

SUSTAINABILITY MATTERS



U.S. General Services Administration

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MESSAGE FROM THE ACTING ADMINISTRATOR



Guiding Principles for Federal Leadership in High-Performance and Sustainable Buildings:

- **Employ Integrated Design Principles**
- **Optimize Energy Performance**
- **Protect and Conserve Water**
- **Enhance Indoor Environmental Quality**
- **Reduce Environmental Impact of Materials**

For more than 30 years, the General Services Administration (GSA) has set the standard for sustainable, high-quality workplaces that improve productivity, revitalize communities, encourage environmental responsibility and promote intelligent decision making with respect to energy use.

Sustainability has been an evolving theme for GSA beginning with energy efficiency initiatives, resulting from the oil embargo, in the early 1970s. GSA, working with the Centers for Disease Control and Prevention, helped develop many of the building protocols for healthy indoor air quality. In the early 1990s, GSA created the first-ever program for reducing the toxicity of cleaning products. In 2001, GSA was the first Federal agency to join the U.S. Green Building Council, and continues to play an active role to this day.

GSA's successes—from 30% energy use reduction at 12% less cost than private sector buildings to 24 LEED-rated buildings in six years—stem from the seamless integration of sustainable design principles into the design, construction and renovation of our buildings and build-to-suit leases through GSA's Design Excellence program. From requirements through construction, occupancy and use, GSA is committed to following the Guiding Principles for Federal Leadership in High-Performance and Sustainable Buildings.

Changing mindsets to embrace a whole building integrated design approach is a challenge, but this collaborative process allows creative solutions that are economical, environmental and innovative. GSA has just begun that, both internally and with the consultant teams we hire. In doing so, we will continue our impressive record of sustainability excellence and achievement.

David L. Bibb

Acting Administrator, U.S. General Services Administration
GSA Senior Environmental Official



MESSAGE FROM THE COMMISSIONER



Sustainability Goals:

- Sustainable design practices in all major projects
- Reduce energy use by 30% in 10 years
- Exceed ASHRAE energy standards by at least 30%
- Reduce fossil fuel-generated energy by 55% now and 100% by 2030

GSA's Public Buildings Service (PBS)—landlord for the civilian Federal government—has an opportunity and a responsibility to lead by example and to demonstrate how to create sustainable buildings by intelligently integrating energy efficiency and environmentally sound decisions into building designs while still creating places where people can work effectively.

Sustainability in building design, construction, and operation, is fundamental to and indivisible from our core agency mission of providing superior workplaces for Federal customer agencies at best value to the American taxpayer. We want to be part of transforming the building industry so that “green” is the only way of doing business.

This book provides examples of our progress toward sustainability to date. It is meant to inspire the people who work for and with GSA to surpass—not just continue—the excellent work PBS has already accomplished in meeting the sustainability goals of the Federal government.

We celebrate the accomplishments recognized in this book, but merely continuing this good work will fall short of our needs. The Energy Policy Act of 2005, the President's Executive Order 13423, “Strengthening Federal Environmental, Energy and Transportation Management,” and the Energy Independence and Security Act of 2007 have each raised the performance bar. Our task is increasingly difficult and the new goals will be tough to achieve.

PBS builds buildings to last a century. Integrating sustainability into all of our activities will leave a legacy for America that will outlast our buildings. I urge all of us to embrace these ideas and enhance them through our actions.

David L. Winstead

Commissioner, Public Buildings Service

INTRODUCTION

GSA presents this resource as an aid to improve current practices and to encourage continuing innovations that create and maintain sustainable work environments. Whatever mission a Federal agency may have, this publication presents an integrated approach, illustrated with numerous and various examples, that will improve buildings and workplaces and achieve legislative and executive mandates: at best value to taxpayers and without compromising the quality of life of future Americans.

The book begins by setting the stage for sustainability in the Federal government. The second chapter, “The Greenest Alternative” highlights the importance of the preservation of existing resources and the sustainability of not building at all. The third chapter addresses the value proposition and practical procurement practices for green buildings. The following five chapters offer proven examples of processes and techniques GSA can and should be implementing. The strategies address the broad panoply of a building’s lifecycle—from choosing a site through operations, maintenance and renovation.

Each chapter’s content is illustrated by case studies of GSA facilities that emphasize the knowledge and strategies presented therein. In aggregate, they highlight the creativity, diligence and understanding of asset managers, project managers, property managers, and realty professionals. Their success should inspire project teams to solve the new challenges we face, and improve each building through an integrated approach from the earliest phase.

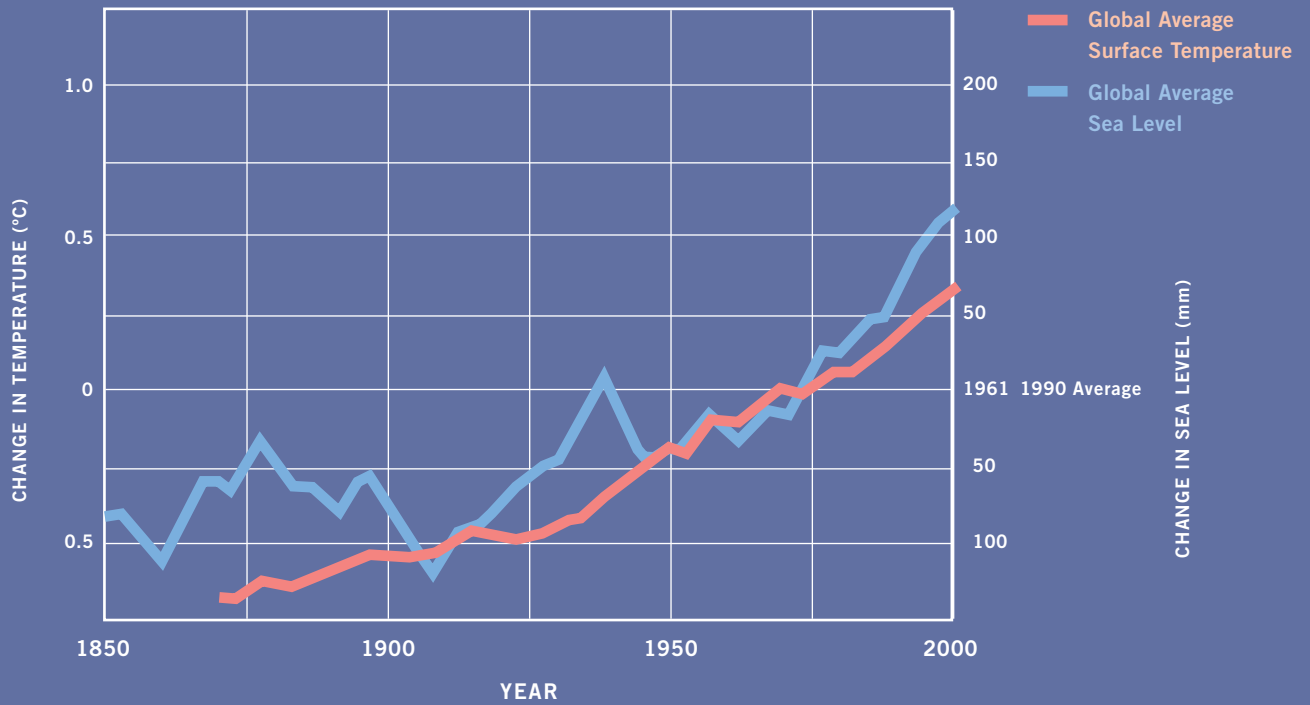
The book's concluding chapters acknowledge the green movement external to the Federal government, its influencers and GSA's continuing and emerging efforts to participate in and, in fact, lead by deed and example.

As seen in the following charts, the world is taking notice of the urgency before us. Global scale environmental changes demand an examination of current practice and a vision for the future. It is in this context that GSA must make operational and design decisions to continue to meet the mission-related needs of customer agencies.

Changing standard practices always involves risk. But the examples herein contain ideas and strategies that can reduce energy consumption, discourage resource depletion, increase productivity, and create healthy work environments. This is the legacy we at GSA wish to leave behind—buildings of today that incorporate our hopes for tomorrow.

For the past 150 years, sea levels have mirrored rising surface temperature.

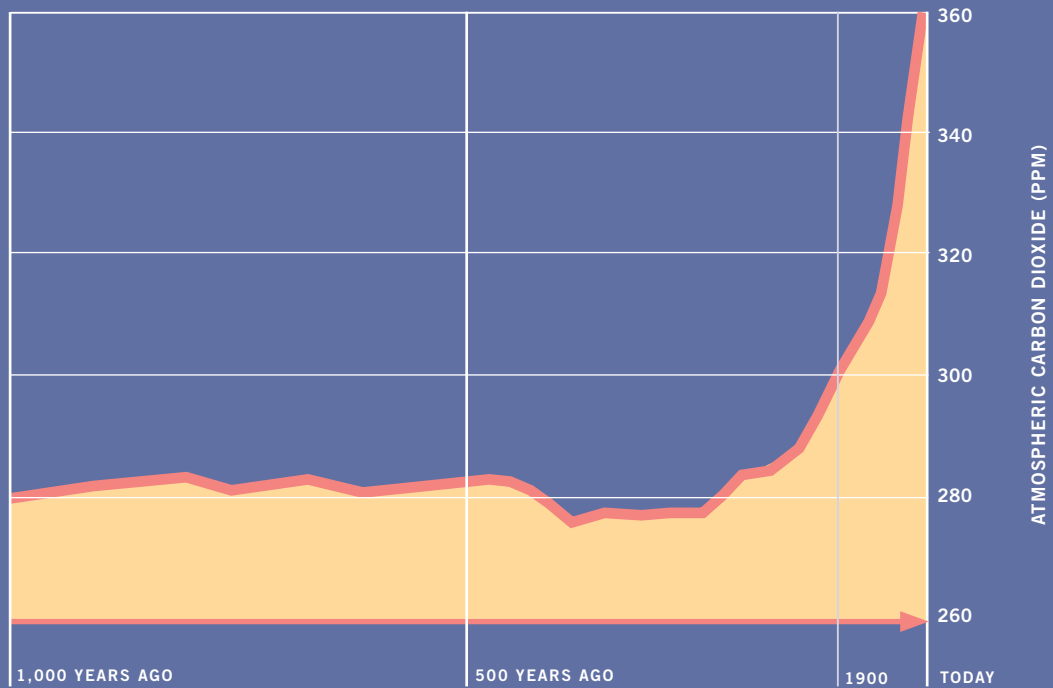
CHANGES IN GLOBAL SURFACE TEMPERATURE AND SEA LEVEL



DATA FROM THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE FOURTH ASSESSMENT REPORT—CLIMATE CHANGE 2007: SYNTHESIS REPORT

From 1800 to the present, carbon dioxide (CO₂) has soared above previously recorded levels.

GROWTH IN CARBON DIOXIDE LEVELS



DATA FROM THE CARBON DIOXIDE INFORMATION ANALYSIS CENTER AT OAK RIDGE NATIONAL LABORATORY BASED ON ANTARCTIC ICE CORES AND, AFTER 1800 AD, FROM MAUNA LOA OBSERVATIONS



SUSTAINABILITY AND THE FEDERAL GOVERNMENT

The challenge—to make Federal buildings more sustainable—begins in a context of hundreds of thousands of diverse buildings, serving unique purposes, and owned by numerous agencies, with significant environmental impacts and the opportunity for improvement.

FROM THE FEDERAL COMMITMENT TO GREEN BUILDING: EXPERIENCES AND EXPECTATIONS, 2003, OFFICE OF THE FEDERAL ENVIRONMENTAL EXECUTIVE

The Federal government's environmental footprint is enormous. As the owner of nearly 450,000 buildings with more than 3 billion square feet of floor space—an area larger than the state of Nevada—the Federal government has both the responsibility and the unique opportunity to reduce its impact on the environment. Through the sustainable design, construction, operation, and maintenance of Federal buildings, our government can reduce the emission of greenhouse gases, curtail energy costs, contribute to national security by reducing our dependence on foreign energy sources, improve working conditions for its millions of employees, and perhaps most importantly, serve as a model for the private sector.

Arriving at this holistic view of sustainability has taken decades—now the challenge is to apply its universal principles to the individual missions of every governmental agency.

Also, green building and issues of sustainability have come to bear on policy decisions made outside the environmental arena. Energy security has become increasingly important to the Federal government, and in particular the Department of Defense—itself responsible for more than half of the government's energy use. It was a concern of the Energy Independence and Security Act of 2007 and the subject of current legislative proposals. As far back as the oil embargo of the mid-1970s, agencies understood that reducing dependence on foreign oil was as much a military as an economic strategy, and that energy conservation could play a major role in that effort. Just as importantly, by spending less money on energy, the government will have more funds available to meet its core missions. The adoption of environmentally sound design, building, and maintenance practices not only makes sense for the planet, it also makes sense for the Federal budget and for our national security.

left: THE REPETITIVE INTERPLAY OF SUNSHADES, LIGHT SHELVES, AND RECESSED WINDOWS CONTROLS DAYLIGHT AT THE OKLAHOMA CITY FEDERAL BUILDING.

The Case for Sustainability

The U.S. General Services Administration is, therefore, committed to sustainable design defined by five overarching goals:

- 1 Using an integrated team approach to design, construct and operate its buildings,
- 2 Reducing the total life-cycle ownership cost of facilities,
- 3 Improving energy efficiency, water conservation, and reducing material consumption,
- 4 Providing safe, healthy, and productive built environments,
- 5 Promoting excellence in environmental stewardship.

A Short History of GSA and Sustainable Practices

GSA's energy program began like that of many Federal agencies—as a response to the energy crisis of the early 1970s. Unlike the general public, however, whose interest in conservation waned once the crisis passed, GSA's interest in sustainability grew throughout the decade. As a result, when oil prices began to spike again in the early 1980s, the agency was prepared. In addition to numerous energy-saving initiatives involving the lighting, heating, and cooling of its facilities, GSA also promoted water-saving programs, environmentally beneficial landscaping, and incorporated guidelines established by the Environmental Protection Agency (EPA) for the use of recycled-content and environmentally preferable building materials. The design of mechanical systems included economizers and heat recovery equipment, saving energy as well as enhancing indoor air quality through an increased use of outside air. Recognizing the impact of a healthy workplace on employee satisfaction and productivity, GSA developed green cleaning policies as early as 1992.

U.S. BUILDINGS ACCOUNT FOR:

39% of total energy use

12% of total water consumption

68% total electricity consumption

38% of all carbon dioxide emissions

60% of total non-industrial waste

COMPILED BY EPA GREEN BUILDING
WORKGROUP 2004

Over time, individual “best practices” within the agency were included in GSA’s Facilities Standards for the Public Buildings Service, the most comprehensive and progressive set of building standards then in existence. In essence, GSA had implemented a comprehensive sustainable design strategy for new buildings *in advance* of any policy directive.

Furthermore, GSA created a *strategy* for the adoption of the principles of sustainable design, focusing on three specific goals: 1) commitment at the strategic level; 2) integration into current standards and processes; and 3) gaining the support of GSA associates through training and education. The goal was a challenging one, and involved the design, implementation, and seamless integration of a sustainable design program into the day-to-day business practices and processes of the Public Buildings Service.

In the late 1990s a series of Executive orders focused on “greening” the government laid the foundation for many of the Federal environmental policies in place today. Executive Order (EO) 13123 “Greening the Government through Efficient Energy Management,” signed in June of 1999, was the first to mention sustainable design. That order charged an interagency team, led by GSA and the Department of Defense, to define precisely what sustainable design and development principles would mean to the Federal government. The resulting six principles guided the future development of the Whole Building Design Guide, which emphasizes a holistic, sustainable approach to facilities design, construction, and maintenance. Sustainable design became an umbrella term encompassing all of the best environmental building strategies.



WBDG is a web based portal providing government and industry practitioners with access to up to date guidance toward sustainability.

WHOLE BUILDING DESIGN GUIDE

As they began the monumental task of upgrading criteria documents for the Naval Facilities Engineering Command in 1997, the members and staff of the Sustainable Buildings Industry Council (SBIC) and its then Chairman, visionary architect and educator, Don Prowler, first conceived of the on line resource, the Whole Building Design Guide (WBDG). After nearly two years of development, the site was turned over to the National Institute of Building Sciences. It has since become the primary web based portal for architects and engineers in government and industry to gain access to up to date information on a wide range of buildings related guidance, criteria and resources.

Design Objectives, the website's first section, focuses on eight critical aspects for designing, delivering and operating almost any building: accessibility, aesthetics, cost effectiveness, functionality, historic, productivity, safety and security, and sustainability. Sustainability became the first of these to be fully developed. The original outline for the sustainability section emerged as SBIC worked with GSA, DOD, DOE and EPA to write the Sustainability Principles called for in Executive Order 13123.

Now updated regularly by committees of Federal agency representatives, the various sections of the WBDG have expanded to cover additional design criteria, always emphasizing an integrated whole building approach. More than 1 million documents are downloaded each month from the site and over 10 million visits are expected in 2007. Access to the site is free to all.

GUIDING PRINCIPLES:

I. Employ Integrated Design Principles

- Integrated Design
- Commissioning

II. Optimize Energy Performance

- Energy Efficiency
- Measurement and Verification

III. Protect and Conserve Water

- Indoor Water
- Outdoor Water

IV. Enhance Indoor Environmental Quality

- Ventilation and Thermal Comfort
- Moisture Control
- Daylighting
- Low-Emitting Materials
- Protect Indoor Air Quality during Construction

V. Reduce Environmental Impact of Materials

- Recycled Content
- Biobased Content
- Construction Waste
- Ozone Depleting Compounds

Following these early initiatives, GSA continued to develop and implement sustainable policy into the 21st century. The Energy Policy Act of 2005 formally established the wording of EO 13123 as national policy, requiring all Federal agencies to apply sustainable design principles to the siting, design and construction of all new facilities if life-cycle cost effective.

GSA, in partnership with the Departments of Defense and Energy and through the Interagency Sustainability Working Group, worked to pool the strength of the three agencies to support Federal construction requirements that mandated the incorporation of sustainable design strategies. The group identified the most commonly used, financially feasible and measurable strategies with the intention that a Memorandum of Understanding (MOU) between participating agencies would make them de facto standards for Federal construction.

The office of the Federal Environmental Executive adopted the resulting document and its signing became a highlight of the first White House Summit on Sustainable Federal Buildings held January 24-25, 2006. Nineteen agencies signed the MOU on the first day. Exactly one year later President Bush signed Executive Order 13423, "Strengthening Federal Environmental, Energy and Transportation Management," establishing the MOU and its "Guiding Principles for Federal Leadership in High Performance and Sustainable Buildings" as formal Federal policy.

As Congress and the American people continue to learn of how buildings contribute to climate change, energy efficiency has taken on an even greater significance. During the 2007 Congressional session, legislators introduced 26 pieces of legislation with the potential to affect Federal energy and sustainable design programs. The Energy Independence and Security Act of 2007 (EISA 2007) is the result that codified many of the goals of EO 13423, and for the first time set targets for the reduction of fossil fuel-generated energy used by buildings.

GSA LEED BUILDINGS



**SOCIAL SECURITY
ADMINISTRATION (SSA) ANNEX**
WOODLAWN, MD

LEED NC rated: Nov 19 2002

CERTIFIED

| | | |
|------------------------------|---|----|
| Sustainable Sites | 4 | 14 |
| Water Efficiency | 2 | 5 |
| Energy and Atmosphere | 8 | 17 |
| Materials and Resources | 5 | 13 |
| Indoor Environmental Quality | 5 | 15 |
| Innovation and Design | 2 | 5 |

26 69

GREEN FACTS

- 25%** energy usage reduction using thermal ice storage
 - 41%** materials locally manufactured, reducing transportation impacts
 - 77%** reuse of existing building shell
-

GSA and LEED®

In 2000, in order to objectively measure the success of its sustainable design achievements, GSA decided that all capital projects from 2003 on—the next funding cycle—would be assessed using the U.S. Green Building Council’s (USGBC) Leadership in Energy and Environmental Design (LEED) rating system. Recognizing that opportunities for sustainable practices existed in all building types, the agency began incorporating sustainable design principles into all aspects of its business processes. GSA updated leasing language to introduce green strategies and concepts, encouraged repair and alteration projects of all sizes to adopt sustainable design principles, and revised standard guidance and building processes to include sustainability requirements.

The Office of Management and Budget (OMB) also sought ways to strengthen the Federal commitment to green buildings. In 2002, recognizing the enhanced asset value of better building design and construction, OMB revised Circular A-11, Section 55—Energy and Transportation Efficiency Management—to encourage Federal agencies to incorporate ENERGY STAR or LEED into design concepts for new construction and/or building renovations.

In 2004, in response to concerns about the first costs of green buildings, GSA examined the costs of LEED certification for its most recent construction projects and found that LEED ratings could indeed be achieved within a standard GSA budget. In fact, the potential costs for either certified or silver LEED certification were below the 5% estimate variance normally associated with early conceptual cost estimates. As a result of a 2006 evaluation by GSA of sustainable building rating systems, the Administrator concluded that LEED remains the most credible rating system available to meet GSA’s needs. EISA 2007 requires GSA to re-evaluate the rating systems every five years.

Enhancing the Vision

Support from the Administrator of GSA and the Commissioner of the Public Buildings Service (PBS), as well as training programs throughout all GSA regional offices continue to maintain and strengthen the entire agency's commitment to sustainability.

GSA's long established emphasis on healthy and productive work environments is perfectly compatible with the principles of sustainable design, which, at times, calls for going beyond standard building codes. Whether within or in addition to existing design and construction guidelines, GSA's goal has been to provide superior workplaces for Federal workers at the best value to the U.S. taxpayer. It is the position of GSA that this vision—in essence, to be the best public real estate organization in the world—is enhanced through its increased focus on all aspects of sustainability in buildings.



DESIGN EXCELLENCE

PBS initiated the Design Excellence Program in 1994 to foster the creation of Federal buildings of enduring value and to ensure the continued viability of GSA's existing portfolio. The program engages the broad and diverse spectrum of America's most creative designers, engineers, and artists to deliver buildings that embody the finest design quality and enhance the communities in which they are built. Through its National Register of Peer Professionals, Design Excellence uses the expertise of distinguished private-sector design, art, and construction professionals to assist GSA's 11 regions in creatively meeting the facility needs of Federal customers with buildings that GSA can effectively and efficiently own and operate. In 2006, recognizing the importance of sustainable design, GSA added 15 of America's most knowledgeable voices in this area to its peer review register.

