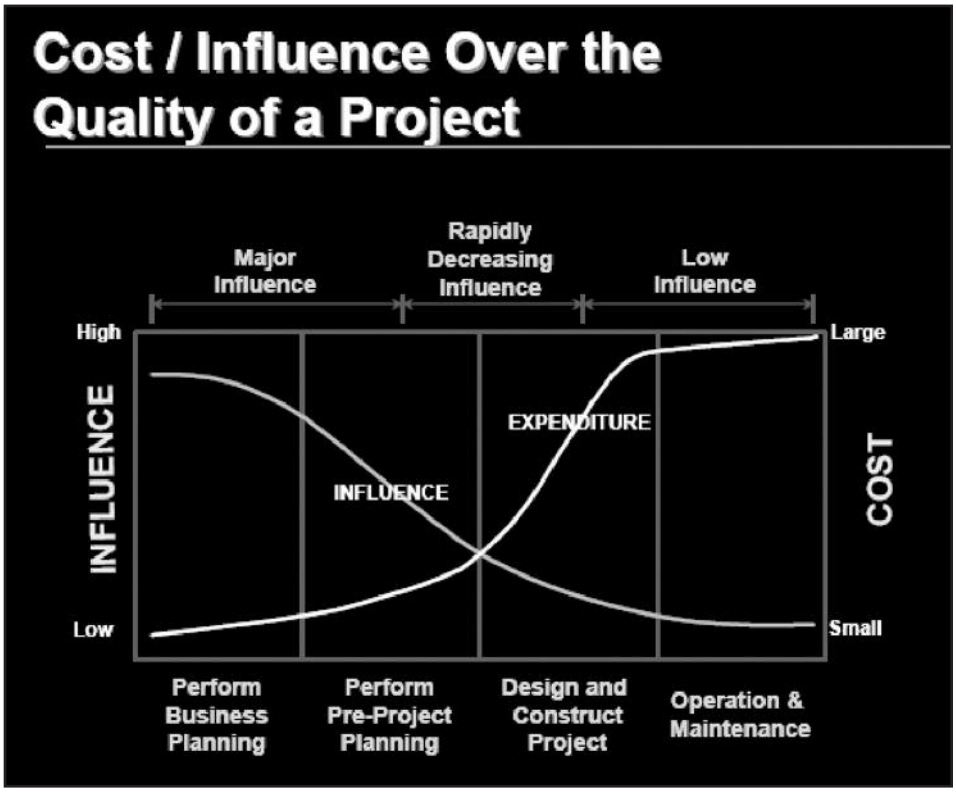


*Figure 8*


***Figure 9***

result in less time in the construction documents phase to correct coordination errors and to make unforeseen design changes in later phases of the design process, thus resulting in no net increase of fees or design time. But, as with all new processes, A/E project managers should allow time for a learning curve on the first few whole-building projects.

Reinforcing adoption of the whole-building or integrated design approach is the use of Building Information Modeling (BIM) technology in the building design professions. As facility owners and developers try to accelerate the building development process, the A/E design team will be under pressure to populate the building information model earlier in the design process than before. These impacts on A/E practice are summarized in *AIArchitect*, April 27, 2007, as based on the 2006 AIA Firm Survey.

The end result of a whole-building approach is a long-term, high-performance building (*Figure 9*). They come in all shapes, sizes, budgets, building types, and functions, and they result from careful consideration of design objectives, constructability issues, construction sequencing, occupant education, and operations and maintenance procedures.