Integrated Design

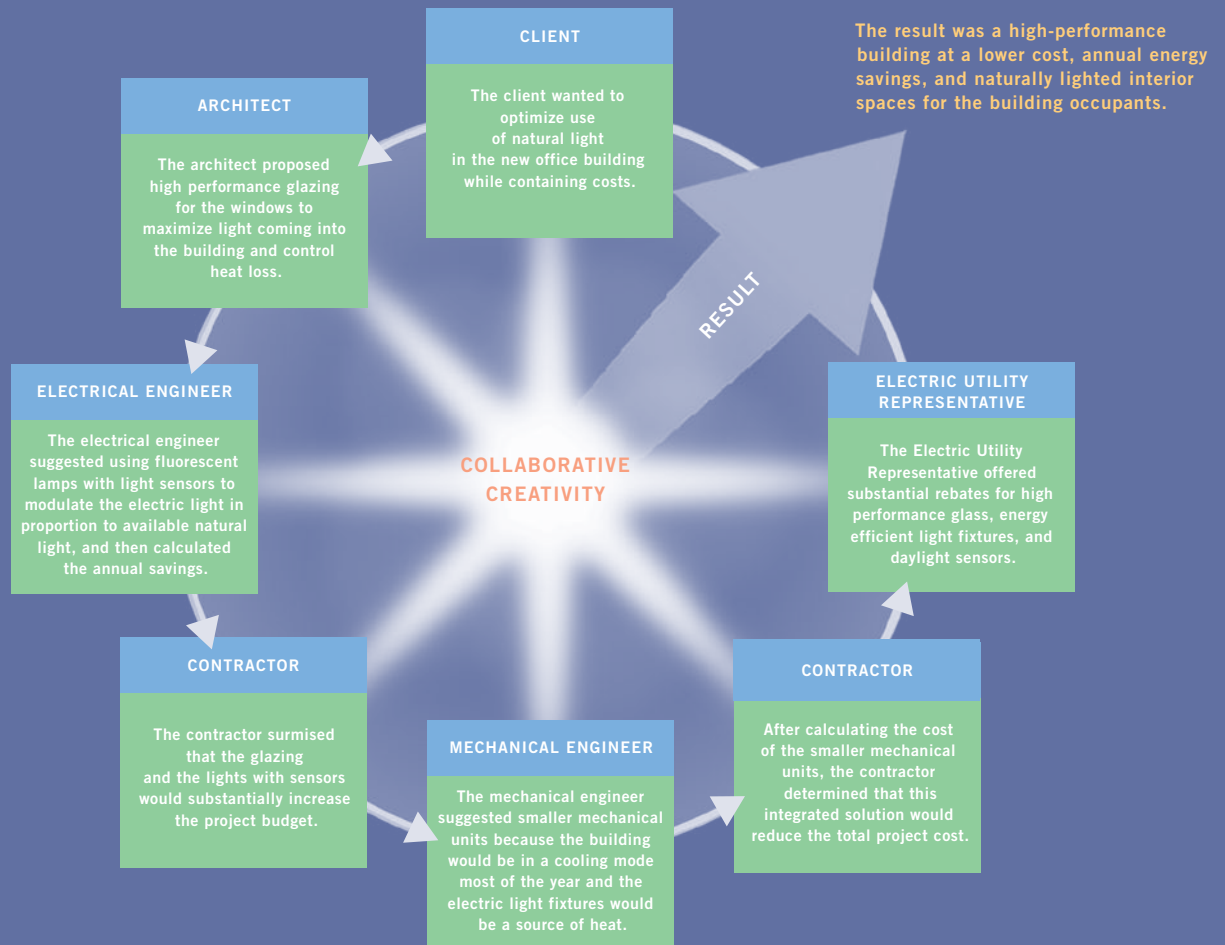
Delivery and management of buildings that accomplish the multiple goals of sustainability cannot reasonably result from processes that focus on single systems and short-term goals. From the beginning of any project, all the parties' need to be involved in a structured process that ensures that the result will deliver performance that meets all the parties needs. The building tenants and their customers; the building operators; the entire design and delivery team; all bring crucial understanding of different aspects of building performance.

One key to such change is an integrated design process. This is not a difficult concept to understand or to embrace, but, at times has proven difficult to practice. Nonetheless, it is the first step toward changing entrenched processes that tend to deliver the same limited results.

The design charrette can be the mechanism that overcomes these obstacles and starts the communication process between the team members, building users, and project management staff. As such, it is important that all relevant decision makers participate. The charrette, viewed as a creative burst of energy that builds momentum for a project and sets it on a course to meet project goals, can transform a project from a static, complex problem to a successful, buildable plan. Usually, it is an intensely focused, multi-day session that uses a collaborative approach to create realistic and achievable design ideas that respond holistically to the issues at hand.

An example of the factors at play in an actual project, and how the presence of key players in one room at one time in a charrette fostered rapid communication and decision making.

THE CHARRETTE PROCESS



EXAMPLE BY NATHAN GOOD, AIA, IIDAA, CH2M HILL

The top performing buildings in each metric deliver significantly better results than the national average.

PERFORMANCE OF GSA BUILDINGS COMPARED TO NATIONAL AVERAGES



KEY FINDINGS-

Compared to national averages, buildings in this study have:

26% less energy use
(65 kBtu/sf/yr vs. 88 kBtu/sf/yr)

13% lower maintenance costs
(\$2.88/sf vs. \$3.30/sf)

33% fewer CO₂ emissions
(19 lbs/sf/yr vs. 29 lbs/sf/yr)

27% higher occupant satisfaction

Measuring Results

GSA recently completed a comprehensive post-occupancy evaluation of 12 of its sustainably designed buildings in order to answer the question, “Does sustainable design deliver?” The evaluation of these buildings was comprehensive, including environmental performance, financial metrics, and occupant satisfaction. No previous U.S. study has taken such a holistic approach to building performance. The buildings studied all incorporated sustainable design criteria to varying degrees, with seven receiving LEED ratings. The study compared the energy performance, operating cost, and water use of the GSA buildings against the average performance of U.S. commercial buildings.

Results show that an integrated approach to sustainable design—addressing environmental, financial, and occupant satisfaction issues in aggregate—improves building performance. Taken together, the GSA buildings in the study produce 33% lower carbon emissions than the national average. They use 26% less energy and 3% less domestic water. On average, their occupants are 27% more satisfied than U.S. commercial building occupants. However, the two LEED Gold buildings in the study, which best reflect an integrated sustainable design approach, performed markedly better, using 34% less energy and 54% less domestic water than the national average, and their occupants report 34% greater satisfaction.

Findings such as those documented by this study validate the efforts and achievements of green building initiatives, providing sometimes needed incentives for clients and their design teams to take on sustainable design challenges. By undertaking this study, and hopefully others like it, GSA encourages the needed practice of measuring results.



CASE STUDY: INTEGRATED DESIGN

San Francisco Federal Building

A MODEL OF SUSTAINABLE DESIGN

One of GSA's newest federally constructed office buildings, opened in 2007 in San Francisco, exemplifies the integrated design approach essential to achieving sustainability. The building responds to the climatic conditions of its site, the functional and operational needs of its owner, and the workplace productivity needs of its tenants — now and into the future.

From the initial planning stages, GSA wanted the new Federal building to be among the nation's finest high performance, environmentally friendly commercial office buildings. Climate and urban context considerations guided the vision of a building that would not only provide a healthy environment for its occupants, but would also serve as a national template for the sustainable use of natural resources and energy.

left: THE SAN FRANCISCO FEDERAL BUILDING IS A STRIKING ARCHITECTURAL STATEMENT THAT DEMONSTRATES AN INTEGRATED, ENVIRONMENTAL APPROACH TO DESIGN.

Building Facts

Building Location: San Francisco, California

Date of completion: 2007

Budget: \$144 Million

Size: 18 story tower with four story annex;
652,433 gross square feet

INTEGRATED DESIGN

The effort required to meet sustainable design and energy efficiency goals had an impact on nearly every aspect of the project, beginning with the make up of the design team, and extending to the selection of building materials and tenant space requirements. It also required an unprecedented level of cooperation between team members and client representatives from the earliest phases of schematic design through the final phases of furnishing the interior.

In 2000, GSA selected the design team led by architect Thom Mayne and his firm, Morphosis, with Ove Arup providing engineering and the Smith Group (architect of record) as key team members. Their winning proposal called for an 18 story, \$144 million structure with 605,000 rentable square feet, which promised to be an enduring model of sustainable design on many levels.

Ove Arup, a global design and business consulting firm responsible for the project's structural, mechanical, and electrical engineering, was already involved at the schematic design kickoff necessary for integrated solutions, but, an unusual arrangement since architects traditionally bring engineers in much further along into the design process. Their early involvement paid large dividends, allowing the team to fully exploit the project's potential for energy efficiency and to optimize the use of sustainable materials before architectural concepts were fixed. This early collaboration cultivated the whole building, integrated design approach.

In this case study, we highlight many of the facets of the process which led to the total building solution: neighborhood, energy efficiency, structure, performance studies, workplace innovations, metrics and measurement. While every individual aspect is interesting, it is how they combined and influenced each other that is the story.



Neighborhood

The San Francisco Federal Building (SFFB) is located across from GSA's historic U.S. Court of Appeals and is on axis with San Francisco's Civic Center. The South of Market neighborhood is a socially and economically diverse area known for its three- and four-story light industrial, commercial and residential buildings.

As the building design took shape, an intense dialogue between GSA, its design team and neighborhood advocates helped all stakeholders better understand both the opportunities and the design challenges before them. The slender tower along the northeast boundary frames the beautifully detailed façade of the Court of Appeals, juxtaposing the Beaux Arts building with the SFFB's contemporary architecture and creating a large public plaza. Federal employees and neighborhood residents alike are able to take advantage of the open plaza and the café with outdoor dining, as well as the conference center and child care center inside. This sensitivity to the urban setting and to the neighborhood respects the lower buildings to the south, while the tower anticipates the greater density and monumental buildings of the Civic Center across Market Street.

In short, the SFFB design team sought not only to use the natural advantages of the site—wind, sun, and light—to create a more sustainable and productive place to work, but also to revitalize a long neglected site without overwhelming the unique character of the neighborhood.

above: THE NORTHWEST FACE OF THE FEDERAL BUILDING
AS VIEWED FROM THE CIVIC CENTER PLAZA.

San Francisco Federal Building



Energy Efficiency

From the outset, the project team aimed for a building of uncompromised architectural vision, and a demonstration that energy efficiency is possible on a standard (\$240/square foot) construction budget. The SFFB is projected to use fewer than 25,000 Btu per square foot per year for naturally ventilated portions of the tower, less than one third as much energy as the average office space in GSA's portfolio.

By creating an 18 story tower, the designers were able to take advantage of the site's dependable northwest prevailing winds and San Francisco's year-round mild climate to help cool the building. Thus the design allows a majority of the office space to rely on operable windows, rather than air conditioning, for year-round cooling, resulting in the construction of our nation's first naturally ventilated, high-rise commercial building since World War II. Moreover, since the local zoning code imposes a height limit of 120 feet on any structures to the north, the design not only ensured that the SFFB would stand as an icon on the skyline, but also that no future construction would block the cooling breezes.

The narrow 66-foot floor plate of the tower allows daylight to serve as the primary illumination for 80% of the workspace, a fiscally sound and sustainable achievement in an office environment where electric lighting typically represents 18% of total energy use. An undulating perforated metal screen on the southeast façade and vertical glass fins on the northwest façade of the tower are designed to control sunlight. Each makes a bold architectural statement while serving to dissipate the unpleasantness of direct sun and reduce solar heat gain without restricting natural light. On each floor of offices, controls automatically dim or turn off electric lighting as natural light fills the space, thus reducing energy use and minimizing heat loads.



above: VERTICAL GLASS FINNS ON THE NORTHWEST SIDE DIRECT COOLING OCEAN BREEZES INTO THE BUILDING.

right: A PERFORATED STAINLESS STEEL SCREEN ON THE SOUTHEAST SIDE FORMS A SECOND SKIN FILTERING SUNLIGHT ENTERING THE BUILDING.



Structure

The SFFB's whole building, integrated design approach aims to provide not only optimal performance throughout the building's life cycle, but also return significant and recurring cost savings through reduced operating costs.

The structure's form—derived principally from its energy design, particularly its natural ventilation—also includes other strategic elements:

- Desk height windows that can be opened or closed by employees
- Upper level windows controlled by electronic temperature monitors
- Trickle vents and finned tube convectors near the floor that provide small amounts of ventilation and heat for cold days
- Wall panels and file storage that are six inches off the floor and do not exceed 52 inches in height to allow natural airflow

The building is made of concrete, rather than steel, which is integral to the energy strategy. The exposed ceiling slab functions as a thermal mass, cooled by the night air and continues its work during the day by radiating coolness to the building occupants and absorbing heat from their activities. The design team developed a wave-shaped slab that provides the needed mass without reducing either the amount of reflected light or the proper flow of nighttime air.



The concrete mix contains a high proportion of ground granulated blast furnace slag, which increases the strength of and whitens the concrete, allowing the surfaces to reflect light without being painted. Slag, a steel industry by-product, replaced 50% of the energy-intensive Portland cement in the concrete, dramatically reducing the building's carbon footprint.

The lobby floor has the appearance of terrazzo but the design team avoided added material by using simple polished concrete, providing a sustainable, durable, uncoated finish at a fraction of the cost of other flooring options.

Performance Studies

To ensure that the natural ventilation system would provide a comfortable environment for the building's occupants, GSA commissioned a series of third-party performance studies. Wind tunnel tests were used to simulate worst-case build-out on surrounding properties to make certain that sufficient natural ventilation could not be compromised.

Consultants from Lawrence Berkeley National Laboratory evaluated the façade system and determined that building performance did not require a full double-skin façade, resulting in a savings of \$1.5 million. A design team from the University of California San Diego also provided a computational fluid dynamics analysis to help finalize the shape of the window mullions, which serve to deflect incoming air away from the desk and seating areas on the windward side of the building.

left: DESIGN ELEMENTS, INCLUDING THE UNDULATING CEILING AND THE OPERABLE WINDOWS, ARE INTEGRAL TO THE VENTILATION SYSTEM.

above: A PUBLIC CAFÉ AND A CHILD CARE CENTER, EACH COVERED WITH PERFORATED STAINLESS STEEL SCREENS, RESIDE IN THE PLAZA FRONTING THE TOWER.





Given the building's complexity, the level of integration achieved among all parties would have been impossible with standard two-dimensional drawings. Therefore, the design team used three-dimensional building information modeling (BIM) technology, enabling the integration of information across all disciplines. Early digital models facilitated the study of climate and wind data and validated the natural ventilation scheme. As the plans evolved, BIM also facilitated team integration and allowed the architect to provide virtual views of the building, which helped GSA and its prospective tenants understand the design. Later, BIM was essential to refining the natural ventilation design in a three-dimensional simulation model, which verified its capacity to provide a comfortable indoor environment. Finally, as the building moved into construction, BIM became the groundwork for the shop drawings used to manufacture specific building elements and served as a guide for their installation.

Workplace Innovations

The building's innovations also extended to workplace design and challenged conventional views with a new model for large organizations. Open plan workspaces are arrayed along the building's perimeter, while private offices and enclosed conference rooms form an enclosed core of cabins along the center of each floor. These changes in conventional office design make the natural ventilation and daylighting far more effective.

Additionally, the office tower is served by a skip stop elevator system stopping only every third floor. The design not only reduces waiting time but also aims to encourage use of the wide and conveniently located stairways to promote occupant interaction and fitness.

left: RAISED FURNITURE AND PRIVATE CABINS
ENDING BELOW THE CONCRETE CEILING
ENABLE AIR TO FLOW THROUGH THE OFFICE.

above: OPENINGS IN THE FAÇADE INCLUDE SKY
LOBBIES FOR THE SKIP STOP ELEVATORS
AND A THREE STORY SKY GARDEN.

San Francisco Federal Building



Metrics and Measurement

To verify that the commissioned building would achieve a real world performance similar to that predicted by computer models, GSA measured temperature conditions in the unoccupied, uncommissioned building prior to occupancy. After occupancy, GSA will re-measure the same conditions to ensure the predicted improvement in comfort and working conditions are realized.

One of the few early concerns, in fact, came from results showing that interior illumination levels, as a result of the design's emphasis on daylighting, were considerably higher than those found in conventionally lighted offices. This knowledge enabled GSA to prepare the future tenants for the degree of change.

Because the performance modeling was unusually detailed, the building will provide GSA a unique opportunity, not only to evaluate how the building performs, but also to evaluate the performance of sophisticated modeling techniques. Post occupancy evaluation will focus on five areas: energy savings; indoor environment including employee comfort, satisfaction and engagement; social networks and communications; and, occupant health and well being.



left: A FOUR STORY ANNEX CONTAINS AN ADDITIONAL 100,000 SQUARE FEET OF OFFICE SPACE.

above: DRAMATIC SKYLIGHTS ENLIVEN THE CHILD CARE CENTER WITH LIGHT AND COLOR.

right: A PROTECTED PLAY AREA FOR THE CHILDREN IS COVERED WITH A CUSHIONED, RECYCLED RUBBER SURFACE.



REFLECTIONS ON THE PROCESS

At every stage of the building's development and construction, projected levels of financial and contractual performance have been or are being verified by multiple independent analyses. These analyses demonstrate that the SFFB, built at a total cost comparable to conventional commercial office buildings, will become a model of sustainable design principles.

The GSA team's progressive thinking, passion, and commitment allowed the strong initial design concepts of the design team to be carried through to completion. The extraordinary integration of expert consultants, spearheaded by a design architect who strove for innovation and sustainable design excellence, was central to the project's success.

The SFFB uses techniques and systems appropriate for its location and its use. The specific strategies implemented in the building—in particular the use of natural ventilation—are not readily transferred to some less salubrious geographic locations. The project's design goals and methods, rather than the technical solutions, are applicable for all projects: an insistent commitment to energy efficiency, a focus on sustainable design excellence, the provision of a healthy working environment, the reduced use of natural resources, and the use of an integrated design approach to achieve these goals—all these are the future of excellent design.

MATERIAL SIMPLICITY IS
ARTICULATED BY BOTH DAYLIGHT
AND ELECTRICALLY LIT PENETRATIONS
IN THE ENTRANCE LOBBY.





RETHINKING THE NEED TO BUILD

The greenest alternative is to not build at all. This catches many building owners and designers off guard. How can organizations meet their workplace needs without constructing a building? Alternatives do exist—renovating existing facilities, interior retrofits, reorganizing work processes, reusing resources and materials—with potentially enormous benefits for owners, occupants and the environment.

THE MODERN WORKPLACE

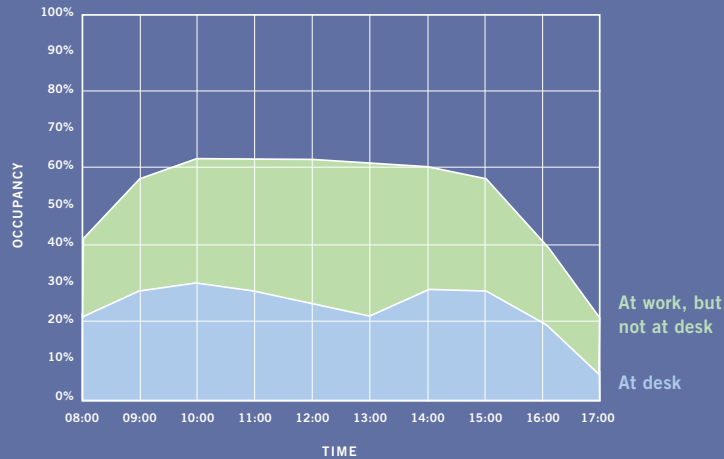
The nearly universal adoption of modern office technology—fax machines, laptops, cell phones, and pda's—introduced unprecedented mobility into the nation's workforce. Even so, though the nature of work has changed over the last two decades, many offices continue to be built out with the same late 1960's design assumption that “one size fits all,” an outmoded workplace concept.

As a result of the modern workforce's increasing mobility, and the growth of more strategic, knowledge-based work—by its nature less routine and more collaborative workplace strategies that rely on single individual places are unlikely to effectively support modern work practice. Work is no longer a solitary pursuit, performed exclusively in an office.

Perhaps the most dramatic change over the last decade has been the decrease—from 34% in 1997, to only 8% in 2007—in traditional nine to five workdays spent exclusively in the office. Workers today have more flexible schedules and job demands that regularly take them away from their desks.

In 2001, Robert Probst, also known as the “father of the cubicle” for his “Action Office” design of the late 1960's, labeled the current use of the cubicle as “monolithic insanity.”

TIME SPACE UTILIZATION (TSU) SURVEY DATA



GSA'S WORKPLACE 20-20 PROGRAM

To create a better fit between the workforces of present day world-class organizations and their workplaces, GSA initiated the WorkPlace 20-20 program in 2002. Some of the program's most important findings are:

- Organizations often underutilize their workspace
- Organizations often configure the available workspace in ways that do not support the new work styles
- The workforce itself has an inaccurate idea of how it spends its time
- Self-reporting is a poor source for reliable programming data

GSA's WorkPlace 20-20 partners—including HOK, Spaulding & Slye Colliers, DEGW, Gensler, Studios Architecture, Business Place Strategies, Interior Architects, as well as Carnegie Mellon, MIT, University of California Berkeley, Georgia Tech, and the University of Michigan—confirm that underutilization of workstations is typical of the government and private sector as well.

During individual client engagements, researchers observed and documented the many ways employees actually use their workspaces in terms of occupancy and task parameters. The survey data show the use of space over time of organizations and provides an objective counterpoint to the ways employees *think* they are using their spaces.

- Workspaces are temporarily unoccupied 23% of the time on average
- Work tasks are consistent throughout the day, with a modest lunch dip
- Computer work is the dominate activity while at the desk—approximately half the time
- Desks are vacant up to 60% of the time, even at times of the highest occupancy!

This last startling statistic poses the question, where are these workers? They are on site but away from their desks, at agency client offices, or traveling—in other words, doing their jobs the way work is done in the 21st century and using the full range of modern tools.

Typically, workforces have a mistaken idea of how they actually use their workspaces. In general, GSA found that they use their workstations about half as much, and in different ways, than they think.

These findings regarding *actual* space usage should prompt a reexamination of traditional programming procedures that rely on self-reported space requirements and use. Most organizations need to consider replacing much of their “fixed” space with “flexible” space in order to accommodate the new, more mobile work style of the modern office worker.

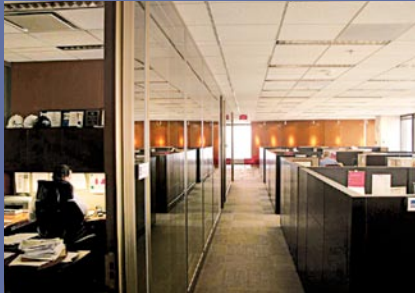
THE SUSTAINABILITY QUESTION

There will always be a place for closed offices, open workstations and demountable partitions that characterize a well-designed workplace. However, the layout must be *consciously designed*, and informed by an understanding of modern work styles in order to serve the organization well. Many furniture manufacturers are responding to the more mobile workforce with components and designs that are not only more sustainable, but far better suited for the way work is done today. Nevertheless, for some organizations, *the reality that 30–50% of their workstations will be vacant for large parts of the day will beg the (sustainable) question: Is this really a beneficial use of resources?*

These findings also lead to the conclusion that building more space should not always be the first answer to meeting an organization's workplace needs. As an alternative, desk sharing and conference room scheduling procedures can greatly reduce the amount of office space an organization requires, and at the same time, increase the flexible, varied use of that space. All of these factors affect the amount and type of space, furnishings, finishes and electric lighting that an organization needs, which directly relates to resource use.

Hewlett Packard, for example, has been able to reduce its total portfolio use of space by over 30% through the re-alignment of space to reflect the working habits of a mobile workforce.

JOHN C. KLUCZYNSKI FEDERAL BUILDING
CHICAGO, ILLINOIS



LESS IS MORE

In June 2006, GSA leveraged WorkPlace 20-20 tools and guidelines to renovate two floors of Chicago's timeless Mies van der Rohe designed John C. Kluczynski Federal Building for the Great Lakes Region, Public Buildings Service. Workplace consultants conducted in-depth analyses of the organization and its work patterns through interviews, focus groups, surveys and cultural analysis. As a result, they optimized the interior environment to fit the way the agency works while also maximizing environmental goals.

The analysis identified a widely held desire to increase interpersonal communication while breaking down organizational stovepipes. The resulting design created egalitarian and nimble work settings by combining:

- Stunning corner views, reserved for group spaces
- Low partitions and increased individual work surfaces
- Rapidly reconfigurable standard sized offices and meeting rooms
- Glazed walled private offices throughout, located away from windows
- Open, well appointed reception and break room areas as gathering destinations

Post occupancy surveys confirm that the new plan strikes the right balance. Flexible configurations contributed significantly to the reduction in total space consumed and lowered churn costs to a bare minimum.

GSA also reclaimed over 16,000 square feet of inefficient file storage space by investing in a managed 1260 square foot high density system that centralized all regional document and supply management services. Not only do the occupants use space more efficiently and better control their files and supplies, but resulting savings (14,000 square feet at \$32 per square foot), equate to \$450,000 per year, or enough to finance the system support, file management, copy and mail operations, and plotting needs of the growing agency.

above: THE INTERIOR LAYOUT AND DESIGN REFLECTS
THE FINDINGS OF THE DEEP DIVE ANALYSIS.

INTERNAL REVENUE SERVICE CAMPUS
KANSAS CITY, MISSOURI



FLEXIBILITY: THE NEW MODEL

The recently opened IRS campus in Kansas City, Missouri, is the result of a master planning effort between IRS and GSA to create service centers reflecting the changing work processes and the new reality of electronic tax return filings. The primary goal for this facility is to increase efficiency and cost effectiveness in the tax collection process and specifically to aid in the servicing of individual taxpayer returns.

The new IRS campus preserves a 475,000 square foot historic Post Office and integrates a 600,000 square foot addition facility into the existing urban fabric reinforcing the vitality of the midtown Kansas City location. The project not only received historic preservation tax credits but a LEED certification.

What really makes this project a model for building only what is needed is the way it accommodates the fluctuation between 3,000 full time employees and up to 5,000 additional seasonal workers, depending upon the tax cycle. In another era with different perceptions of environmental and financial stewardship, it is likely that the building might have been built for 8,000 leaving 60% of the desks unoccupied during the off season.

Given the challenge of designing for a changing workforce, IRS, GSA and two Kansas City architectural firms BNIM and 360 Architects collaborated with the winning developer, Pershing Road Development Company, to create an addition featuring three processing wings connected by a main street spine and a series of courtyards. During those parts of the year when a seasonal workforce is not required and the wings are not being used, they can be closed off and shut down, dramatically cutting utility usage. The highly flexible solution accommodates seasonal changes in work loads as well as changes in processes, programs and technology over time.

SHARED PORT OF ENTRY
SWEET GRASS, MONTANA / COUTTS, ALBERTA



WHY BUILD TWO WHEN ONE WILL DO?

In 1996, when the U.S. and Canadian governments signed the Shared Border Accord, separate building projects for the Sweet Grass, Montana / Coutts, Alberta, border crossing had already been planned, each within a few hundred feet of the other. Instead, the accord allowed the two governments to consolidate the projects into one building, conserving construction materials and minimizing life cycle costs through reduced maintenance and utility expenses over the building's lifespan. The design and administrative challenges, however, associated with building one border crossing instead of two were exceptionally challenging. Everything from currency exchange rates for subcontractor payments to locker rooms for the construction crews eventually located in the U.S. for both American and Canadian personnel because the possession of firearms is not permitted in Canada had to be carefully considered.

GSA and the Canada Customs & Revenue Agency along with the design firm of Felchlin and Diamond executed the project using a design build process, which allowed the joint venture to reclaim the nearly one year delay that had resulted from the decision to abandon the individual U.S. and Canadian projects.

The project fulfilled its objectives of capital cost reduction and demonstration of internationally cooperative environmental stewardship. Sweet Grass/Coutts is the first border station to achieve LEED certification, even though, at the time of the building's design, GSA did not yet require LEED for new all construction projects.

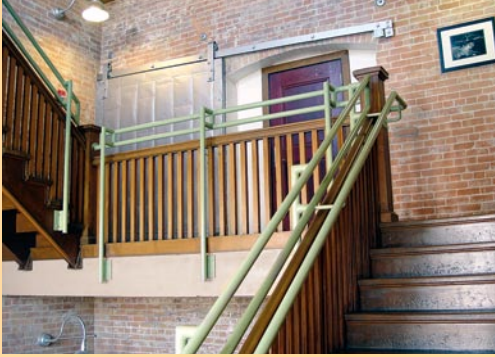
“Historic preservation is the ultimate form of sustainable development. By encouraging the reuse of older buildings instead of abandoning or demolishing them, historic preservation reduces the demand for environmentally costly new building materials and lessens the amount of waste dumped in our landfills. It also protects and celebrates the social and cultural resources that define and unite us as Americans, and ensures that they will survive to enrich our communities and our lives for generations to come.”

RICHARD MOE, PRESIDENT,
THE NATIONAL TRUST FOR
HISTORIC PRESERVATION

USING WHAT YOU HAVE

As we consider the need to build, we must think about the environmental impact of the manufacture and transport of the materials, energy used, and pollution generated by the construction of a new structure. This is not to say that building new is never necessary. A new structure provides a fresh opportunity for the user by focusing on a new construction budget. We often do not consider the environmental impact of new buildings, and thus fail to account for the total cost of ownership. Green building design strategies and the rethinking of outdated work patterns can minimize these costs, thus providing functional space while reducing the environmental footprint. The appeal of the “clean slate” of a new facility is undeniable; the truth is that such a slate may not be so clean after all.

Preservation of our existing building stock is the greenest alternative of all. For GSA the construction of a new building generally involves the demolition of an existing building on an urban site, generating a considerable amount of waste. Unfortunately, some buildings are no longer functionally viable and a decision may be made to tear them down; however, that decision cannot be made lightly and must include not only the financial impacts of the decision but also the social and environmental impacts—it is a balance of often competing considerations.



Given that 60% of the buildings that will exist 30 years from now have already been built, new construction will affect only a fraction of our inventory of space. GSA must focus on how reusing (and continuing to use) existing buildings makes sense. Just as we are concerned with the earth's irreplaceable natural resources, so must we learn to preserve the irreplaceable cultural resources that our buildings represent. Executive Orders 12072 and 13006 encourage locating Federal facilities in city centers and in historic buildings, strengthening not only our communities but also the value of the investment in the reuse of existing buildings and infrastructure.

Adaptive reuse strategies make it possible for existing facilities to meet modern office needs while eliminating the huge environmental burden of building anew. Redesigning existing space or fulfilling programmatic needs in alternative ways, including designing for mobility, may require even greater resourcefulness and creativity than a new building. Working with existing conditions, often the result of decisions made far in the past, in order to modernize a structure to serve present day needs, can not only make formerly mute spaces sing, it can also save money and reduce the strain on our nation's overburdened landfills.

above: MATERIALS REFLECT THE ORIGINAL
WAREHOUSE FUNCTION OF THE HISTORIC
SCOWCROFT BUILDING IN OGDEN, UTAH.

INFO: Executive Order 12072: Federal Space Management, 1978
INFO: Executive Order 13006: Locating Federal Facilities on Historic
Properties in Our Nation's Central Cities, 1996

U.S. PATENT AND TRADEMARK OFFICE
ALEXANDRIA, VIRGINIA



ONLINE RESERVATIONS SAVE OFFICE SPACE

The Department of Commerce's U.S. Patent and Trademark Office (USPTO) in Alexandria, Virginia, implemented a work at home program in 1997. Designed to improve workforce recruitment and retention and relieve office overcrowding, the program achieves multiple quality of life and environmental goals, including a reduction of the carbon footprint associated with the agency's workforce. The agency, in turn, benefits from higher productivity, reduced costs, and greater employee satisfaction.

The USPTO telework program provides employees with fully equipped workstations, including computers, multifunction laser printers and a high speed data line. Even though the cost of each home workstation is approximately \$5,500, the program saved the agency a significant amount of money by reducing the need for office space. Employees also have access to an online reservation hoteling system that allows them to reserve shared office space on the agency's main campus. The telework program has enabled the USPTO to avoid building nearly three floors, or 47,000 square feet, of office space for an annual cost avoidance of over \$1.4 million.

For GSA, which controls some 351,900,000 square feet of existing space (176,400,000 of it federally owned), the opportunity for imaginative reuse is vast indeed. One quarter of the agency's existing inventory is either listed on or potentially eligible for listing on the National Register of Historic Places.

History provides us with innumerable examples of the imaginative redesign of existing structures. One of the best of these, though not widely known, is Michelangelo's reuse of scattered and unrelated, asymmetrical Roman and medieval structures to create the Campidoglio, an architectural masterpiece of majestic symmetry. At GSA, it's refreshing to consider that Michelangelo was both a great practitioner of adaptive reuse and a civil servant!

Federal Building and
U.S. Courthouse, 1937

Baker Building, 1946



Public Library,
1899

Annex, 2004

Connector, 2004

**GSA REUSED THREE HISTORIC BUILDINGS ALONG WITH NEW CONSTRUCTION
TO CREATE THE FEDERAL COMPLEX IN ERIE, PENNSYLVANIA**



CASE STUDY: THE GREENEST ALTERNATIVE

Howard M. Metzenbaum U.S. Courthouse

HISTORICALLY PRESERVED, FUNCTIONALLY IMPROVED, ENVIRONMENTALLY ADVANCED

Rather than increasing the size of the newly constructed Carl B. Stokes U.S. Courthouse in Cleveland, Ohio to accommodate the bankruptcy courts, GSA decided to renovate the city's monumental Metzenbaum Courthouse, and to use the remaining space to consolidate several Federal tenants from leased spaces scattered around the city. The resulting renovation is a brilliant accommodation of both the preservation of the original courthouse, built in 1910, and the requirements of modern jurisprudence. This remarkable achievement has resulted in more than 14 awards for design, historic preservation, engineering and environmental stewardship.

GSA LEED BUILDING

**HOWARD M. METZENBAUM
U.S. COURTHOUSE**
CLEVELAND, OH

LEED NC rated: Apr 19 2006

CERTIFIED

| | | |
|------------------------------|-----------|----|
| Sustainable Sites | 6 | 14 |
| Water Efficiency | 4 | 5 |
| Energy and Atmosphere | 3 | 17 |
| Materials and Resources | 6 | 13 |
| Indoor Environmental Quality | 7 | 15 |
| Innovation and Design | 3 | 5 |
| | 29 | 69 |

GREEN FACTS

32% water use reduction

95% reuse of historic building shell

green housekeeping
procedures employed

Often the most effective strategy for sustainability is to creatively redesign currently occupied space. In the case of this Cleveland landmark, the designers successfully introduced modern functionality into the existing historic footprint. Central to their strategy was the adaptation of the original five level courtyard into functional space, repurposing it as far more than just a lightwell.

The courtyard now houses the security screening area, which was not only designed to blend beautifully with the original architecture, but did not require the use of space on the highly sought after first floor. It also allows more logical and safer movement within the building by using a portion of the courtyard's former volume for new circulation balconies. Finally, to prevent heating and cooling loss through the walls and windows surrounding the courtyard, an impressive glass skylight now caps the space, dramatically reducing the building's energy use.

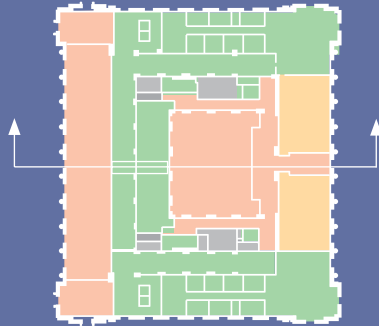
The historic nature of the structure made it necessary for the design team, Westlake Reed Leskosky Architects, to balance the sometimes conflicting needs of modern convenience with the preservation of the building's original grandeur. Toward that end they tucked mechanical chases and risers into no longer used chimneys. They removed the drop ceilings that had been built to contain ductwork for the 1960's era air conditioning, and in the process, revealed the original ceilings, including one with ornate plasterwork. The architect's mechanical engineer also succeeded in locating a demand control ventilation system in the attic. This ingenious solution solves the design problem of placing modern equipment and improves the mechanical function



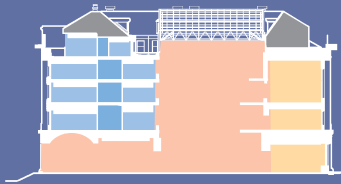
above: A HISTORIC CEILING DISCOVERED DURING RENOVATION ADORNS A JUDGE S CHAMBER.

right: SECURITY FEATURES ARE INTEGRATED INTO THE BUILDING BRIDGING THE HISTORIC LOBBY AND A NEW ATRIUM.

Howard M. Metzenbaum U.S. Courthouse



FIRST FLOOR PLAN



SECTION

by introducing more outside air into the building when concentrations of CO₂ reach undesirable levels. The strategy not only reduced costs but also created a more comfortable productive workplace.

The project reinstated restored murals and rebuilt an original chandelier to accommodate low energy lamps. Other reused materials include hardware, grills, wood doors, glazed brick, and marble from the basement to patch floors and wainscots.

GSA's renovation of the Metzenbaum Courthouse proves that buildings designed and built in the past can gain new life through the application of the same thought, concern and ingenuity that produced them. The great nineteenth century English architecture critic, John Ruskin, said, "When we build, let us think that we build forever." Recognizing both the beauty of the past and the needs of the present, GSA has, more than a century later, heeded Ruskin's advice.



left: AS SEEN IN SECTION, ENCLOSING
THE ATRIUM CAPTURED 5,000 SQUARE
FEET OF NEW INTERIOR SPACE.

right: THE NEW ATRIUM IMPROVES CIRCULATION
EFFICIENCY THROUGHOUT THE BUILDING.



Cost, Value and Procurement of Green Buildings

THE COSTS OF BUILDING GREEN

How much does it cost to build green? To this day, despite our increased awareness of the impacts that the construction, operations, and maintenance of buildings can have on our environment, almost every discussion of green eventually turns to costs. There is a persistent perception that sustainably designed buildings cost more than conventional. While that may have been true once, today the evidence shows that a green building does not need to cost more than a conventional one.

In the 1990's, as the design and construction of green buildings began to gain momentum, many nonstandard building materials and technologies did have additional costs associated with their selection, installation, and use. As awareness of our impact on the environment grew, however, the market quickly evolved to provide a variety of energy-efficient and cost-effective green building materials, and designers accordingly overhauled their product libraries and specifications to include them. At the same time, contractors learned how to use the new materials, master new construction techniques, and employ integrated processes and quality control measures necessary to deliver high-performance green buildings that do not necessarily come with a green premium. However, rising standards and expectations for today's buildings have undoubtedly created more complex design problems, increasing the challenge to design teams to deliver green buildings within conventional budgets. Today, the exponential growth in the expertise of design teams coupled with the continually falling costs of environmentally preferable materials has resulted in buildings more routinely being delivered green with little or no measurable cost premium.



A DEVELOPER'S VIEW

POTOMAC YARD, ARLINGTON, VIRGINIA

“Developing places to live and work requires taking a look at the big picture... a picture that is bigger than some developers realize.

“By teaming with lead tenant, the U.S. Environmental Protection Agency (EPA), Crescent Resources, LLC and the construction team aimed to create architecturally distinctive, first-class designs that would promote environmental sustainability and reflect the values of the EPA, among other future government tenants.”

CRESCENT RESOURCES, LLC

GSA's Green Strategy Cost Studies

In 1996, GSA began to look at the cost implications of green buildings with its first green project, the Alfred A. Arraj U.S. Courthouse in Denver, Colorado. The then-PBS Commissioner challenged the project team to create a showcase green building, providing an opportunity for the government to lead the nation in the infancy of this emerging discipline. A panel of nationally recognized experts on environmental design identified nearly 150 green building strategies to reduce the environmental impact of the courthouse and grouped them into low-, medium- and high-cost categories.

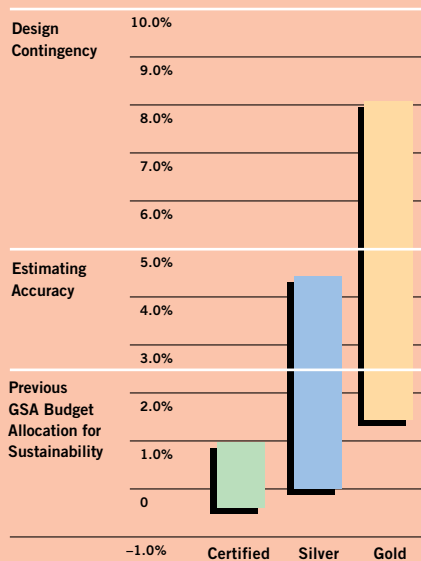
The greening of the Denver courthouse helped the agency answer the critical question, how much additional funding is necessary to make a project green?

A follow-up Green Buildings Cost Study drew upon the strategies identified by the panel and identified actual cost implications. While implementing all of the strategies would result in a substantial increase in cost, it was advantageous for design teams to only consider those that would provide the best overall benefit for the lowest initial cost. This approach found that, at the time, an increase of 2.5 to 7% in a project budget could produce a good, green building at optimal value. This reinforced the idea that only by examining options in their totality—rather than each individually—will a team find the optimal value.

In 1998, as a result of this analysis, GSA increased the budget estimates in its General Construction Cost Review Guide (GCCRG) by 2.5% across the board in order to accommodate sustainable design solutions. However, by 2000 sustainable design strategies had already become so fully integrated into the Facilities Standards for the Public Buildings Service that building green no longer required special cost considerations.

GSA LEED CONSTRUCTION COST IMPACTS

as compared to cost factors related to Estimating Accuracy and to Design Contingency



The Cost of LEED

Because the original increase in the GCCRG was put in place before LEED was fully developed as a rating system, GSA conducted another study in 2004 to determine the cost of LEED certification. The GSA LEED Cost Study examined the additional costs, if any, of developing green facilities using LEED 2.1. The study looked at two building types—a new mid-rise Federal courthouse and a mid-rise Federal office building modernization. These building types reflected a significant percentage of GSA's planned capital projects at the time.

The study determined incremental costs for green by comparing GSA's requirements, reflected in the construction cost table, to changes required to achieve LEED credits. The courthouse project analysis considered low- and high-cost scenarios for certified, silver and gold levels of LEED certification and the results ranged from a reduction in cost to a premium of 8.1%. It is interesting to note the estimated construction cost impacts for the certified or silver LEED scenarios fall well below both the 5% expected estimating accuracy and 10% design contingency carried by projects in the concept phase.

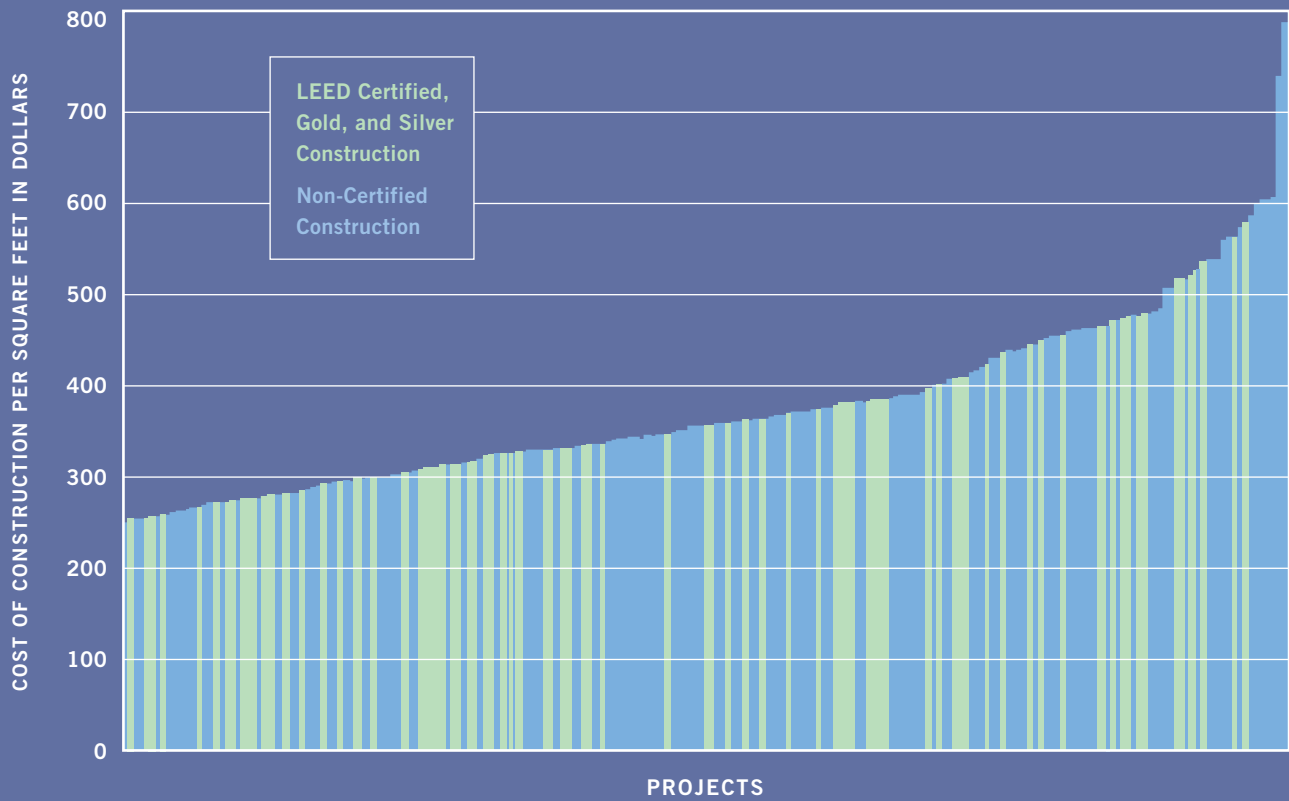
The Federal building modernization analysis had similar results but reflected scopes of work based on full or partial façade replacement. Soft costs were identified from firms with actual experience on GSA sustainably designed projects providing anecdotal information on the additional time required to achieve LEED. It should be noted, however, that the GSA LEED Cost Study addressed first costs only, without examining potential benefits or cost-benefit relationships.

Additional Research and Results

GSA was not the only entity of the Federal government concerned with the value of sustainable design. The Federal Energy Management Program (FEMP) and the Interagency Sustainability Working Group (ISWG) initiated another early research effort on the cost of green buildings. Their research document, *The Business Case for Sustainable Design in Federal Facilities*, completed in 2004, examined the economic, social, and environmental benefits of sustainable design. The report provides significant financial evidence, from both research findings and case studies, that sustainable design is not only good for the environment, but is also a smart business choice. Benefits include annual energy, water, and O&M cost savings, lower churn (reconfiguration) costs, higher resale value, lower liability, reduced environmental impact, and increases in the productivity, safety, security, health, and well-being of building occupants.

Davis Langdon, a consulting firm offering cost planning and sustainable design management services, published a study, *Examining the Cost of Green* in 2004, followed by *Cost of Green Revisited*, an updated version in 2007. The conclusions of both reports were nearly identical; in short, there are so many cost factors in construction today that it is nearly impossible to detect any statistically significant difference between the cost of conventional and green buildings. The report examined the budgets for 221 projects over a span of 10 years. Eighty-six of them had pursued various levels of LEED certification. The resulting data suggest that green building aspects tend to have a lesser impact on costs than other factors and led the authors to conclude, “buildings cannot be budgeted based on averages.”

DAVIS LANGDON COST COMPARISON STUDY



DATA SOURCE:
COST OF GREEN REVISITED, 2007





left: A DESIGN/BUILD APPROACH WAS USED FOR THE U.S. CENSUS HEADQUARTERS IN SUITLAND, MARYLAND.

top: THE U.S. COURTHOUSE IN SEATTLE INCORPORATED GREEN STRATEGIES THROUGH A TRADITIONAL DESIGN/BID/BUILD CONTRACT.

above: USING A CM @ RISK CONTRACT ENABLED THE MORSE COURTHOUSE IN EUGENE, OREGON, TO ACHIEVE A LEED GOLD RATING WITHIN BUDGETED COSTS.

GREEN BUILDING PROCUREMENT STRATEGIES

The common theme to successful green procurement is to structure the procurement to capitalize on the combined knowledge of the team (designer, builder, developer, lessor and government). Prescriptive contracts are problematic in any complex procurement, and especially so in green procurement for new buildings or major renovations. Seeking the best value begins before the procurement and should continue through project execution. Success is achieved through technically solid and imaginative solutions evaluated by competent and open-minded government teams. Performance-based specifications—measurable and linked to contract terms that provide incentives to achieve the outcomes—are more likely to succeed than rigid specifications for particular materials or design solutions. Although this section does not fully describe the several procurement methods currently in use, it makes suggestions for each that should enhance the likelihood of excellent results.

New Construction

Design/bid/build, also referred to as “traditional” delivery, has been the standard method of procuring GSA-owned buildings since competitive bidding regulations were established in government procurement laws. Missed opportunities to incorporate the expertise of construction companies in the evaluation of design alternatives are a sustainability downside to this method, because the design and construction process is separated by procurement. The solution to this potential problem is to keep the design team involved in the inevitable evolution of the design during the construction phase.

Design/build and bridging design/build are newer delivery methods used by GSA. The key to success on design/build delivered projects in GSA has been the ability of project delivery teams to work collaboratively toward achieving the project's sustainable design goals, and to not sacrifice life-cycle cost-effective design features in favor of lower first costs (construction costs) as key design decisions are made. It has proven essential in design/build delivered projects to clearly define sustainable design goals, expectations and requirements in the request for proposals (RFP).

Much like design/build, Construction Manager as Constructor (CM @ Risk, or CMc) has more recently been used as an alternative delivery method to control costs better in the pre-construction phases of GSA projects. GSA teams that have used CMc often favor it over design/build because the architect-engineer is independent of the CMc, thus providing greater flexibility and collaboration in evaluating and pricing out sustainable/green building features during design phases.

Leasing

GSA's lease construction projects have earned not only the greatest share of LEED ratings, but also the highest LEED ratings. As early as 2000, GSA realty specialists began using LEED requirement compliance to help ensure that tenants receive quality work environments that meet GSA sustainable design mandates without raising the cost of the leases. Typical procurement language requires a LEED rating at the certified or silver level. Soon developers began to exceed the new mandates, providing GSA with buildings that achieved gold



shown: THE LEASE FOR THE 600,000 SQUARE FOOT
IRS CAMPUS IN KANSAS CITY, MISSOURI,
REQUIRED LEED CERTIFICATION.

Cost, Value and Procurement of Green Buildings



LEED ratings. This is further evidence that the cost of building green can be managed within market budgets; developers would not be exceeding GSA standards if they could not construct projects profitably.

Private sector developers, in fact, have learned to juggle initial costs and operating costs to deliver projects that not only meet sustainability objectives, but with rents at or below market rates. Some developers have also learned to leverage lower operating costs—achieved through energy efficiency, use of daylight, and more durable materials—to more effectively market these buildings for leasing both to the private sector and to the government.

GSA has used both incentive and penalty clauses in its contracts. In two cases, GSA included a clause in leases that allowed it to deduct a \$250,000 penalty on one project or 10% of the annual rent payments on the other if the lessors did not deliver a silver LEED rating. In both instances, the completed buildings achieved LEED Gold and the leases were awarded at or below market rates.

Some of GSA's most prominent leases—and even some smaller ones—use a two-stage procurement method resulting in a design/build project with the potential of achieving a greener building. This short-listing method provides a far more efficient competition between those best qualified for the project. In-depth discussions, covering every aspect of the proposals, are held with each finalist in order to determine which promises the most innovative solutions to the project's design challenges.



AT THE PENTAGON: 16-PAGE PERFORMANCE REQUIREMENTS

In the continuing evolution toward true performance-based requirements, all of the technical language for the architectural and building systems of Wedges 2–5 are included in a 16-page solicitation. Missing are the “how-to” instructions typical of former solicitations, which limited the contractor’s creativity and innovation in achieving the specified results. To fully gauge how significant this step is, consider that in 1997 the technical requirements for the construction of Wedge 1, acquired under the design/bid/build method, and representing only 25% of the square footage of the total acquisition, comprised more than 3,500 pages of the solicitation.

left/top: **THE DEPARTMENT OF TRANSPORTATION HEADQUARTERS IN WASHINGTON, DC, RESULTED FROM A TWO-STAGE LEASE PROCUREMENT THAT INCLUDED A POST-AWARD DETAILED DESIGN.**

left: **THE EPA LEASE AT POTOMAC YARD IN ARLINGTON, VIRGINIA, INCLUDED A PENALTY CLAUSE TO ENSURE A MINIMUM LEED SILVER CERTIFICATION; IT ACHIEVED GOLD.**

Innovative Procurement

The Pentagon Renovation Team developed a unique incentive clause for their construction contract awarded in 2000. At quarterly sustainability reviews, the project manager evaluated the contractor’s performance against a number of factors, including use of environmentally preferable materials, construction waste management, and energy-efficient solutions. The team received the contracted amount if it met the project expectations. A specified percentage bonus was available if the team exceeded the goals. The entire construction team became focused on making sure they earned the bonus for each quarter.

Energy Savings Contracts

Two types of contracts allow agencies to accomplish energy projects for their facilities without up-front capital costs. The Chairman of the Council on Environmental Quality, establishing Executive Branch policy, has required all agencies to increase their use of ESPCs and UESCs.

Energy Saving Performance Contract (ESPC)

Energy Saving Performance Contracts can help the government leverage private sector investment in projects through the use of energy services company (ESCO). ESPCs make it possible for agencies to undertake more and larger efficiency improvements than their budgets might otherwise allow.

The ESCO contractor begins by conducting a comprehensive energy audit at the facility and identifies improvements that will save energy. Next, the contractor designs and constructs a project that meets the agency’s needs and arranges financing to pay for it. The ESCO guarantees that the



above: THE FDA CAMPUS IN WHITE OAK, MARYLAND, INCLUDED AN ESPC TO PROVIDE A COGENERATION PLANT.

improvements will generate energy cost savings sufficient to pay for the project over the term of the contract, which can run up to 25 years. In return, the government pays the contractor over the agreed number of years amounts that cannot exceed the guaranteed savings in any year until the improvements have been paid off, including interest. Any negotiated performance period services provided by the contractor, such as measurement and verification (M&V) and maintenance, are also paid for by the government over the term from within the guaranteed savings. After the contract ends, all additional cost savings accrue to the agency. The ESPC can also be combined with government-funded renovations, either through the ESPC contract, or in conjunction with it.

Utility Energy Service Contract (UESC)

Utility Energy Service Contracts are similar to ESPCs, except the electric or gas utilities serving the agency's site performs the work. With a UESC, the utility arranges financing to cover all or a portion of the capital costs of the project and is repaid over the contract term from the cost savings generated by the energy-efficiency measures. These contracts can either be negotiated directly by the agency, placed through an existing "area-wide agreement" the utility has with GSA, or established through a "basic ordering agreement."

WORKING WITH GSA TO GET GREENER BUILDINGS

The U.S. Environmental Protection Agency believes that its partnership with GSA produces better leases and better buildings, which provide highly functional, quality workspaces with significantly reduced environmental impacts.

EPA supports GSA by clearly defining our space needs, functional requirements, and environmental performance standards prior to acquisition; by asking GSA to structure each major procurement to maximize results; and by requesting information on current market conditions including the benefits and costs of new construction versus leasing space in existing buildings.

Together, the two agencies consider appropriate acquisition approaches. The source selection process — whether a design competition for a new build to suit lease or a best value to the government lease evaluation — requires more work than a standard low cost procurement, but we strongly believe these approaches produce innovative, higher quality and greener buildings.

My guess is that not all clients come to GSA with the same passion or background as EPA. I encourage GSA project managers and GSA acquisition staff to take the time to educate these clients and pass on the passion for excellence in environmental performance and great workspaces. EPA has learned a tremendous amount from GSA over the years, and, in some ways, I believe EPA has helped GSA expand its horizons and comfort zone. It has been a long and productive partnership, and one that will continue.

Bucky Green
Chief, Sustainable Facilities Practices Branch
U.S. Environmental Protection Agency



above: THE SCIENCE AND TECHNOLOGY CENTER IN KANSAS CITY, KANSAS, IS A GSA LEASE FOR EPA THAT EXCEEDED SUSTAINABILITY GOALS TO ACHIEVE A LEED GOLD RATING.



CASE STUDY: COST, VALUE AND PROCUREMENT

EPA Region 8 Headquarters

SETTING A STANDARD FOR SUSTAINABLE DESIGN

In 2004 a significant lease procurement in downtown Denver captured the interest of many of the nation's major developers and top architects and engineers. The project, a new 250,000 gross square foot, state of the art regional headquarters for EPA, called for Class A space that reflected EPA's core mission of protecting the environment. Complete with retail space, security standards for a Level IV facility and LEED Silver certification (at a minimum), the lease became the most sought after construction project in the region.

left: BUILDING ORIENTATION ALONG WITH HORIZONTAL AND VERTICAL FINS HELPS TO OPTIMIZE THE ENERGY PERFORMANCE OF THE EPA HEADQUARTERS IN DENVER, COLORADO.

GSA LEED BUILDING

EPA REGIONAL HEADQUARTERS
DENVER, CO

LEED NC rated: Sep 17 2007

GOLD

| | | |
|------------------------------|-----------|----|
| Sustainable Sites | 9 | 14 |
| Water Efficiency | 4 | 5 |
| Energy and Atmosphere | 9 | 17 |
| Materials and Resources | 7 | 13 |
| Indoor Environmental Quality | 6 | 15 |
| Innovation and Design | 5 | 5 |
| | 40 | 69 |

GREEN FACTS

40% water use reduction

100% green power supplied by facility

1st planted roof in downtown Denver

Collaboration between EPA and GSA resulted in a detailed solicitation for offers (SFO) that incorporated both the essential elements of a government lease and the specific program requirements of the tenant agency. To speed the procurement process and to take advantage of Denver's slow construction market, GSA decided to select a site before soliciting design proposals. The chosen site, on the 16th Street Mall in the Lower Downtown Historic District, is near public transit and urban amenities in keeping with GSA's and EPA's sustainable design goals.

TWO-STEP SOURCE SELECTION PROCESS

The first phase in the selection process, a competition, drew interest from over 40 development teams who were evaluated on the basis of the proposed team members, their qualifications, financial strength and past experience on similar projects. The teams had to demonstrate successful experience within the last five years in delivering LEED rated buildings or using widely recognized green building design criteria in projects of similar size and scope. Price was not considered during the first phase of the selection process, and the government selected five teams to proceed to the next step.

In phase two, the process required a conceptual design package that included a site plan, typical floor plans, representative elevations, sections, a narrative of the HVAC and other systems, material selections, and a rendering. The solicitation also requested details related to sustainable design and energy efficiency.

Evaluation criteria for this phase reflected EPA's particular preferences, weighted as follows: sustainability, 25%; design, 20%; workplace, 20%; building operations, 20%; and price, 15%. The offerors were responsible for funding, preparing, and submitting LEED registration and documentation and understood that failure to meet a silver LEED rating would result in a one time penalty of \$250,000, to be deducted from the rental payments. In addition,



shown: THE TWO L SHAPED SECTIONS SURROUNDING THE ATRIUM HAVE A BRICK FAÇADE TO MAINTAIN THE SCALE OF NEIGHBORING BUILDINGS IN THE HISTORIC WAREHOUSE DISTRICT.



the facility was to meet ENERGY STAR certification within 14 months of reaching 95% occupancy.

The second phase also included three interactive sessions between the selection panel and the short listed project teams. The first involved a review of the project s objectives, the second required a formal presentation by each team, followed by written feedback from EPA and GSA, and the third was a two hour presentation covering the design requirements in the SFO. A contracting officer from GSA participated throughout the process to ensure that all parties adhered to government regulations.

This type of procurement can be very beneficial to the government; however, in order to provide the developer with accurate cost estimates, architects and engineers frequently feel it necessary to design in more detail than is asked for by the solicitation. The effort requires a substantial commitment of time and resources – as much as \$500,000 for the Denver EPA procurement.

One way to reduce the cost of both competition and delivery is to rely more heavily on performance specifications. There is significant support for performance specifications in government contract law and developers generally prefer performance contracts rather than a prescriptive approach. According to Marshall Burton of Opus: The government...should allow us to do what is best for the project, within the requirements of the performance specification...

POST-AWARD TEAMWORK

In August 2004, GSA awarded the lease to Opus Northwest, LLC. They had previously delivered a LEED rated facility on another GSA lease construction project, the Department of Transportation facility in Lakewood, Colorado, which



left: FILE CABINETS INSTALLED BENEATH WINDOWS PROVIDE OCCUPANT ACCESS TO DAYLIGHT AND VIEWS.

top: A 20,000 SQUARE FOOT MODULAR GREEN ROOF IS THE FIRST IN DENVER.

above: A PROJECTING CORNICE PROVIDES A SUNSCREEN.

achieved LEED Silver. Opus would serve as both developer and contractor, with Zimmer Gunsul Frasca (ZGF) as the design architect. ZGF recommended Syska Hennessy as project engineers, based on previously successful collaborations.

In order to ensure that the goals of the project were not compromised, GSA and EPA worked with the developer to negotiate project team and buildings system changes that arose after the contract was awarded. Some of the proposed structural and mechanical system changes resulted in potential cost savings for Opus, and the two agencies worked together to negotiate contract modifications. GSA and EPA also both hired technical consultants to provide review assistance and a representative from EPA's Sustainable Facilities Branch reviewed contract documents throughout the process to ensure that they respected EPA's priorities.

Biweekly meetings of the entire team began immediately after the award and continued throughout the project. Design changes to meet requirements of the Lower Downtown Design Review Board and GSA's security setbacks reflected the team's ability to balance performance with construction cost, sustainability and security.

Communication was key to managing the changes as well as the integrated design process. For example, the building features horizontal sunshades and vertical fins, recommended by security consultants rather than laminated glass, and by the designers to control solar gain and glare while maintaining access to daylight inside. After detailed modeling and analysis, the depth of the shades and fins were reduced, optimizing both security and daylighting performance and resulting in lower first costs.



A MODEL OF SUSTAINABLE DESIGN

Opus proposed a gold LEED rating with their offer, even though the SFO only required silver. Although the SFO included a LEED scorecard listing EPA's targeted credits and points, it did not prescribe exactly how to achieve the silver rating—an example of a performance based approach. The team, however, was required to submit an updated scorecard—with new energy calculations—at each phase of the project to ensure that goals were being met.

In the end, the Denver EPA headquarters received a LEED Gold certification and has set the sustainable design standard for all new EPA facilities nationwide. A thoughtful procurement process and an integrated team approach resulted in a host of innovative sustainable design strategies, including:

- photovoltaics mounted above a section of the green roof,
- cloud like forms, constructed by sailmakers, which diffuse daylight throughout the atrium,
- underfloor air distribution for all offices above the third floor,
- dual flush toilets as well as waterless urinals—despite skeptical city officials!
- the first green roof in Denver.

The cost of the 10 year, fully serviced lease came to \$32.22/rentable square foot, including all utilities, janitorial services, landscaping, maintenance, snow removal, and security. While somewhat more expensive than the cost of EPA's former location, the agency is more than satisfied with its new high performance facility. Others seem to be as well. More than 1,800 people toured the building within the first four months, underlining EPA's commitment to sustainability through education.

far left: FABRIC CLOUDS, DESIGNED AND CRAFTED BY A SAILMAKER, DIFFUSE DAYLIGHT ENTERING THE NINE STORY GLASS FILLED ATRIUM.

left: WATER FEATURES, LOCAL STONE, AND BAMBOO SURFACES CREATE AN INVITING GATHERING SPACE IN THE ATRIUM.



Energy Efficiency

THE POWER OF SAVING ENERGY

The efficient use of energy is at the heart of GSA's drive for sustainability. Increased energy efficiency not only saves U.S. taxpayers' money, it also reduces our country's dependence on foreign oil and reduces the impact of GSA assets on the environment. Given that more than three-quarters of the electricity and one-third of the total energy in the U.S. are used to heat, cool, and operate buildings, the potential benefit for both energy and cost savings is significant. Given the Federal government's enormous real estate holdings, modest improvement in energy efficiency, including those achieved without sacrificing the comfort or health of its tenants, can result in a significant, strategic reduction of our country's need to import energy. Finally, as part of the Federal government's continually expanding program to reduce greenhouse gases, energy efficiency has the power to greatly reduce our impact on the environment. Consumption is one part of greenhouse gas control; the other is how the energy is produced. Toward these ends, GSA focuses both on reducing energy demand *and* exploring alternative sources of energy supply.

ENERGY DEMAND REDUCTION

Reducing energy through reducing demand involves numerous strategies, some dating back decades and others more recently evolved.

Efficiency Targets

GSA began setting energy reduction targets in response to the energy crisis in the early 1970s. Even after the price of petroleum had stabilized, GSA continued its efforts, and between 1985 and 2005 achieved a 30% reduction in energy consumption. In fact, GSA's utility costs have been consistently lower than those in the private sector. In 2006, the agency reduced the

left: THE WAYNE L. MORSE U.S. COURTHOUSE IN EUGENE, OREGON, PERFORMS 30% BETTER THAN THE REQUIREMENTS OF ASHRAE STANDARD 90.1-1999.

Energy Efficiency

overall energy consumption of its Federal inventory by another 4.7%, compared to 2003 levels, in response to the goals set in the Energy Policy Act of 2005 (EPAAct 2005), the latest in a series of acts, beginning in 1978 that have set Federal policies for energy use reduction. The agency achieved this reduction by direct investment in energy and water conservation opportunities coupled with the concerted efforts of its property managers and tenants.

Today, Executive Order 13423, Strengthening Federal Environmental, Energy, and Transportation Management, the Energy Independence and Security Act of 2007 (EISA 2007), and EPAAct 2005 govern GSA's targets. On new construction projects, EPAAct 2005 directs Federal agencies to ensure that all new Federal buildings exceed the building energy-efficiency standard (ASHRAE Standard 90.1-2004) by at least 30%, if life-cycle cost effective.

The ASHRAE standard does not dictate how to achieve the 30% reduction beyond a limited set of mandatory requirements, such as sealing leaks in the building envelope and air duct systems. Thus, each design team and Federal agency is free to achieve the mandated energy savings as it sees fit. For the purposes of calculating the 30% savings, energy consumption includes space heating, space cooling, ventilation, service water heating, and lighting, but does not include receptacle and process loads.

EISA 2007 requires that new Federal buildings and major renovations of Federal buildings shall be designed so that the fossil fuel-generated energy consumption is reduced by 55% in 2010 and 100% by 2030. Under this law, the comparison is with commercial buildings, as measured in the Commercial

Buildings Energy Consumption Survey, conducted by the Energy Information Agency in 2003. Further, EISA requires that Federal agencies only lease space in buildings that have earned the ENERGY STAR label.

All the discussion above refers to new construction; however, existing buildings offer the best opportunities for energy reduction. Both EAct 2005 and Executive Order 13423 set significantly higher conservation targets for the agency's portfolio of buildings—triple the previous reduction goals. Given that GSA has already reduced the energy consumption in its inventory by over 30% since 1985, these new goals will be challenging and will require taking every opportunity—in both major and minor renovations—to achieve the maximum energy reduction. The Executive Order, for example, requires that renovations must reduce the energy cost to 20% less than the 2003 baseline.

Other salient EAct 2005 provisions:

- Requires advanced metering
- Authorizes the use of ESPCs for all agencies through 2016
- Requires purchase of only ENERGY STAR or FEMP designated products, if available, and only premium efficiency motors as approved by DOE
- Specifies the increased use of recovered mineral content in concrete in all procurements
- Codifies goals for renewable energy purchases

Energy Efficiency

GSA measures energy consumption in all its buildings for which the government pays the utility bill. Every agency has flexibility in how it will achieve the aggregate, agency-wide reduction targets. Because energy costs and building conditions vary widely throughout the country, GSA uses both annual regional targets and specific building targets for all new construction and renovation.

Energy Standards & Codes

Most new construction in the U.S. already meets local minimum energy code requirements, but there is ample room for improvement. Per capita energy use in California and New York, for example, is approximately half the national average due to stringent codes, rigorous enforcement and statewide incentives. Such codes contribute to achieving sustainability goals first by saving energy, second by reducing the need for power plants and thus the use of those natural resources that produce electricity, and third, by reducing emissions into the atmosphere.

Codes generally offer both prescriptive and performance path criteria for compliance. Prescriptive criteria are easy-to-use tables containing minimum or maximum values, while performance paths set the end goal, which can be met by establishing an energy budget and balancing multiple energy-saving measures. For instance, if the wall insulation does not meet the prescriptive requirements, but the ceiling insulation exceeds them, a performance path method may bring the whole building into compliance with the code.

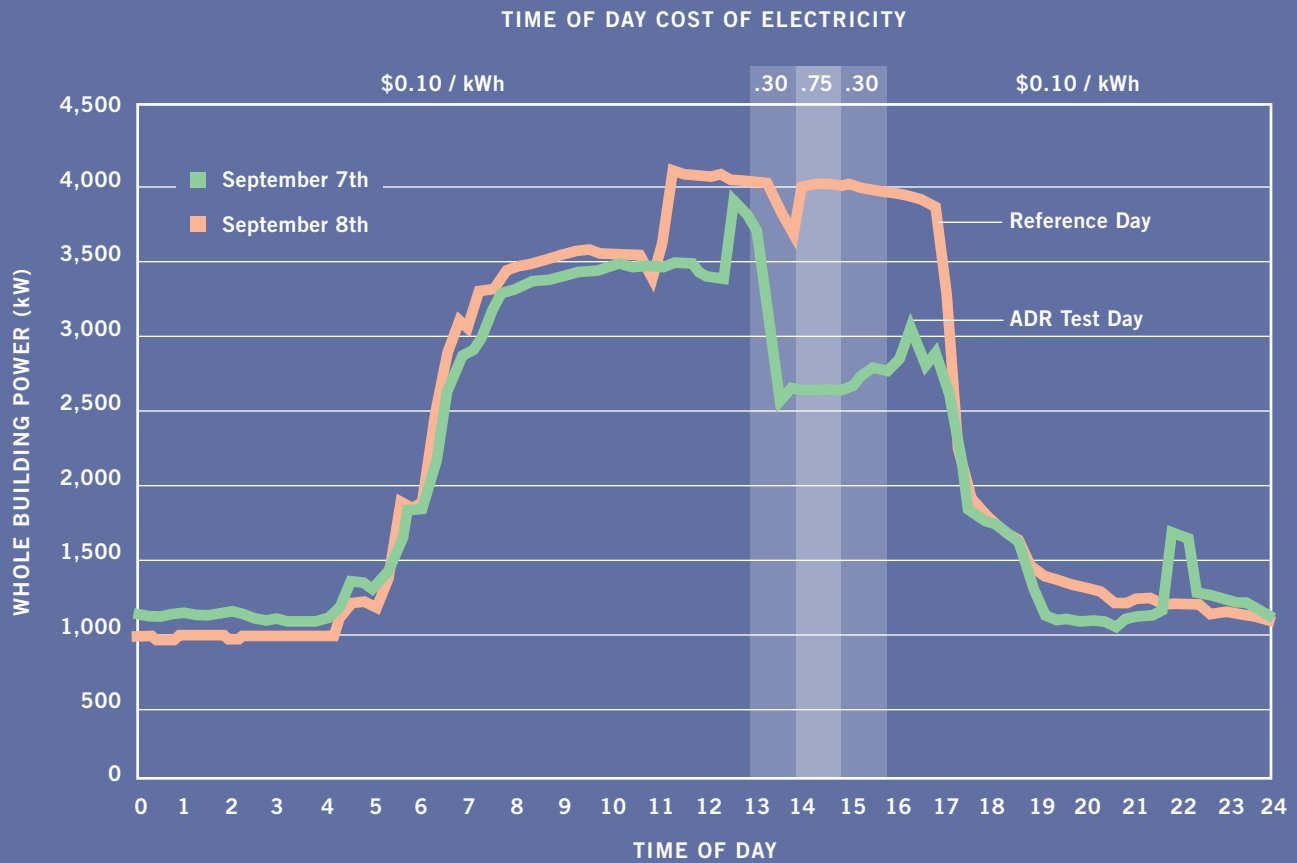
Advanced Metering and Demand Load Management

EPA Act 2005 directs all Federal agencies to install advanced metering to measure electricity use in buildings. GSA, in fact, had already started installing advanced meters in the Washington, DC, and New York areas before the law required it. In the long run, advanced meters save money by managing power consumption more strategically. The minute-by-minute data provide building operators with a wealth of information that a monthly bill does not. Perhaps more importantly, advanced metering helps the government buy power at better prices, because it provides a better understanding of energy use patterns. Users can participate in demand reduction or load-shedding programs offered by utilities or grid operators, which can significantly lower costs either through curtailing use or on-site power generation.

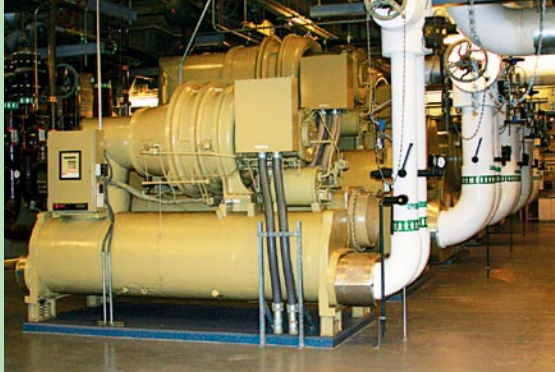
GSA uses a centralized approach to advanced meter data collection, analysis and reporting with a single software program and database, which not only simplifies these functions, but provides data with a uniform appearance to individual users across all regions. Perhaps more important is the analytical capability this provides GSA in managing building energy performance and the contracts for operations and maintenance. GSA's advanced metering system will be integrated with its existing tracking program, Energy Usage and Analysis System (EUAS), thus providing a familiar reporting engine and creating an automated bill verification system.

Demand response systems not only save electrical costs but also help prevent brown-outs or catastrophic grid failure.

EFFECTS OF AN AUTOMATED DEMAND RESPONSE SYSTEM



STUDIES FROM GSA'S OAKLAND FEDERAL BUILDING



Building commissioning arose from the long history of ship commissioning—where a new ship’s “shakedown cruise” resulted in testing and fine tuning of all the ship’s systems, particularly the mechanical systems. In the early 1990s, the industry began to realize the need for similar processes to test and validate the performance of buildings—preferably before the occupants move in. Commissioning procedures for GSA are available in *The Building Commissioning Guide*.

Commissioning

Commissioning, a process that extends ideally from pre-design to project completion, guarantees that the design, installation, and operating procedures of a building’s equipment and systems are in keeping with the overall design, its contractual specifications, and most importantly, the tenant’s needs.

In a process that must touch on every aspect of the project in order to be effective, the commissioning agent reviews and critiques the activities of design and construction teams. This ensures that the building’s systems designs are respected, reduces the likelihood of costly errors, and improves the efficiency and interactivity of all systems, resulting in increased tenant comfort and building profitability. Experience with commissioned buildings across the country, in fact, shows that adding rigorous commissioning to traditional design and construction produces buildings that are less costly, more energy efficient, more comfortable, and easier to maintain.

In the case of existing buildings, the value of re-commissioning, or retro-commissioning if the building has never previously been commissioned, may be greater still, given the level of system inefficiency relative to today’s standards, the skyrocketing costs of energy, and the increased attention paid to the influence of the workplace on productivity. The process can be undertaken for its own benefit, or combined with partial or whole building renovations. EISA 2007 requires that Federal agencies re- or retro-commission buildings every four years.

When retro-commissioning is partnered with an energy-saving performance contract that focuses on equipment replacement and other capital improvements, a facility can greatly improve overall operations and dramatically reduce operating costs.

above: **SYSTEM COMMISSIONING OPTIMIZED THE MECHANICAL SYSTEM OF THE SAM NUNN FEDERAL CENTER IN ATLANTA.**

INFO: **The Building Commissioning Guide – www.gsa.gov/commissioning**

CHARLES E. BENNETT FEDERAL OFFICE BUILDING
JACKSONVILLE, FLORIDA



High energy use in the 1960s vintage 11 story, 330,000 square foot Charles E. Bennett Federal Office Building located in Jacksonville, Florida represented a major challenge for GSA in achieving its energy management goals. In 2004, as part of a \$25 million renovation project, GSA completely gutted the interior, replacing all windows, electrical systems, mechanical systems, and controls.

The holistic redesign effort was based on reducing energy usage and the measurable goal of achieving an ENERGY STAR rating. GSA, the architects and engineers used an integrated approach to develop multiple solutions. Energy simulation using DOE2 modeling allowed the team to evaluate and compare energy savings to determine the best value for the government. Using this comparison, the team selected a design that included web based automation systems and an energy and climate responsive HVAC system.

To ensure their decisions worked once the building reopened, commissioning began in design and continued through construction. This allowed the team to address system deficiencies early in the process. Overall, the team's efforts lowered building energy consumption more than 60% in FY 2005, saving 23,781 Million British Thermal Units (MMBtu) enough energy to power 208 homes for a year. The building received an ENERGY STAR label and a U.S. Department of Energy Federal Energy and Water Management Award.

Life-Cycle Cost Analysis

In any project, ideas compete for inclusion. The number of technologies and techniques that can improve existing building operations or enhance new design concepts vastly exceeds the likely budget for any project. Therefore, beginning with the earliest stage of project development, financial analytical tools will aid project teams in discriminating among options. GSA uses several layers of financial analysis to select which projects can be funded from its limited capital budget. A key result of the analysis is determining the most effective technologies to include in the project. By law, the National Institute of Standards and Technology (NIST) documents the techniques the government uses to perform this analysis. The Building Life-Cycle Cost Program, developed by NIST, provides computational support for the analysis of capital investments in buildings.

Energy Modeling

Energy modeling offers architects and designers an opportunity that was unimaginable only a few decades ago—the ability to foresee the effect of design decisions on energy efficiency long before construction begins. This capability allows designers to consider several approaches to design, siting, and massing, and to understand the energy consequences and potential costs of each.

The most effective use of energy modeling begins early—at the concept stage. Energy modeling does not require a finished set of plans in order to be effective, and is most useful *before* designs are finalized. While it is, of course, impossible to predict the actual energy needs of an incomplete

Energy Efficiency

design, it is nevertheless possible to compare the energy repercussions of alternate approaches. Given the project's location, scope, and specific needs, energy modeling can also help designers concentrate on a project's most important design variables, and how building materials affect lighting, heating, or cooling. GSA is currently leading efforts within the construction industry to document and evaluate the implementation of building information modeling (BIM) technologies, which assist energy performance analyses, as well as operational practices.





THE CONTROL OF LIGHT

GSA requires the use of lighting controls in regularly unoccupied spaces.

- Occupancy sensors use infrared, ultrasonic or microwave technology and respond to movement or object surface temperature, automatically turning off or dimming luminaires when rooms are left unoccupied. Typical savings run from 10 to 50%, depending on the application.
- Timers are simple clocks that turn lighting off on a set schedule. If spaces are known to be unoccupied during certain periods of time, timers are extremely inexpensive and cost-effective devices.
- Daylight sensors, though not required, should be considered within 15 feet of windows and skylights. Energy savings of 10 to 50% are possible.
- Occupancy sensors make sense for the entire building. Modern lighting control systems can reduce the whole-building cost of lighting by 30%.

left: BIM ALLOWS INTEGRATION OF SYSTEM COMPONENTS WITH DESIGN ELEMENTS IN THIS RENDERING OF THE JACKSON, MISSISSIPPI, COURTHOUSE—THE LARGEST BIM MODEL PRODUCED TO DATE.

above: SOLAR THERMAL COLLECTORS ARE A COST-EFFECTIVE SOLUTION FOR PROVIDING HOT WATER IN COMMERCIAL BUILDINGS.

ENERGY SUPPLY

Sustainable energy supply strategies refer to alternative energy sources and their applications.

Solar

The sun's heat and light provide an abundant, inexpensive source of energy that can be harnessed in many ways, including concentrating solar power systems, passive solar heating, daylighting, photovoltaic systems, solar hot water, solar process heat, and space heating and cooling.

Daylighting

Daylighting, a passive solar strategy, is the controlled admission of natural light into interior space to reduce or eliminate electric lighting. Given that electric lighting accounts for 22% of the total electricity used in commercial buildings, good daylighting design will lower lighting operating costs and reduce the energy needed to cool the building by between 10 and 20%. This is despite a relatively small increase in first costs for dimmable ballasts, fixtures, and controls—all of which will be recovered quickly and enable daylighting to help reduce energy consumption.

Solar Water Heating

Solar water heating, a simple, reliable, and renewable energy technology is effective on buildings with appropriate near-south-facing roofs, or with nearby shade-free sites where a collector can be installed. Such systems are most cost-effective for buildings with high fuel costs for heating water, and constant



PHOTOVOLTAIC ROOF

The National Archives and Records Administration (NARA) facility in Waltham, Massachusetts, has a 377-kilowatt building-integrated photovoltaic system installed as its roof. The flexible, flat panel photovoltaic array is heat welded into the roofing material and qualifies as a “Cool Roof” under EPA’s ENERGY STAR program. The project will save approximately \$204,000 and 5.55 billion Btu annually. It is now producing more than 50% of the building’s electricity needs.



SOLAR PARK

In 2007, at the Denver Federal Center, GSA began constructing a one-megawatt solar photovoltaic array on six and one-half acres. This “solar park” will save \$405,000 per year in electrical charges. The energy obtained from the solar park will both feed directly into the regional grid and will be used at the center. It has a positive return on investment after just 11 years.



**“I’d put my money on
the sun and solar energy.
What a source of power!
I hope we don’t wait ’til
oil and coal run out before
we tackle that.”**

THOMAS EDISON

yearly (not absent in the summer) and weekly (using solar heat every day) water-heating loads. Typical best practice, or that which most effectively minimizes life-cycle cost, is a system design that meets 100% of the load on the sunniest day of the year (and thus approximately 70% of the annual load).

Solar cells/photovoltaics (PV)

Solar cells, also known as photovoltaics (PV), convert sunlight directly into electricity, using semiconducting materials similar to those used in computer chips. Because thin film solar cells use layers of semiconductor materials only a few micrometers thick, it is possible for solar cells to be bonded to roofing materials, offering the same increased protection and durability.

Cost-effective renewable opportunities depend on a number of factors, including the utility rate and rate structure, available incentives, and whether the state renewable portfolio standard includes a solar set-aside (thus creating a solar REC [Renewable Energy Credit] market). A potential site must also consult with its serving utility to determine if the electricity generated in excess of local needs can be sold back to the utility at reasonable rates.

PV installations provide an extremely low maintenance, long-lived source of power. The first commercial PV panel installed more than 50 years ago is still producing power.

top: EVACUATED TUBE COLLECTORS CONTAIN METAL PLATES TO CAPTURE AND TRANSFER SOLAR ENERGY FOR HEATING WATER.

above: CRYSTALLINE PHOTOVOLTAIC PANELS ARE ONE OF MANY OPTIONS AVAILABLE FOR TURNING SUNLIGHT INTO ELECTRICITY.



2002: FIRST FEDERAL BUILDING TO USE 100% WIND ENERGY

The Binghamton Federal Building in New York State is the first Federal facility in the nation powered by 100% wind energy. The power flows directly from a new wind turbine installed at the Fenner Wind Farm in the town of Fenner, New York. This project not only demonstrated GSA's commitment to energy independence and environmental stewardship but also helped to spur economic growth of a new industry in a small community economy.



STATUE OF LIBERTY POWERED BY WIND

In 2006, GSA awarded a contract to supply the National Park Service's Statue of Liberty and Ellis Island with electricity generated from 100% wind resources. The three-year contract will supply approximately 28 million kilowatt hours of renewable energy to the two landmark sites. The Statue of Liberty is not only a beacon of freedom to the rest of the world, but also a welcome sign of the future in renewable energy.

LANDFILL GAS HEAT

In FY 2003, NASA's Goddard Space Flight Center (GSFC) became the first Federal facility to heat its buildings with landfill gas. The 6 million tons of waste held by the Sandy Hill Landfill in Bowie, Maryland, generates about 2,300 cubic feet per minute of landfill gas, which will supply 80% or more of the energy needed to heat the facility, and at a lower cost than conventional natural gas. In 2003, this initiative saved GSFC more than \$1 million in energy costs and contributed more than 270 billion Btu toward the Federal renewable energy goal. Since the previous source of heating was natural gas, there was no increase in greenhouse gas production.

Wind

A clean, inexhaustible, energy resource, wind is one of the fastest-growing means of generating electricity in the world. The United States, the world's largest producer of wind-generated energy, currently generates more than 10,000 megawatts of electricity—or enough to power 2.5 million average American homes—and industry experts predict that with proper development, wind energy could eventually provide 20% of all U.S. energy needs. Small wind systems also have potential as distributed energy resources. Distributed energy resources refer to a variety of small, modular power-generating technologies that can be combined to improve the operation of the electricity delivery system.

Biomass

Although wood is still the largest biomass energy resource, other sources include food crops, grassy and woody plants, residues from agriculture or forestry such as paper mill residue or lumber mill scrap, and the organic component of municipal and industrial wastes. The natural gas generated by landfills—methane—is now used as a source of biomass energy. Biomass as fuels can reduce our dependence on fossil fuels and foreign energy sources. Biofuels are, in fact, the only renewable liquid transportation fuels now available.

A key concern, however, is that most biomass energy is produced by burning, thus contributing to the production of greenhouse gases. In some cases it is possible to harness biomass without adding to greenhouse emissions. Even though burning the methane will produce greenhouse gases, the methane is already typically being dumped into the atmosphere from landfills to guard against explosions. Harnessing energy in this way produces *no* increase in harmful gases.

Energy Efficiency

Geothermal

There are two main methods for using the earth for geothermal energy, neither of which burns fossil fuels or creates emissions other than water vapor. The first method is the geothermal power plant, which uses the natural hot water and steam from the earth to turn turbine generators to produce electricity. The second is the geothermal, or ground source, heat pump. It uses the mass of the earth, which maintains a relatively constant subsurface temperature. By pumping fluid through loops of pipe buried near a building, these systems transfer heat into buildings during the winter and out of them during the summer.

Geothermal heat pumps reduce electricity use by 30–60% because the electricity that powers them is used only to move fluid, not to heat or cool it. According to joint studies by EPA and the General Accounting Office, heat pumps are the lowest cost/greatest benefit retrofit technology available today.

Cogeneration

Cogeneration, or combined heat and power, is a method of generating electricity and simultaneously capturing the heat that is traditionally discarded as thermal energy, which is used for cooling and heating. Combined heat and power plants are typically three times as efficient as traditional electrical plants. The increased efficiency reduces emissions and lowers operating costs; local plants also provide for continuity of operations in the case of grid disruptions (blackouts).

In 2003 GSA, working with Sempra Energy Solutions, designed a project for the FDA's White Oak, Maryland, campus that improved energy efficiency, security, and reliability. The team awarded an ESPC to install a 5.8-megawatt combined heat and power (CHP) facility as part of the first phase of the



above: THE FDA CAMPUS IN WHITE OAK, MARYLAND, USES A COGENERATION PLANT FOR ELECTRICITY, HOT WATER, AND STEAM.

CUSTOMHOUSE RENOVATION
PORTLAND, MAINE



In the Portland, Maine, Customhouse renovation, the GSA project manager directed the designers to investigate and run a building life cycle cost comparison on a geothermal system that would eliminate the need for a chiller and boilers and address a host of other issues as well. The analysis demonstrated that the geothermal ground loop heat pump technology saved \$80,000 (present value) over the traditional chiller/boiler HVAC system and achieved the following benefits:

- has a life expectancy of over 30 years, with low maintenance
- eliminates the cost and environmental liability from fuel oil
- lowers emissions of harmful pollutants
- uses up to 30% less energy than the conventional systems
- reduces mechanical space requirements and frees up space for a gas fired emergency generator where there had been no emergency backup
- provides for easy, one hour, switch over from heating to cooling, eliminating typical shoulder month thermal discomfort

The geothermal heat pump system installed at the Portland Customhouse is only the second such installation in the state of Maine.

Energy Efficiency

Renewable Energy Credits (RECs), also known as “green certificates” or “green-e tags,” represent all of the environmental attributes or benefits of a specific quantity of renewably generated electric power. RECs are created when a renewable energy facility generates electricity and are sold separately from the power. RECs create cost savings by spurring renewable power generation in favorable resource locations, regardless of the location of the ultimate power user. When GSA purchases RECs on behalf of the Federal government, the market responds by increasing the production of renewable energy.

campus build-out. The plant generates reliable, on-site electricity for three facilities on campus—a laboratory, office building, and multi-use facility. Heat is also recovered from the generating process to produce hot water, and chilled water in absorption chillers, increasing the thermal efficiency of the plant by 30% and significantly reducing pollution emissions.

Furthermore, the planned expansion of the CHP system will eventually support 100 percent of the power needed for the entire, built-out campus. This will not only provide the facility with energy independence, but will also save the local utility the need to generate an additional 25 megawatts of power. The ESPC also covers installation of a photovoltaic array, lighting upgrades, glazing improvements, HVAC upgrades, and night set-back controls. Together these measures will save more than 37 million kilowatt-hours, \$1.4 million in energy costs, and \$2.1 million in operation and maintenance costs annually.

Renewable Power Purchases

There are three different methods for purchasing renewable power: Regulated Utility Green Pricing Programs, Competitive Renewable Power, and Renewable Energy Certificates (RECs).

Regulated Utility Green Pricing Programs are voluntary plans offered by many utilities that allow customers to purchase renewable energy. Competitive Renewable Power, used in states with competitive electricity markets, allows Federal agencies to purchase renewable power through competitive electricity procurements. RECs allow Federal agencies to purchase renewable energy certificates in lieu of direct delivery of renewable power to a facility.



Distributed Energy

Distributed energy technologies can relieve transmission bottlenecks by reducing the amount of electricity sent long distances along high-voltage power lines. A distributed energy program can be as simple as installing a small, stand-alone, backup electricity generator, or it can consist of a far more complicated electricity and thermal generation, energy storage, and energy management system integrated with the existing electricity grid.

Distributed energy resources (DERs) are electric generation units (typically from 3 kilowatts to 50 megawatts) located within the electric distribution system at or near the end user. Within the electric power industry the terms used include distributed generation (DG), distributed power (DP), and DER. DERs include virtually any device that can produce electricity, from microturbines and fuel cells to internal combustion engines.

DERs are used in the event of reduced frequency variations, voltage transients, surges, dips, or other disruptions, outages, or as a backup to the electric grid. They can also save costs during times when electric use and demand charges are high.

above: DISTRIBUTED ENERGY CAN BE PRODUCED
BY ANY LOCAL SOURCE.



CASE STUDY: ENERGY EFFICIENCY

Bishop Henry Whipple Federal Building

A FOCUSED APPROACH TO ENERGY EFFICIENCY

The Bishop Henry Whipple Federal Building has been the focus of a prolonged and comprehensive effort by GSA to monitor and improve energy efficiency. Situated within the Fort Snelling Military Reservation in Hennepin County, Minnesota, directly between St. Paul and Minneapolis, it has 570,248 rentable square feet and is the most prominent building on the 35 acre Federal government campus. The building houses regional offices for the Department of Veterans Affairs, Bureau of Indian Affairs, and Fish and Wildlife Service. It also serves as the National Hiring Center for Customs and Border Patrol/Department of Homeland Security.

left: A REDESIGNED ENTRY AND OTHER PROJECTS AT THE WHIPPLE FEDERAL BUILDING PROVIDED OPPORTUNITIES FOR IMPROVING ENERGY EFFICIENCY.

Building Facts

Building Location: Hennepin County, Minnesota

Date of completion: 1969

Renovated: 2003

Size: 617,606 gross square feet

Despite its age the Whipple Building was more than 30 years old when GSA decided to readdress its energy efficiency the building was still in good condition. The main components of its mechanical and electrical systems, however, had been in use since the building opened, and therefore had met or exceeded their normal life expectancy. GSA achieved a major milestone with the award of a Super Energy Savings Performance Contract with NORESKO in 2002. This \$3 million investment, funded through the ESPC (see Cost, Value and Procurement of Green Buildings chapter), resulted in lighting upgrades and HVAC and control system improvements. These initial steps convinced GSA to mount a more intense and focused approach to energy conservation, previously unseen in most Federal buildings. To date, results from the five year effort show a 20% reduction in energy consumption.

High-Impact Strategies

This campaign, at the time unique in both its purpose and scope, started with a tough question: how could the combined actions of tenants and building management dramatically reduce energy consumption? In the summer of 2003, a team of energy experts from GSA, the Department of Energy, and the Minnesota State Energy Office explored alternatives to traditional energy management. They identified and implemented three high impact strategies:

- 1 Design energy efficient building envelopes,
- 2 Select energy efficient equipment,
- 3 Improve building operations and maintenance (O&M)

The group concluded, however, that of the three, O&M based energy savings were the most elusive because they are actions, not things, and are thus much harder to measure and influence. The energy savings associated with a more efficient motor or an improved lighting system is easily determined through life cycle cost accounting. Once tried and proven, such changes are transferable to other sites, translating into immediate reductions in energy usage. This is not the case for O&M based conservation.



IAQ and Energy Savings

In order to define and measure the O&M impact as quickly and efficiently as possible, the group installed comprehensive indoor air quality (IAQ) monitoring sensors throughout the building. Detailed analysis of the data, including carbon dioxide (CO₂) levels, revealed over ventilation of the building, particularly when unoccupied. Temperature data showed certain areas overcooled in the summer and overheated during the winter. Both findings presented valuable energy conservation opportunities. On the other hand, relative humidity trends did not require additional mitigation. There were also no significant concentrations of carbon monoxide in the monitored spaces, and levels of odors and gases were relatively low. In general, these data indicated that occupancy related measurements like that of CO₂ can be an adequate indicator of air quality.

Using both the continuous IAQ data to target specific locations within the building for remediation and detailed energy studies of thermal processes measured at the fan units, the team identified energy savings opportunities of approximately \$144,000/year more than 20% of the total annual energy used to heat, cool, and ventilate the building.

Building on these basics, the team found additional savings. The largest of these was achieved through the control of room ventilation rates using continuous CO₂ data and occupancy monitors. Additional savings came from improved temperature monitoring and control. The simple payback period calculated for all conservation measures ranged from 0.5 to 11.3 years; the weighted average payback for all measures was fewer than 2.2 years. In all, continuously monitoring the indoor air quality of the Whipple Building saved more than 20% of the energy used to heat, cool and ventilate it.

above: NEW VALVES AND METERS PROVIDE BETTER CONTROL OVER THE HVAC SYSTEM TO OPTIMIZE ENERGY PERFORMANCE.

Lessons and Recommendations

In order to determine if the savings at the Whipple Building could be replicated, GSA conducted a management study far more comprehensive than an energy audit. The study focused only on equipment inventories and operating plans. The following recommendations are thought to be applicable to all existing buildings:

- Adopt a building performance standard contingent upon achieving a superior workplace. Operating criteria established to deliver this environment should govern estimates of the amount of energy needed for a specific building.
- Consider stating energy usage as a function of occupancy, as well as a function of square feet.
- Adopt energy optimization goals not absolute energy savings consistent with superior workplace environments. Focus national directives, regional goals, and building specific targets toward maximizing conservation, but without degrading the work environment.
- Extend annual, weather normalized, regional energy goals through 2015.
- Use the GSA Energy Center of Expertise and its regional energy experts to determine which facilities to include in calculating regional energy goals, and to reach consensus on facility types and weather normalization rates.



- Adopt building specific energy targets. Building personnel need such targets to know whether they are ahead or behind their goals.
- Review and amend the building operator bonus/reward system to take energy usage into account.
- Reconfirm tenant temperature and ventilation requirements, identifying possible tenant incentives – rent rebates, energy credits, and in kind benefits – for single tenant, multi tenant, and multi zone spaces.
- Amend O&M contracts to include an energy savings goal statement.

For the Whipple Building, operating and maintenance expenses are projected to remain relatively stable, even though costs are steadily increasing, because the energy savings are offsetting the higher cleaning, mechanical, building support, and O&M administration expenses.

The government's energy efficiency goals must always be in balance with an agency's primary mission – a balance between well managed, reasonably priced space and the accomplishment of the agency missions – both achieved at best value to the taxpayer. By this calculus, the Whipple project team greatly exceeded its goals.



SUSTAINABLE SITE DESIGN

Site selection and designing for “place” is key to providing new buildings that are iconic, respectful of taxpayer’s dollars and environmentally responsible. However, because the location of building sites are often set and not easily changed, many government projects overlook the opportunities for including sustainable site design objectives. Ignoring the site, its use and response to environmental factors, will affect building energy and water consumption, comfort, and tenant satisfaction.

“These buildings will be here for hundreds of years—long after we [have] relocated the last tenant, or written the last report. They should be in the right location—that is our overriding responsibility.”

GSA *SITE SELECTION GUIDE*

SITE SELECTION

There are political and financial implications to consider in choosing a site as well as customer requirements to address. GSA's *Site Selection Guide* (2003) is a great resource that focuses on how the basic concepts of site section will affect the overall success of the project.

As stated in the guide, “...site selection is a “life-cycle” decision that recognizes the balance among the initial cost of the real estate, the overall cost of executing the project, and the cost of operating the facility. It also recognizes the benefit (or cost) to the local community and the environment. While the initial cost may be a significant driver, all factors must be considered in order to make the right decision.”

Transportation and Parking

Site selection decisions are multifaceted. Two of the most important, but often overlooked criteria are access to public transportation and parking availability. Removing vehicles from our highways benefits the community and the health and well-being of commuters by improving air quality and removing the stress of extended daily travel. Therefore, whenever possible,

left: THE OKLAHOMA CITY FEDERAL BUILDING EMBRACES ITS SITE WITH AN URBAN PARK OPENING FROM THE BUILDING AND A COURTYARD ACCENTED WITH TURF GRASS, HARDSCAPE, AND A WATER FEATURE.

Site and Water



Federal offices should be located in buildings with convenient, walkable access to light rail, subway and bus lines. A good rule of thumb is to be within a pedestrian-friendly distance of one-half mile.

At some locations there are few, if any, alternatives to automobiles and parking will need to be provided. In those cases it is important to encourage car and van pools by providing priority parking at the facility. Other strategies include initiating car-sharing programs, designating preferred parking for hybrid cars and providing recharging stations for electric automobiles.

It is also important to consider the neighborhood and its amenities when selecting a site. A facility near transit but without a range of amenities, such as restaurants, stores and other conveniences within walking distance, will increase the likelihood that people will want to drive to work. Providing secure storage areas and changing rooms with showers will encourage bicycle use.

Brownfields

Government building sites frequently involve the remediation of land identified as a brownfield, which EPA defines as “abandoned, idled, or under-used industrial and commercial facilities where expansion or redevelopment is complicated by real or perceived environmental contamination.”

GSA views brownfields as underutilized Federal properties that, through a partnership between the agency and the local community, can be reused to bolster revitalization efforts and remediate environmental contamination. As landlord and real estate agent for the Federal government, GSA understands that underutilized Federal real property can serve as a catalyst for urban revitalization when reused by localities to provide jobs, contribute to the local tax base, or preserve greenspace. Redeveloping former Federal property makes efficient use of existing infrastructure while providing an alternative to developing open space and contributing to urban sprawl.



left: THE EPA HEADQUARTERS IN DENVER, COLORADO, ENHANCES THE NEIGHBORHOOD WITH SIDEWALK AMENITIES AND RETAIL SPACE ON THE FIRST FLOOR.

above: THE FDA CAMPUS IN WHITE OAK, MARYLAND, IS LOCATED ON A FORMER BROWNFIELD SITE PREVIOUSLY USED BY THE MILITARY FOR INDUSTRIAL AND ORDNANCE OPERATIONS.



Optimizing Building and Site

After selecting a site, the project team can positively affect building performance by taking best advantage of the site's opportunities and constraints. The topography, geology and hydrology of the site will influence orientation and thermal massing decisions, as will the adjacent structures, existing trees and habitats. Solar and wind conditions can greatly influence the design team's decisions and contribute to reduced energy use and renewable energy strategies.

One of the most obvious approaches is using the sun, a perpetual source of energy, to lower utility bills. Passive solar strategies, such as glazing alternatives and the selection of appropriate shading devices, take advantage of the daily and seasonal changes in the sun's movement to lower both energy use and heating and cooling costs. Design teams can employ architectural solutions that include building overhangs, fins, light shelves, louvers and variations in window depths to assist with sun control and optimize daylighting. Dense or well-placed vegetation such as trees and vines provide natural shading, as do geographical features like berms, hills and embankments.

The Envelope

A key component of the exterior of a building is its envelope or skin. This protective layer keeps the elements out, comfort in, allows daylight and views, and provides the aesthetic image for buildings. The design team must pay careful attention to the selection of materials, moisture control management, thermal conductivity, and resistance, while also being attentive to the overall appearance.

An important resource is the Building Envelope Design Guide by the National Institute of Building Sciences (NIBS) found on The Whole Building Design Guide website. Among its features are tools for computational fluid dynamics,



left: EXTERIOR SUNSHADES ALSO FUNCTION AS LIGHT SHELVES TO REFLECT DAYLIGHT TO INTERIOR CEILINGS AT THE FDA CAMPUS IN WHITE OAK, MARYLAND.

top: LARGE AREAS OF GLAZING ARTICULATE PUBLIC SPACE IN CONTRAST TO SMALLER OFFICE WINDOWS WITH LIGHT SHELVES AT THE DHS LEASE IN OMAHA, NEBRASKA.

above: HIGH-PERFORMANCE GLASS COMBINES TRIPLE GLAZING, FRITTING, TINTING AND SUNSHADES TO OPTIMIZE VIEWS AND ENERGY EFFICIENCY FOR THE ARRAJ COURTHOUSE IN DENVER, COLORADO.

wind modeling, and sophisticated dew point analysis. Although the guide includes a specific section on sustainability, it is important to remember that envelope decisions are integrated with and inseparable from the whole-building design.

Site characteristics can help determine the building envelope. Architects design the building's form and select materials for the skin to achieve the desired aesthetic image but also to suit the climate conditions. Insulation, fenestration and glazing, for example, of each solar orientation may vary according to prevailing winds.

In fact, architects and engineers are realizing that wind can influence design and contribute to better building performance. Air movement resulting from pressure differentials can be used advantageously. Aerodynamic building form can harness air movement for ventilation and removal of heat from the building or even drive turbines to create electricity. Double skin façades are being used increasingly in commercial buildings and can affect performance related to wind and ventilation through the building. Computer analyses such as computational fluid dynamics allow modeling of airflow and temperature patterns to optimize the design.

Glazing choices are among the most important decisions an architect makes. High-performance glazing products are now readily available with many combinations of U-value, visible light transmittance and shading coefficient of the glass. Climate considerations will often dictate whether to use double or triple insulating units. Beware of reflective glass as it diminishes the available natural light inside the building and can cause unpleasant glare on the exterior.



WATER MANAGEMENT AND USE

Both inside and outside the building there are alternative strategies to manage water use more effectively and with less environmental impact than current practices, many of which make little sense from an environmental standpoint. For example, rainwater, wastewater and potable water are commonly all conveyed from the site without regard for source, cleanliness or reusability.

Quickly moving rainwater away from buildings, while protective of the envelope, can contribute to erosion and introduce chemicals and pesticides into waterways. At the same time, cleaned and purified water is used for non-potable purposes like irrigation and waste disposal. A better approach is to design site conditions that mimic the pre-development site and help restore natural hydrologic conditions. EISA 2007 requires that any development over 5,000 square feet restore the site's hydrology to pre-development conditions.

Stormwater Management

Low-impact development (LID) is a sustainable stormwater management strategy. It is decentralized "source-control" technology that capitalizes on integrated design principles to create a balanced, hydrologically functional, beautiful, and sustainable site. The LID approach emphasizes conservation, impact minimization techniques, pollution prevention measures and controlling runoff.



left: A VEGETATED SWALE FILTERS WATER TO HELP RESTORE THE PREDEVELOPMENT HYDROLOGY OF THE SITE AT THE SSA TELESERVICE CENTER IN AUBURN, WASHINGTON.



top: A UNIQUE FEATURE OF THE EPA SCIENCE AND TECHNOLOGY CENTER IN KANSAS CITY, KANSAS, IS A 10,000 GALLON UNDERGROUND TANK TO COLLECT RAINWATER FOR REUSE IN THE COOLING TOWERS AND TOILET FLUSHING.

above: A PARKING AREA OF PERMEABLE PAVEMENT ALLOWS STORMWATER TO FILTER INTO THE GROUND AT THE OKLAHOMA CITY FEDERAL BUILDING.

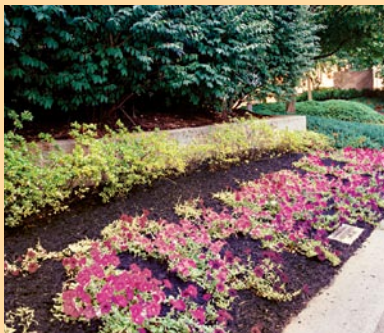
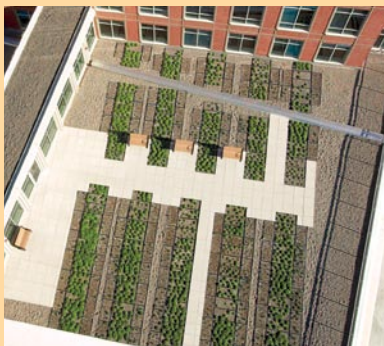
Three basic strategies for comprehensive stormwater management are:

- 1 Distribute stormwater to allow infiltration into the ground to replenish the water table while minimizing runoff into storm drains.
- 2 Remove barriers to water infiltration including curbs and nonporous pavement.
- 3 Filter, store and reuse the water that lands on-site.

Strategies to achieve these goals include raingardens, bioswales, tree box filters, permeable paving, rainwater capture and planted roofs.

Rainwater capture involves collecting rain—a natural resource—and holding it for future use. Cisterns, underground tanks, above-ground tanks and building integrated storage systems can be used to collect and store rainwater from either the roof or the site. Some systems use gravity while others require a pump. Collected water can be used as is for irrigation or filtered for flushing toilets. Some jurisdictions require labeling or coloring the stored water to prevent its use as potable water.

Paved surfaces make up a large portion of developed sites and the use of permeable pavement is very effective at meeting the LID goal of stabilizing hydrologic conditions. Some types of alternative pavement include permeable asphalt, permeable concrete, grid block pavers, plastic grids, gravel, brick, and natural stone. These alternative pavements can be combined with traditional pavements to provide stormwater management, such as a parking lot with an asphalt driving lane and permeable parking areas.



top: A GREEN ROOF OF PRE-PLANTED TRAYS ADORNS AN OUTDOOR TERRACE AT THE EPA OFFICE AT POTOMAC YARD IN ARLINGTON, VIRGINIA.

above: MULCH MADE FROM RECYCLED TIRES CREATES A LOW MAINTENANCE LANDSCAPE AT THE DUNCAN FEDERAL BUILDING IN KNOXVILLE, TENNESSEE.

Environmentally Preferable Landscaping

Environmentally beneficial landscaping guidelines that specify sustainable landscape management practices for conserving water are available from EPA's GreenScapes program. Examples include mulching with organic matter to cool the soil and reduce moisture evaporation from the root area around plants and trees. The guide also suggests grouping plants of similar water needs together and irrigating the landscape by watering deeply, infrequently and slowly.

Xeriscape™ is a set of common-sense gardening principles designed to save water while creating landscapes that take full advantage of indigenous plants to provide interest and beauty. Any selected plants must be native to the place and able to thrive in the area's available rain supply, making irrigation unnecessary.

The Green Roof

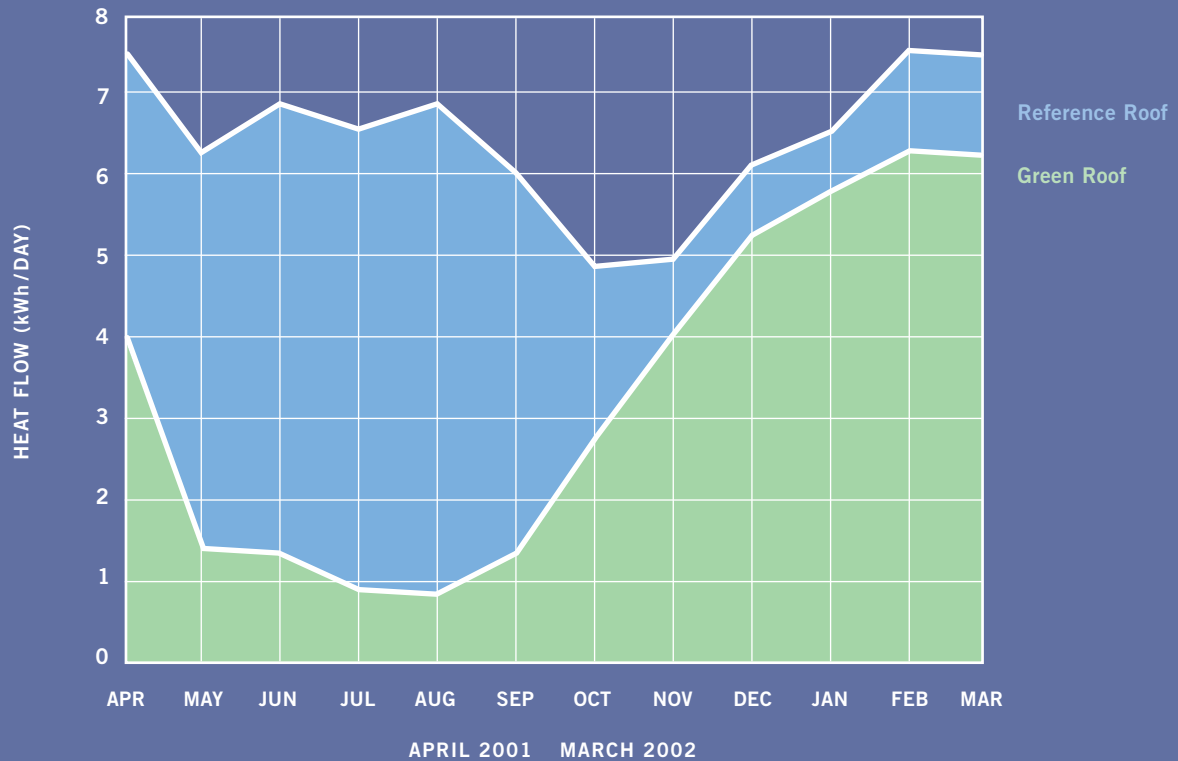
For many, a planted roof is viewed as complicated to design and install. In reality, a planted roof is simply a ballasted roof system installed on a flat or low slope roof, except the ballast consists of a planting medium and plants. There are two basic types of planted roof, extensive and intensive.

An extensive green roof has a planting medium that is six inches or less in depth, does not require irrigation and includes plant species such as sedums or other succulents. It is generally lightweight and applicable to new construction and many existing buildings. Load calculations are required to determine if structural reinforcement is required in existing buildings. Maintenance generally includes a yearly inspection, removal of debris and periodic fertilization. Modular systems where all the components of the planted roof are conveniently installed in a 2'x2' or 2'x4' tray, provide an alternative that is gaining popularity.

Intensive green roofs are load intensive. These roofs are as deep as needed to allow for a variety of plants, shrubs, and trees that may require irrigation. They

Measurements showed a significant reduction in the average daily heat transfer through a green roof compared to a typical roof in the spring and summer.

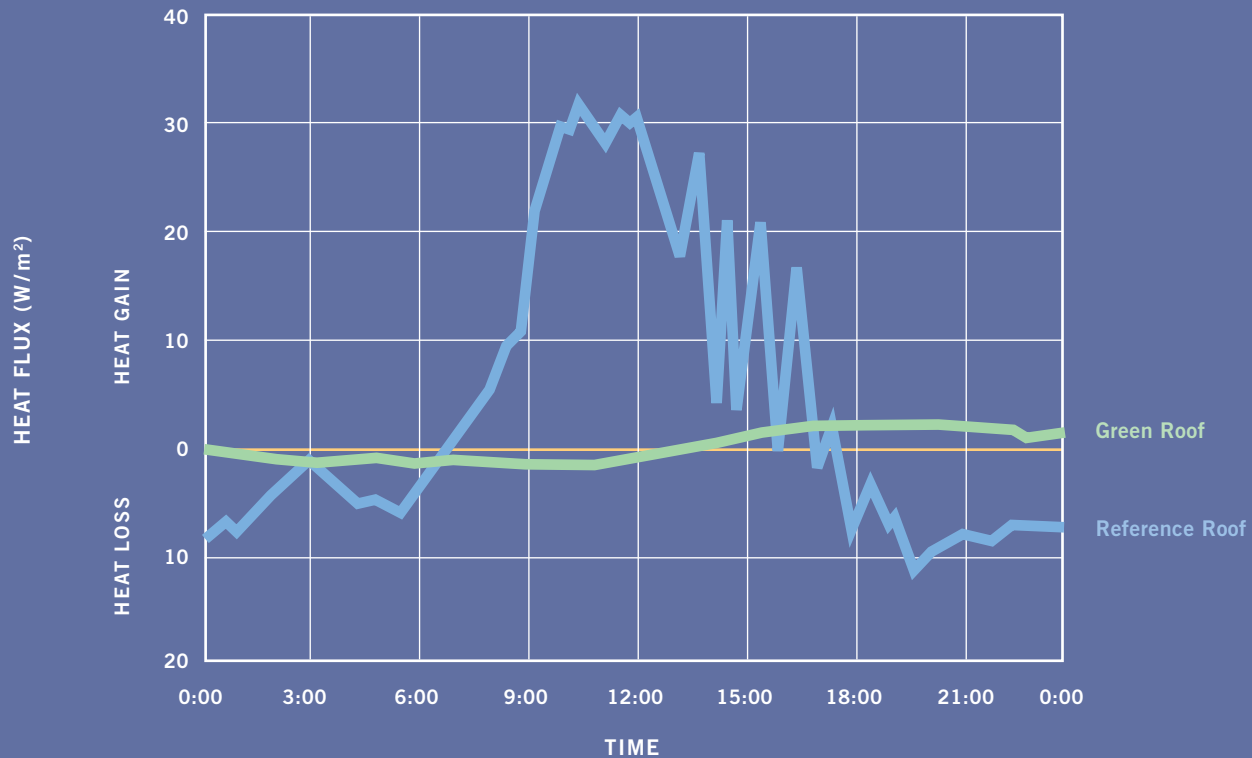
AVERAGE DAILY HEAT FLOW THROUGH ROOF SYSTEMS



The National Research Council of Canada constructed an experimental Field Roof Facility (FRF) in Ottawa, Canada. A median divider separates the roof of the FRF in two equal areas: a generic extensive green roof and a modified bituminous reference roof. Both roof sections were instrumented to allow direct comparison of their thermal performance.

Heat flow through the roofing systems on a summer day (July 16, 2001) indicated that the green roof reduced the heat flow through the roofing system significantly.

HEAT FLOW THROUGH ROOFING SYSTEMS



The National Research Council of Canada constructed an experimental Field Roof Facility (FRF) in Ottawa Canada. A median divider separates the roof of the FRF in two equal areas: a generic extensive green roof and a modified bituminous reference roof. Both roof sections are instrumented to allow direct comparison of their thermal performance.



GSA'S FIRST GREEN ROOF: 33 YEARS AND GOING STRONG

In 1975, the Edith Green/Wendell Wyatt Federal Building in Portland, Oregon, was constructed with an attached below-grade parking garage. Rather than a paved parking deck, the roof—an intensive green roof—serves the community as a park. Part of the Portland Park Blocks, the Terry Shrunken Plaza is the size of a city block, measuring nearly 40,000 square feet, with large trees, landscaped areas, a grass tiered seating area and an amphitheater. This integrative solution provides necessary secure parking for the building, stormwater management for the city, public amenities for the people, habitat for the animals, and green space in an urban center. This roof has been an asset to GSA, already exceeding an average life expectancy with over 33 years of service without a leak, repair, or any anticipated replacement in the near term.

may even include water features or areas for recreational activities. Maintenance will vary depending on the plant species but is similar to any landscape.

Overall, the benefits of a planted roof include reducing stormwater runoff, improving water quality, reducing urban heat island effect, conserving energy, reducing sound reflection, creating wildlife habitat, and improving the aesthetics of the typical roof. An often overlooked benefit—and one with significant asset management impact—is the prolonged life of the roof membrane. Because a planted roof protects the membrane from the sun's ultraviolet radiation, extreme temperature swings, and harmful pollution, the roofing membrane can last 50 to 100 years.

Interior Water Management

Increasing droughts and water scarcity are a growing global problem making potable water use reduction in buildings an environmental as well as an economic necessity. It is estimated that the Federal sector spends nearly \$1 billion on water and sewage charges annually, much of it on potable water used for purposes other than drinking. There are a number of effective strategies available to designers and building managers.

Site and Water



EPAct 1992 saves the United States over six billion gallons of water every day.

Restroom Strategies

Restrooms offer the best opportunity for water conservation inside buildings. New high-efficiency single-flush toilets, for example, provide satisfactory performance using only 1.1 gallons per flush, significantly better than the 1.6 gpf established by the Energy Policy Act of 1992. Dual-flush toilets, which offer two volumes—a full flush for solid waste and a lesser amount for liquid waste—are now available from all the major plumbing fixture manufacturers.

Urinals by law may use up to 1.0 gpf; however, many are available in the market that use a half-gallon or less, and some do not use any water at all. Waterless urinals operate with several different technologies that eliminate the use of water to flush. They connect to typical drain lines but do not require water supply connections. Most utilize a replaceable cartridge filled with a lighter-than-water liquid sealant. All are odor-free if properly maintained. They do require different maintenance procedures from traditional installations and it is essential to train the custodial staff. However, with proper training, studies have shown that long-term maintenance costs are lower than traditionally plumbed urinals.

Equipping faucets with flow restrictors is a common water-saving strategy. Also, infrared sensors, to control urinals, toilets, and sinks, as well as soap dispensers and paper towels, can reduce water or resource usage if properly calibrated and maintained. If not, they can waste more water than they save, especially with electronic motion sensors on toilets that often flush repeatedly or unnecessarily. New solar-powered faucets that can gather energy from any source, including restroom lighting, have come into the market.



left: **WATERLESS URINALS CAN SAVE 40,000 GALLONS OF WATER PER FIXTURE PER YEAR AND LOWER COSTS IF MAINTAINED PROPERLY.**

above: **A WATER-SAVING PROGRAM IS INCLUDED AT THE CAFETERIA OF THE DEPARTMENT OF TRANSPORTATION HEADQUARTERS IN WASHINGTON, DC.**

Other Interior Means and Methods

In addition to restrooms, food services facilities, such as cafeterias, offer water-saving opportunities. Many of the ENERGY STAR rated appliances are also water efficient. Additionally, an awareness program for cafeteria staff can help reduce wasteful practices.

Changes to mechanical room equipment also may contribute to water conservation. Cooling towers, for example, have traditionally used a lot of water because mineral concentrations cause scaling on the tower slats that reduce efficiency. New life-cycle cost-effective models require fewer and less harmful chemicals and automatically monitor the concentrations. This also makes it possible to reuse cooling tower water for other purposes like irrigation or flushing toilets.

A relatively new but viable water conservation method for commercial buildings is harvesting a building's greywater, which can also be used for non-potable uses such as flushing waste or irrigation. Sources of greywater include sinks, showers, and drinking fountains as well as captured rainwater, and its use requires the installation of dual plumbing systems—an added expense that can be justified in some parts of the country. Local jurisdictions may have requirements about the treatment and labeling of these alternative wastewater sources. Additionally, it may be necessary to meter the sewage pipe to properly calculate sewage and water use.

To protect the future of our nation's water supply by promoting and enhancing the market for water-efficient products and services, EPA sponsors the WaterSense program. The WaterSense label, similar to that offered by ENERGY STAR, identifies and labels products and programs that meet water efficiency and performance criteria.

INFO: WaterSense – www.epa.gov/WaterSense



CASE STUDY: SITE AND WATER

NOAA Satellite Operations Facility

TURNING TRADITIONAL DESIGN UPSIDE DOWN

The National Oceanic and Atmospheric Administration (NOAA) Satellite Operations Facility, a 208,000 square foot building located on 15.6 acres within the Federal Center in Suitland, Maryland, features both a bold design and a LEED Gold rating. The facility is a prime example of the way in which a sustainable site strategy can save money and provide a striking setting for the building.

left: UNDERGROUND PARKING AND A LARGE GREEN ROOF GREATLY REDUCE THE AMOUNT OF IMPERMEABLE SURFACES AT THE SITE OF THE NOAA SATELLITE OPERATIONS CENTER.

GSA LEED BUILDING

NOAA SATELLITE OPERATIONS FACILITY SUITLAND, MD

LEED NC rated: Oct 26 2007

GOLD

| | | |
|------------------------------|-----------|----|
| Sustainable Sites | 10 | 14 |
| Water Efficiency | 3 | 5 |
| Energy and Atmosphere | 6 | 17 |
| Materials and Resources | 5 | 13 |
| Indoor Environmental Quality | 11 | 15 |
| Innovation and Design | 5 | 5 |
| | 40 | 69 |

GREEN FACTS

84% site area restored with
native and adaptive plants

99.9% non equipment roof
area planted

100% landscape is not irrigated

The design team of Morphosis and EYP worked through an integrated design process and developed a scheme based on several underlying goals. First, given that the site was part of a naturally wooded and grassy area, the team sought to hide as much of the building as possible in order to reduce its visual impact. Second, the team wanted to improve the work environment of the employees by locating all on a single floor, in contrast to the multi level workspace of the agency's previous World War II era building. Finally, the team wished to accommodate the satellite operations, its employees, and the necessary technology in an elegant and integrated form.

As the site design progressed, the team became aware of the project's extensive requirements for stormwater management. If built in a typical fashion, the size of the facility and its 340 parking spaces would cover a good portion of the site, and require a large and expensive stormwater remediation plan including the construction of a retention pond, enlargement of drain connections under a local road and measures to protect an on site stream. Such an approach would expend too large a share of the project budget for site remediation and would, therefore, compromise or detract from the space requirements and level of technology needed within the facility.

The program for the Satellite Operations Facility called for both general office space, and a highly technical satellite control and operations center. Had it been designed in the standard way, the architects would have located the offices in a multi story, above ground building with the satellite control rooms relegated to a "black box" structure, most likely underground. Instead, the team turned the traditional scenario upside down and placed the office space underground and the satellite operations within a slender horizontal bar above



ground capped with satellite dishes. This solution allowed nearly all of the employees to work on a single level, limited the visual impact of the structure and its intrusion on the adjacent residential neighborhood, and provided an unobstructed view of the sky for the satellites.

The office area is, in a sense, the foundation of the building, and is defined by a vast floor area with a shallow domed, 23 foot high ceiling. To prevent the feeling of being underground, the design team provided four light wells and a 14 foot high window wall on the southwestern perimeter, ensuring that no employee is farther than 60 feet from a window. In addition, 21 circular skylights penetrate the roof to provide an even level of daylight throughout the space. A 146,000 square foot planted roof over the main office flows seamlessly into the landscape, making the majority of the building's volume disappear from view. Finally, the mechanical rooms and two levels of parking are located under the building to further limit the site disturbance.

By placing the offices underground and planting the roof with vegetation, the building exposes just 47,000 square feet of roofing over the operations center, which also serves as a structure for the satellites themselves. As such, only 20% of the finished site is impervious, eliminating the need for a detention pond or increased stormwater piping, leading to significant savings, and allowing the on site stream to remain as an amenity, rather than a liability.

With this bold plan by the design team, GSA was able to economically provide NOAA with an architecturally striking facility tailored to its mission, with strong sustainable achievements.

top: SKYLIGHTS DOT THE GREEN ROOF TO BRING DAYLIGHT INTO THE OFFICE SPACE BELOW.

above: TWENTY THREE FOOT CEILINGS, SKYLIGHTS AND GLASS WALLED COURTYARDS MAKE THE OPEN OFFICE AREA BRIGHT AND CHEERFUL.



IEQ: INTEGRAL TO PEOPLE, BUILDINGS, AND RESULTS

GSA embraces good indoor environmental quality (IEQ) first, as a matter of principle—GSA knows that a healthy, energy-efficient workplace is every employer’s responsibility—and second, as a matter of practical necessity—a workplace with good IEQ leads to increases in productivity *and* has the potential to reduce costs. Unlike some building features—such as IT, furnishings, and equipment—indoor environmental quality is primarily “built into” a facility, and, as such, must be addressed early in the design process, and designed with sustainability in mind. For that reason, GSA employs an integrated life-cycle approach to the design, construction, operation and leasing of its public spaces. It’s in our best interest, too, because GSA is not only a provider, but a customer as well; we work in the spaces we create.

A SHORT HISTORY OF INDOOR ENVIRONMENTAL DESIGN

The design of the indoor environment has been important since man first built shelters, but the quality of that environment has, in recent years, received more thoughtful attention. Early construction standards consisted primarily of building and fire codes, or “boss codes” written to prevent buildings from catastrophic failure, either natural or man-made.

Over time the design and construction industry became more concerned with the safety of the occupants inside of buildings and developed the National Fire Protection Association’s (NFPA) “Building Exits Code,” which would become the “Life Safety Code” in use today. Organizations such as the American Society of Heating Refrigerating and Air Conditioning Engineers (ASHRAE), the American Conference of Governmental Industrial Hygienists (ACGIH), and the National Institute for Occupational Safety and Health (NIOSH) began to issue guidelines for thermal comfort and the protection

left: THE WATER SECURITY FEATURE IN THE LOBBY OF THE SEATTLE COURTHOUSE REFLECTS THE ABUNDANT DAYLIGHT FROM THE SKYLIGHTS AND GLASS WALLS.

of human health and safety. However, for most of the last 50 years, building standards have been governed by rigid, “one size fits all” requirements (e.g., area per person, standard aisle widths, temperature boundaries, and lighting loads).

As building materials, construction and installation techniques changed, the list of potential indoor hazards grew. The late 1960s brought concerns over radon, followed in the 1970s by formaldehyde, airborne asbestos, and a suite of problems that became known as sick building syndrome. More recently, concerns have shifted to problems associated with molds and allergens. Throughout this period EPA and GSA were proactive, testing for radon, issuing formaldehyde limits, developing comprehensive asbestos control programs, and dedicating significant resources to managing indoor air quality. This was effectively an era of “prevention” during which EPA and GSA developed many indoor air quality (IAQ) protocols. While the agency is justifiably proud of its progress in improving indoor air quality, much of that effort consisted of a series of fixes, as opposed to carefully considered, systemic designs.

IAQ To IEQ

Throughout the 1990s GSA increased the scope of its indoor air program, going beyond traditional health concerns and including stressors such as irritants and allergens. The agency also realized that air quality was a subset of a broader issue that came to be known as indoor environmental quality, or IEQ. Therefore, in addition to comfort and air quality, GSA began to examine lighting, views, acoustics, even ergonomics—in other words, *all* of the factors that affect the occupant’s indoor experience.

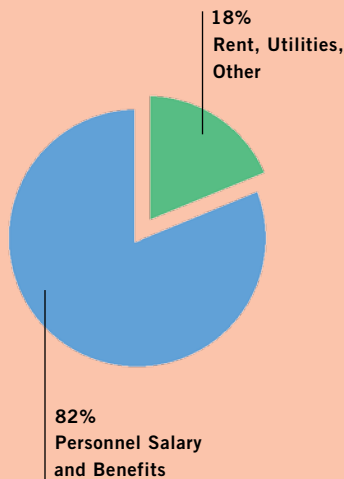
COMPONENTS OF INDOOR ENVIRONMENTAL QUALITY





THE VAV FERVOR

The energy crisis of the 1970s directly and indirectly created a number of building indoor air quality problems, which called attention to the deficiencies of the then prevalent HVAC system. While constant air volume with reheat and dual duct systems delivered both exceptional thermal control and reliable outdoor air delivery, it was not energy efficient. Building owners and operators desire to reduce energy costs resulted in the widespread use of variable air volume (VAV) systems for new construction and retrofits. Unfortunately, what the industry did was akin to combining an aquarium's heater with its air pump and then shutting down *both* systems when only the thermostat was satisfied. Again, fixes were eventually developed, but they were applied subsystem by subsystem rather than as an integrated strategy.



COST OF DOING BUSINESS

Annual office costs per square foot

IEQ AND COST CONSIDERATIONS

Like most building characteristics, improved environmental quality often impacts other program areas. While IEQ is sometimes perceived as being in competition with energy efficiency and security, the priorities are not mutually exclusive. The increased adoption of integrated systems thinking makes it possible to simultaneously achieve multiple goals—good IEQ, reduced energy use and cost efficiencies. Demand control ventilation, natural ventilation, and increased air and water-side economizer utilization are only a few examples that illustrate this point.

The financial implications of IEQ practices are clear when compared to other building expenditures. For example, while life-cycle costs for operations and maintenance are approximately three to four times the capital cost of a new building, the capital costs of the people inside the buildings, including salaries and benefits, are often *one or two orders of magnitude* above traditional capital *and* O&M costs. Therefore, it is obvious that even small increases in occupant comfort, especially given the resulting gains in productivity, can yield substantial cost savings.

INDOOR ENVIRONMENTAL STRATEGIES

Today, GSA takes an integrated, whole-systems approach to the design, construction, operations and maintenance of its world-class indoor environments—the result of a team effort involving the agency’s environmental, environmental health, engineering, architectural, and building operations champions. Together they have identified integrated and sustainable IEQ design goals and strategies.

Provide a Comfortable Indoor Environment

Thermal Comfort and Occupant Control

Smaller HVAC zones, along with occupant control, increase both thermal comfort and occupant perception of air quality. Effective strategies include limiting zone sizes, and positioning controls as close to the occupants as possible. Also, consider under-floor air distribution (UFAD) and task/ambient conditioning (TAC) systems, where appropriate, to facilitate localized air distribution and control.

Dehumidification

Proper humidity control is a critical aspect of comfort control, healthy indoor air, and occupant perception of air quality. For that reason GSA now requires dedicated outdoor air delivery systems as part of the building's HVAC design. During the cooling season these systems provide better dehumidification control, and reduce energy use. Such systems also facilitate building pressurization, which controls moisture infiltration.

Using smaller systems in parallel avoids the dehumidification limitations caused by the short-cycling of systems during part-load conditions. This design approach allows more operating time at the full-load conditions resulting in greater efficiencies and better dehumidification.

Humidification

Locations in the northern U.S., where the air can be both cold and dry, can be particularly problematic during the heating season. Dry air negatively impacts occupant comfort and health, can damage wood finishes, and also results in electronic equipment damage. Clean humidification technology where warranted, combined with lower thermostat temperatures, can offset the additional costs of winter humidification without sacrificing comfort levels.

HIERARCHY OF CONTROLS

GSA employs a “hierarchy of controls” model to prioritize strategies to effectively eliminate or reduce indoor environmental quality risks. In order of preference:

- 1 Eliminate the substance or hazard
- 2 Substitute less hazardous substances or materials
- 3 Provide engineering controls, such as isolation and source control
- 4 Remove indoor contaminants

Improve Indoor Air Quality

In 1991 EPA ranked indoor air pollution as one of the top five environmental threats to public health, a serious problem considering that Americans spend 80 to 90% of their time indoors. Many people—some estimates are as high as 40%—experience adverse effects from poor indoor air, ranging from respiratory problems to allergic reactions and asthma. Establishing and maintaining first-rate IAQ is a top priority for GSA.

Source Elimination and Reduction

A “hierarchy of controls” approach to design—a concept accepted in the health and environmental fields as a means to most effectively reduce hazards and environmental impact at the lowest life-cycle cost—is based on the premise that it is far easier to achieve good indoor air quality through prevention than through remediation.

In this hierarchy the first priority is the elimination of hazardous and undesirable materials *from the design*, beginning in the earliest stages of site selection and project planning. Some potential sources of contamination will require major modifications—sub-slab de-pressurization, for example, is recommended for radon-prone locations and brownfield sites. Others will appear to be less important, such as avoiding high pollen-creating plants in landscaping and on green roofs. Collectively, however, source elimination or reduction results in benefits for both occupant health and comfort and cost.

Building materials are a potentially common source of contaminants that can be easily avoided by eliminating, or at least limiting the use of products that contain formaldehyde and other volatile organic compounds (VOCs). This is especially important in specifying “wet” products such as paints, coatings, adhesives and sealants. Recent product introductions have made it easier to find low- or no-VOC formulations.

Source Control

The next priority is to isolate and control the hazardous materials and processes that cannot be eliminated. GSA's Facilities Standards, for example, require local ventilation and negative pressure for smoking areas, detention cells, toilets, showers, locker rooms, custodial spaces, and other areas with the potential to generate contaminants and unwanted odors. The Facilities Standards also recommends grouping printers, copiers, shredders, and facsimile machines in separately ventilated areas.

During construction, staging techniques help prevent clean materials from becoming contaminated. Strategies include sealing duct terminations and installing off-gassing materials prior to absorptive "sink" materials. Also, consider putting appropriate barriers in place and using negative pressure, particularly during the renovation of occupied facilities.

Toxic cleaning products and inattentive maintenance and repair procedures can ruin even the most carefully executed IAQ plan. It is essential that building operators establish and use green custodial means and methods as addressed in GSA's national custodial performance work statement. Green cleaning compounds used at minimum recommended concentrations without over-wetting surfaces will deliver the best environmental result. HEPA vacuuming is an option in current specifications, and may eventually become an agency-wide requirement. Even something as simple as timely trash removal can impact indoor air quality.



Infiltration Control

Outdoor air may, depending on geographic location and seasonal conditions, be cleaner than indoor air. Even so, it is necessary to address the infiltration and intrusion of contaminants. An important strategy is to use dedicated outdoor air delivery systems for dehumidification and building pressurization. Also, specify minimum heights for outdoor air intakes and ensure that such locations are far from contaminating sources such as loading docks and cooling towers. Sheltered entranceways and walk-off mats also help reduce particulate intrusion into buildings. To minimize the impact of second-hand smoke, provide specific criteria for the placement and design of outdoor smoking areas.

Air Cleaning and Ventilation

Despite diligent efforts, contaminants can and will degrade the quality of indoor air. IAQ can be significantly improved by removing pollutants from the air stream, and by controlling areas susceptible to microbial growth. Ultraviolet germicidal irradiation (UVGI), used in air-handling units, prevents microbial growth on coils and in condensate pans. UVGI also maintains coil efficiency. This approach reduces—and in some cases eliminates—the use of biocides to clean coils and condensate.

Under-floor air distribution (UFAD) used in select applications results in better ventilation effectiveness and can improve the quality of indoor air. UFAD can also be used to stratify the room air and reduce ventilation loads by exhausting more “contaminate-concentrated” return air.

GSA has adopted one of the most stringent filtration requirements in the commercial building industry: particulate pre-filters must be a minimum of MERV 8, and final filters MERV 13.

above: A COURTROOM IN THE MORSE COURTHOUSE, EUGENE, OREGON, WITH UNDER-FLOOR AIR DISTRIBUTION

“Acoustics doesn’t show up in the records of building complaints because people don’t complain about it. They don’t think the building manager can do anything about it, and that’s generally true.”

KEVIN KAMPSCHROER, GSA
DIRECTOR OF EXPERT SERVICES



Noise Reduction and Acoustical Privacy

Proper acoustic design can significantly contribute to tenant satisfaction and productivity. Numerous studies have shown that office workers regard unwanted noise as a major irritant. It is, therefore, important to consider acoustics early in the design process. Use low transmittance decks and walls, specify vibration isolation for mechanical equipment, and size ductwork to avoid the noise associated with high-speed forced air. While internal duct lining can significantly reduce such noise, liners also absorb dirt and harbor microbes; metallic duct silencers are a better choice. In some situations, efforts at reducing airflow noise have been so successful that workplaces have become too quiet. In these situations sound masking—often referred to as white noise—will provide acoustical privacy.

High-Performance Luminous Environment

In general, lighting levels have historically been unnecessarily high, and therefore unnecessarily expensive and energy inefficient. Overly bright and poorly designed lighting also detract from occupant comfort and productivity. Splitting the lighting load between overhead and task lighting yields more appropriate light levels and makes economic sense. Since the intensity of light fades approximately with the square of the distance, task lighting is a more cost-effective solution than general overhead lighting. In addition, task lighting puts control of light levels with individual occupants, increasing workplace satisfaction and reducing energy consumption. Current practice also recommends the use of high-frequency electronic ballasts to reduce flickering, and directs design teams to reduce glare from all sources in the workplace.



Daylighting and Views

The use of daylighting is an essential design element in all buildings. It not only reduces energy costs, but also offers the occupants the psychological satisfaction of a view of the outdoors. Numerous studies have shown that good daylighting and views significantly increase worker productivity, with some estimates as high as 18%, further contributing to the economic benefits of the strategy. A study by Heschong Mahone, a research group, found that office workers performed better on tests of mental function and memory recall when they had a view versus those with no view. Reports of increased fatigue were most strongly associated with a lack of view.

Both the art and the science of daylighting involve more than simply adding windows or skylights in order to allow light to enter an occupied space; good daylighting design must also take into consideration the possibility of undesirable side effects and preserve the occupant's view by using integrated design strategies to balance occupant needs. These include balancing heat gain and loss, controlling glare, and dealing with variations in the availability of daylight. Therefore, successful daylighting designs almost invariably include the use of shading devices to control heat loads and to reduce both glare and excessive contrast between lit and unlit spaces. In addition, designers must evaluate window size and spacing, glass selection, the reflectance of interior finishes, and the location of any interior partitions. Despite these varied design challenges, daylighting has the potential to significantly reduce life-cycle costs, to reduce operating costs, to reduce emissions, and to increase occupants' productivity.

left: A FOUNTAIN PROVIDES BOTH WHITE NOISE AND HUMIDIFICATION IN THE ATRIUM OF THE EPA REGIONAL HEADQUARTERS IN KANSAS CITY, KANSAS.

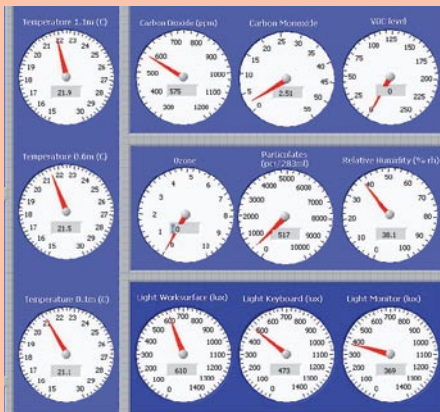
above: HIGH CEILINGS, LIGHT SHELVES AND DIRECT/INDIRECT LIGHTING PROVIDE A LUMINOUS WORK ENVIRONMENT AT THE OKLAHOMA CITY FEDERAL BUILDING.

Ergonomic Design

Ergonomics is the science of engineering the workspace in light of human factors. A properly designed ergonomic work environment reduces injuries, absenteeism, errors, and dissatisfaction, and maximizes productivity. The Occupational Safety and Health Administration (OSHA) offers industry- and task-specific guidelines including those for ergonomically correct workstations. It is easiest to achieve ergonomic excellence when the total indoor environment is designed and delivered as an integrated product rather than from different entities.

INFO: OSHA Ergonomic Approach – www.osha.gov/SLTC/ergonomics





left: WORKSTATIONS AT THE CENSUS HEADQUARTERS, SUITLAND, MARYLAND.

above: GSA MEASURES NOISE, AIR MOVEMENT, TEMPERATURE, RELATIVE HUMIDITY, CO, CO₂, OZONE, VOCs, PARTICULATES, LIGHT AND GLARE.

VERIFICATION AND FOLLOW-UP

GSA verifies its progress and success in providing world-class sustainable indoor environments through various efforts:

- GSA surveys its customers on a regular basis. The agency now has over 200,000 tenant satisfaction surveys in its archives for both owned and leased buildings, including data on satisfaction with comfort, air quality, lighting, and acoustics. The data show a slow but steady increase in occupant indoor air quality satisfaction over the last three years.
- Post-occupancy evaluations (POEs) verify design intent and proper commissioning but also assist in the “shakedown” of new buildings. Errors that occur when the building is handed over to the O&M staff, if left uncorrected, can have a long-term effect on the quality of indoor environments.
- Where satisfaction surveys indicate potentially problematic buildings, GSA performs in-depth environmental quality investigations and recommends specific actions. The use of data loggers also allows the agency to sample environmental conditions both temporally and spatially, providing a whole-building evaluation throughout the workweek.

These efforts provide an ever-increasing repository of lessons learned, and more importantly, a portfolio of best practices.



CASE STUDY: INDOOR ENVIRONMENTAL QUALITY

Alfred A. Arraj U.S. Courthouse

THE FIRST GREEN COURTHOUSE: A MODEL FOR SUSTAINABILITY

The Alfred A. Arraj U.S. Courthouse, located in downtown Denver, Colorado, is GSA's first showcase green courthouse. Completed in October 2002, the building is a model of sustainability and serves as a prototype for cost effective sustainable design strategies with an emphasis on occupant satisfaction through excellent indoor environmental quality. The 320,000 square foot facility includes a 10 story tower with 14 courtrooms, judges chambers, court support areas, office space and a two story pavilion housing the Special Proceedings Courtroom.

left: THE ARRAJ COURTHOUSE IS AN EXPLORATIVE
MODEL OF INTEGRATED SUSTAINABLE
BUILDING DESIGN.

Building Facts

Building Location: Denver, Colorado,

Date of Completion: 2002

Budget: \$83 Million

Size: 327,103 gross square feet

In 1996, GSA assembled a 20 member interdisciplinary advisory committee composed of leading architects, engineers, environmentalists, planners, and research scientists to recommend sustainable design strategies for GSA's courthouse construction program, specifically the proposed courthouse for Denver. The design team then set to work to incorporate the latest proven technologies for environmentally sensitive design, construction, and operation. Early in the development process, the project team established these goals:

- Reduce electrical demand by 50%
- Provide daylighting to all building occupants
- Maximize reusable products
- Maximize flexibility to accommodate changes
- Minimize construction waste
- Provide a healthy and productive work environment

BUILDING FEATURES

The design of the Arraj Courthouse used the most advanced technology available at the time to take advantage of the synergistic effects of integrated features and technologies. Site selection and orientation, landscape features, sustainable construction materials, high performance glazing, advanced building controls, energy efficiency measures, and under floor air distribution are hallmark features of the building, marking it as a milestone project for GSA.

Site Selection and Orientation

The Arraj Courthouse complex completes a four block Federal district, adjacent to Denver's rapid transit system. Collaboration between GSA, the city, and public and private interest groups ensured that the entire complex would be compatible with development objectives for Denver's central business district. The building not only meets the judiciary's current space requirements, it allows for expansion in the future and has a 100 year life expectancy.



Landscape Features

The position of the two story pavilion, which serves as the public entrance and houses the Special Proceedings Courtroom, is on a southeast oriented landscaped plaza. Architecturally, it recalls a historic courthouse in the square. The surrounding plaza is paved with local stone set in sand beds rather than concrete which absorbs water and helps control runoff. The plaza also features hardy drought tolerant regional plants that require little maintenance. An ornamental waterway runs from the sidewalk to the building entrance, symbolizing the streams of the high desert.

Materials

Specific environmental attributes guided the selection of building materials. Locally produced materials include exterior stone paving and precast concrete elements. The interior floors of Spanish limestone are light in color and extremely durable. All paints and adhesives are water based and low in volatile organic compounds. Steel and other recycled content products comply with the Comprehensive Procurement Guidelines for Federal agencies. Maple wood paneling from sustainably managed domestic forests provide beauty throughout the courtrooms and lobby. The courtroom flooring is cork, a renewable natural resource, which is a traditional material used in courtrooms in the 1920s and 1930s.

Daylight

The public corridors of the building are oriented to the southeast to maximize solar exposure. Oversized windows provide occupants and visitors with a connection to the outdoors and magnificent views of downtown Denver. Internal light shelves bounce daylight onto light colored surfaces so that it

above: A STREAM OF WATER THROUGH THE PLAZA MIMICS THE MEANDERING FLOW OF RIVERS AND CREEKS IN THE MOUNTAINS.

Alfred A. Arraj U.S. Courthouse,



reaches deep into the interior. Fluted glass panels bring diffused daylight into the interior courtrooms and other spaces. Automated shades can provide 50% or 100% opacity as needed. Overall, natural light is available throughout 75% of the building.

High-Performance Glazing

After extensive analysis, the architects selected high efficiency triple glazed windows for the south facing public corridors. The initial cost was higher than a double glass curtainwall, but the resulting reduction in heating and cooling load made them an economical choice. Clear glazing used above the light shelves allows more sunlight to enter than the tinted glass below. Fritting, applied in key areas of the building, filters the amount of light entering the space.

Advanced Building Controls

The lighting system takes maximum advantage of daylighting by incorporating electronic dimming ballasts, occupancy sensors, and low level ambient lighting. The state of the art building automation and performance assurance system optimizes building systems within the top 20% of performance. A custom designed energy management system monitors outside temperatures to optimize heating and cooling loads, neutralize the impact of weather extremes, account for weekend building closures and other conditions that may compromise interior comfort.

Energy

The initial design predicted building performance at 46% better than the Code of Federal Regulations energy baseline. Evaporative cooling reduced the need for an electric powered chiller and is the major source for seasonal air conditioning. Variable speed fans and pumps also reduce energy usage during



left: A SOUTHERN ORIENTATION MAXIMIZES EXPOSURE TO SUNLIGHT SO THAT 75% OF THE INTERIOR IS NATURALLY ILLUMINATED.

above: BRIGHT FINISHES AND LIGHT SHELVES CONTRIBUTE TO REFLECTING DAYLIGHT INTO INTERIOR COURTROOMS.

partial load conditions. The Arraj Courthouse was the first federal courthouse to include a building integrated photovoltaic system, one that both produces electricity and serves as an integral component of the building envelope. The 1,491 square foot system produces up to 60 kWh of electricity and up to 1% of the building's peak electrical demand. Despite the efficiency of numerous individual building elements the overall building performance has not met expectations due to programmatic changes and lack of an integrated approach to value engineering.

Under-Floor Air Distribution

The courtrooms, with 16 foot high ceilings, use displacement ventilation from an under floor air system and take advantage of thermal stratification to maintain standard temperature ranges within the occupied areas. Air delivered at a low velocity passes through the breathing zone and exhausts near the ceilings providing high quality air in an extremely quiet manner. A full scale mockup and heat load test demonstrated the adequacy and proper balancing of the low velocity system before work continued on the remainder of the building. Under floor air distribution supplies the first three floors of offices, allowing for individual user control and flexibility for future reconfiguration.

BUILDING ASSESSMENT

The use of a variety of assessment tools allows GSA to compare methodologies and study the most appropriate metrics and indicators of sustainability from various perspectives, both nationally and globally. The Arraj Courthouse has been evaluated with multiple tools to better understand the design features and performance.



LEED Green Building Rating System

As a forerunner of green design, the Arraj Courthouse preceded the LEED rating system and GSA's requirement for certification. An attempt to gather LEED documentation after completion of construction was not successful, proving that new construction certification is more likely when begun in the early stages of a project. The building is currently working toward certification through LEED for Existing Buildings: Operations and Maintenance.

Green Building Challenge

In 2005, GSA participated in the Green Building Challenge, an international collaborative effort to evaluate and improve the performance of buildings worldwide, by assessing the design phase of the Arraj Courthouse using the Green Building Tool, now called the SBTool. The Green Building Challenge seeks to advance building environmental performance assessment methodologies through addressing state-of-the-art or controversial aspects of building performance and presenting the findings of buildings from participating countries at the World Sustainable Building Conference held every two to three years.

The SBTool is an extremely challenging system with few if any buildings reaching the top score. The Arraj Courthouse scored the highest in the Long Term Performance category, primarily due to the 100 year life expectancy, and scored the lowest in Social and Economic Aspects, a category not currently addressed in LEED. Site Selection, reflecting GSA's emphasis on urban development, scored well as did Indoor Environmental Quality, but as a whole the building fell short of best practices of the world's greenest buildings.



left: **DISPLACEMENT VENTILATION THROUGH A RAISED FLOOR COVERED WITH CORK PROVIDES QUIET FOR COURTROOM PROCEEDINGS.**

above: **ROOFTOP BUILDING INTEGRATED PHOTOVOLTAICS AND A SUNDIAL BASK IN THE DENVER SUN.**

Post Occupancy Evaluation

GSA also evaluated the Arraj Courthouse using WorkPlace 20•20 research tools. The two components include a workplace satisfaction survey developed through the University of California Berkeley's Center for the Built Environment (CBE) and physical workplace measurements developed in partnership with Carnegie Mellon University. Questions in the web based survey address thermal comfort, air quality, acoustics, lighting, cleanliness, spatial layout, and office furnishings, and relate physical conditions to their effect on work experience. The physical measurements were gathered from a compact kit of mobile instrumentation that objectively measures acoustics, temperature, humidity, glare, VOCs, particulates and other indoor environmental quality factors. The results are analyzed and compared to accepted industry standards to validate the design intent and the successful achievement of green building operational performance.

Observations from the Arraj Courthouse studies show:

- The Arraj Courthouse has higher occupant satisfaction levels than both LEED and non LEED buildings in the CBE database.
- The lighting satisfaction scores for the Arraj Courthouse are much higher than the average, suggesting that daylight, when properly controlled, can have a significant positive effect.
- Compared with the air quality satisfaction score for all LEED buildings in the CBE database, the Arraj Courthouse had higher satisfaction levels. Potential reasons for the improved satisfaction scores are reduced VOCs or particulates related to material selection, improved ventilation and the use of an under floor air distribution system. Further research is needed to clarify the causal relationships between environmental factors and air quality perceptions.



CHALLENGES AND OPPORTUNITIES

“Asking useful questions and interpreting the responses in a meaningful way requires a lot of knowledge. Even researchers who study these issues intensively still have more questions than answers about the complex interactions between material flows and the environment, and between indoor chemical emissions and human health.”

NADAV MALIN
BUILDINGGREEN, INC.

The array of products that go into the manufacture of materials and the construction of buildings today is daunting. Is it safe or not? Is it sustainable or not? Construction material selection can be a challenge but it is also an opportunity for meaningful action.

Two broad considerations are part of materials selection—sourcing and end of life—and each has significant environmental impact. Billions of tons of raw materials are used to construct buildings and to manufacture the furnishings inside them. Eventually, too many of them end up in landfills. For example, EPA estimates that nearly 5 billion pounds of carpet end up in landfills annually. The better strategy is to minimize the use of virgin materials and extend all materials’ service life through planned reuse.

IS IT GREEN?

A sustainable materials selection strategy identifies and considers all product attributes important to the project, and supports the criteria of the Guiding Principles for Federal Leadership in High Performance and Sustainable Buildings from EO 13423 by reducing the environmental impact of materials. It also aligns with important Federal mandates: the Federal government’s Environmentally Preferable Purchasing program, EPA’s Comprehensive Procurement Guidelines and USDA’s BioPreferred products.

left: WHITE PAINT AND GLASS STAIR RISERS
LIGHTEN THE EFFECT OF THE STAINLESS
STEEL WALL AND UNGLAZED FLOOR TILES
OF THE MONUMENTAL STAIR OF THE MORSE
COURTHOUSE, EUGENE, OREGON.

INFO: Executive Order 13423: Strengthening Federal Environmental, Energy, and Transportation Management

INFO: Environmentally Preferable Purchasing – www.epa.gov/epp

INFO: Comprehensive Procurement Guidelines – www.epa.gov/cpg

INFO: USDA BioPreferred Program – www.usda.gov/biopreferred

Materials



“We believed that a noble material [granite] was essential and that the buildings should be of classic design and of the same scale.”

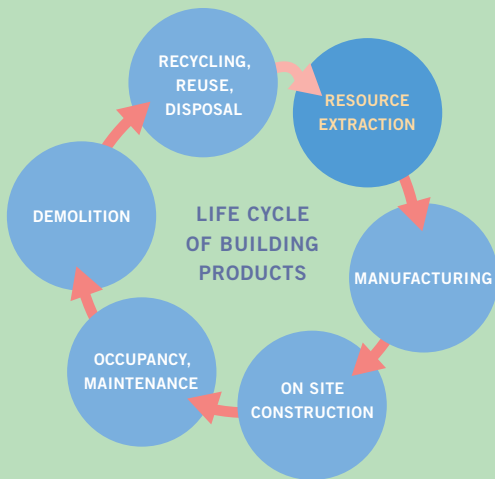
**ARNOLD W. BRUNER, ARCHITECT,
CLEVELAND FEDERAL BUILDING
[METZENBAUM COURTHOUSE].C.1910**

Designers have traditionally focused on the core material characteristics—function, aesthetics, availability and cost—and rightly so. They remain the cornerstone of product selection; without them, inappropriate and costly materials will prematurely be sent to the landfill as building occupants tire of non-performing products. This perpetuates unnecessary consumption and adds undue stress on available material and energy resources.

New thinking integrates sustainability issues into the decision-making process. The basic list of questions is deceptively short but the answers to each are extensive.

- Do I need to use it at all?
- Where did it come from?
- What is it made of?
- How was it made?
- How is it maintained?
- Is it safe?
- How much energy and water does it use?
- What happens to it at the end of its life?
- How do I know you're telling me the truth?

By drilling down into the complexities, the questions begin to delve into specifics. For example, “where did it come from” addresses the extraction, processing, and manufacturing for finished products as well as their component parts. Were they locally or regionally sourced or have they accumulated embodied energy by traveling long distances? For complicated products, the research can be exhaustive; even simple products, such as certain types of glass, require finding out where the *sand* came from.



By looking at some of the other questions prompted by those listed above—

- Does this material support design strategies for heating and cooling the project?
- Will it increase or decrease loads if placed in the project?
- Is this material toxic to humans or the environment?
- What is known about this material's toxicity during its extraction, processing, installation, use and disposal?
- How durable is this material?
- Can it age gracefully in the local climate?
- Does this material replace a harmful product?
- Does it reduce construction impacts?
- Does it minimize water use? Is the production of the product conducted in an environmentally or socially responsible way?
- Does the material have independent green labeling?
- And finally, how does this material uphold the goals and requirements of the project?

— it becomes apparent how complex these issues are.

Material characteristics can be readily quantified and evaluated individually but none alone provides a complete picture of the desired environmental aspects of a product. For example, some recycled content products may have higher toxicity, or some bio-based products may promote unsustainable agricultural practices. However, when these characteristics are carefully

Materials



weighed in alignment with broader environmental goals, through the life-cycle assessment (LCA) process, then the most appropriate choices can be made for any project.

The International Organization of Standardization (ISO) defines LCA as “a compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life-cycle.” LCAs can be complex to complete. When project schedule and budget permit and dependable tools are available, however, it is the best method to evaluate the environmental impact of a given product or service throughout its entire lifespan—raw material production, manufacture, distribution, use and disposal, including all intervening transportation steps. The goal of LCA is to identify opportunities to make informed choices that meet prioritized core characteristics, yet are the least burdensome to the environment. A life-cycle cost analysis (LCC) can also be used to calculate the cost of a system or product over its entire life span, and is often an easier metric to evaluate.

Different types of LCA tools are available to manufacturers, designers and specifiers. One of the first tools for assessing the environmental impact of individual materials is Building for Environmental and Economic Sustainability (BEES), developed by the National Institute of Standards and Technology (NIST). It allows users to set parameters for specific building products and compare the results against other alternatives. Another emerging tool for evaluating structural and envelope materials is the Athena Environmental Impact Estimator, developed by the Athena Institute. Their EcoCalculator is a useful tool that offers quick data on selected building assemblies.



HOW DO I KNOW YOU'RE TELLING ME THE TRUTH?

“Greenwashing” is the act of misleading consumers regarding the environmental practices of a company or the environmental benefits of a product or service. It can be a challenge to determine which environmental statements are meaningful and relevant from those that are misleading or simply false. The more informed one becomes, the easier it is to avoid being greenwashed.

When evaluating the environmental attributes of a product, consider what type of environmental claim is being made. Is a copy of the environmental standard or testing protocol readily available for review? How has the environmental standard or testing protocol been developed and who developed it? Is it possible to verify that the material actually meets the standard or passed the testing requirements? Asking questions distinguishes legitimate products, such as those that have no harmful emissions affecting indoor air quality, and those that go beyond existing forest industry protocols and truly follow sustainable forestry practices.

As a result of the doubt generated by false environmental claims exposed in the media and the sheer number of environmental claims, many materials specifiers use environmental standards, including ENERGY STAR, GREENGUARD, GreenSeal, and EcoLogo. These entities offer independent third party verification. They objectively confirm that “green” claims for a product are true and accurate through quantifiable and measurable methods and are preferable to second party certifications from industry related groups, or first party self-certification claims.

left: THE EXTERIOR CLADDING OF THE NOAA SATELLITE OPERATIONS FACILITY, SUITLAND, MARYLAND, IS LOW MAINTENANCE AND VERY DURABLE.

above: THE BREAKROOM INCLUDES RECYCLED CONTENT MATERIALS AND ENERGY STAR APPLIANCES AT THE EPA OFFICES IN POTOMAC YARD, ARLINGTON, VIRGINIA.

Materials



It is crucial when using any standard or certification that its development process is transparent. This allows free and easy access to information about the corporate and political influences and the creation of a given certification or standard. Many standard developers seek accreditation by The American National Standards Institute (ANSI), which requires openness, balance, consensus and due process. By using legitimate environmental standards and certification organizations and asking insightful questions, specifiers can be confident they are selecting quality 'green' materials.

MATERIALS EVALUATION METHODOLOGIES

To further support sustainable material selection, numerous methodologies and schools of thought have arisen. GSA encourages their use to meet Federal mandates and inform building design which can, in turn, facilitate sustainability and life-cycle cost savings. The methodologies discussed below are only a sampling of those available to support sustainable buildings. Many of these methodologies require a deeper understanding of systems that enable buildings to have greater performance and capabilities. The methodologies listed are inter-related and supportive of each other and espouse an integrated design process.

The Precautionary Principle

The Precautionary Principle is a core guiding parameter that informs other design methodologies. If the exact consequences of an action are unknown but are determined to have a high risk of negative impact, then it is better not to carry out the action than risk the uncertain, but possibly negative, consequences. It is often used to evaluate the effects specific acts have on the environment and on human health: for example, the use of phthalates in soft vinyl products.

LBC MATERIALS RED LIST OF PROHIBITED SUBSTANCES

- No added formaldehyde
- Halogenated Flame Retardants
- PVC (except in wiring applications where it is mandated by code)
- Mercury (except in low-mercury fluorescent lighting)
- CFCs
- HCFCs
- Neoprene (chloroprene)
- Cadmium
- Chlorinated Polyethylene and Chlorosulfonated Polyethylene (HDPE and LDPE are excluded)
- Wood treatments containing Creosote, Arsenic, or Pentachlorophenol
- Polyurethane
- Lead (except for solder and off-grid solar battery systems only)
- Phthalates

The Natural Step

The Natural Step is a powerful scientifically based design methodology built on a common framework of consensus and systems thinking. It is based on four system conditions: “In a sustainable society, nature is NOT subject to systematically increasing:

- 1 concentrations of substances extracted from the Earth’s crust,
- 2 concentrations of substances produced by society,
- 3 degradation by physical means, and in that society...
- 4 people are not subject to conditions that systematically undermine their capacity to meet their needs.”

The Living Building Challenge

The Living Building Challenge (LBC) is a product of the Cascadia Region Green Building Council. It goes beyond best practices and differentiates material choice priorities based on five criteria: the materials red list of prohibited substances, the embodied carbon footprint, responsible wood use, appropriate materials/service radius, and diverting construction waste from landfills. LBC materials requirements seek to remove the worst known offending materials from buildings as measured from a health standpoint, and to reduce and offset the environmental impacts associated with the construction process.

left: EPA IDENTIFIES ENVIRONMENTALLY PREFERABLE ATTRIBUTES FOR MATERIAL SELECTION IN THEIR BUILDINGS SUCH AS POTOMAC YARD, ARLINGTON, VIRGINIA.

INFO: The Natural Step – www.naturalstep.org
INFO: Living Building Challenge – www.cascadiagbc.org/lbc



Materials

Cradle-to-Cradle

Cradle-to-Cradle (C2C) is a design paradigm developed by McDonough Braungart Design Chemistry (MBDC), seeking to transform industry by creating products for cradle-to-cradle cycles rather than the take-make-waste cradle-to-grave legacy of the past. Through careful design of component materials and product assemblies, the product's component materials can, at the product's end of useful life, be perpetually circulated for reuse in closed loops. This maximizes material value without damaging ecosystems. MBDC offers material and product certifications through the C2C process.

PHAROS

The PHAROS protocol developed by the Healthy Building Network is a valuable framework for evaluating sustainable materials and a progressive building material assessment tool. Products are evaluated for progress toward ideals in three defined measurement categories: impact on health and pollution, resource attributes and social and community factors.

Dematerialization

Dematerialization aims to produce the same quality of life while using significantly fewer resources. Given a particular building material, dematerialization guides a series of questions by assessing the need for the material to support the mission of the facility, local sourcing possibilities and durability. This relies on the inventive ability of designers to avoid raw material consumption and waste, by steadily closing material loops, by using renewable energy and renewable raw materials and by moving towards a service-oriented economy. The process goes beyond increased energy and resource efficiency but actually reduces consumption.

ELIMINATE CONSTRUCTION WASTE

At the Kluczynski Federal Building, GSA saved green by building green. Renovation contractors salvaged or recycled over 90% of all construction and demolition waste—everything from ballasts to concrete blocks—providing an excellent example of recycling through all phases of construction. The success of the project created a cultural shift in GSA's contracting procedures, which now emphasize a comprehensive construction waste management tracking system.

left: **BRICK, GLASS, AND STEEL—MATERIALS WITH ENVIRONMENTALLY FAVORABLE CHARACTERISTICS—FORM THE EXTERIOR OF THE DEPARTMENT OF HOMELAND SECURITY FACILITY IN OMAHA, NEBRASKA.**

Biomimicry

Biomimicry (from bio, meaning life, and mimesis, meaning to imitate) is defined by Janine Benyus, who coined the term, as “a new science that studies nature’s best ideas and then imitates these designs and processes to solve human problems.” Product designers have used biomimicry to produce a beetle-inspired water harvester, termite-inspired ventilation systems, mollusk-inspired fans and epoxy, abalone-inspired lightweight building materials and a fabric modeled after a lotus leaf to stay clean. The premise behind the approach is that nature has already solved most design problems.

THERE IS NO AWAY

Amory Lovins, co-founder and chairman of the Rocky Mountain Institute, estimates that 99.98% of the U.S. materials flow is pure waste. A large portion of all consumer goods manufactured is thrown away within one year. Statistics aside, there is no “away” and material not recycled or reused ends up in an incinerator or landfill. Neither is a good choice.

Building designers make choices based on many criteria; amongst them should be end-of-life considerations. The Natural Step suggests, “The design and use of materials in the building will meet the following in order of priority:

- A** Material selection and design favor deconstruction, reuse, and durability appropriate to the service life of the structure.
- B** Solid waste is eliminated by being as efficient as possible, or
- C** Where waste does occur, reuses are found for it on-site, or
- D** For what is left, reuses are found off-site.
- E** Any solid waste that can not be reused is recycled or composted.”

INFO: Biomimicry – www.biomimicry.net

ADAPTING THE OLD AND PLANNING FOR THE FUTURE

According to GSA Associate Tammy Eatough, older buildings are more adaptable. If they've survived the first 80 years they are likely to go on for many more. The renovation of the historic Scowcroft building in Ogden, Utah, preserved 100% of the shell and 50% of the non shell and diverted close to 76% of construction waste through an effective waste management plan. The tenant agency, anticipating the need for flexibility during their 20 year lease, included a raised floor system to accommodate the changing needs of current and future tenants.

REUSE REDUCES WASTE

The Howard M. Metzenbaum U.S. Courthouse in Cleveland, Ohio, emphasizes the GSA priority to reduce waste by preserving 100% of the existing structure and shell. Existing glazed brick in the atrium, not available in today's market, was salvaged for reuse. Historical chandeliers in the main lobby, courtrooms, and judges' chambers were refurbished for reuse. Original marble stock stored in the basement was reused for patching floors and wainscots. Resource reuse on this project even includes artwork! The Francis Millet murals original to this building were found, restored and reinstalled in the public areas.



Plan to Minimize Waste

Design projects for deconstruction and reuse to allow the possibility for continuing the useful life of the materials. This approach considers both the whole building design and construction process, incorporates disassembly, and makes continued reuse or renovation more cost-effective. While designing, ask if this material will be able to withstand reuse? What attachment or assembly method is most appropriate to enable reuse? How could salvaged materials be incorporated into a new construction project, and the handling of the materials themselves? The premise of Repeat, Rethink, and Renew informs the design.

Also consider designing for modular construction, often a missed opportunity. It can enable a facility to adapt to changes over time and can enhance the quality control of construction through assembly in controlled conditions. Using demountable rather than constructed walls is an example.

A durability plan informs material and systems decisions, assessing potential risk factors and damage functions. Once identified, measures can be incorporated into the building design to address the risk factors. This process follows every phase from pre-design to building occupancy. Durability plans consider effects related to moisture, heat, sunlight, insects, material failure, ozone and acid rain, building function, style and natural disasters.



CASE STUDY: MATERIALS

Carl T. Curtis Midwest Regional Headquarters of the National Park Service

A SHINING EXAMPLE

The Carl T. Curtis Midwest Regional Headquarters of the National Park Service (NPS) in Omaha, NE, serves both as the agency's regional headquarters and as the visitor center for the Lewis & Clark National Historic Trail. NPS's core mission of preserving the natural resources of America, and its location on the Missouri River, dictated that the headquarters serve as an exemplar of sustainable materials selection. In pursuit of those goals, rangers at the visitor center not only lead discussion groups, which provide insights into the Lewis and Clark Trail, but also offer an educational program that shares the story of NPS's success in sustainable building design.

left: LOCALLY SOURCED AND MANUFACTURED
MATERIALS HIGHLIGHT THE CURTIS NPS
REGIONAL HEADQUARTERS, OMAHA, NEBRASKA.

GSA LEED BUILDING

NATIONAL PARK SERVICE MIDWEST REGIONAL HEADQUARTERS

OMAHA, NE

LEED NC rated: May 3 2005

GOLD

| | | |
|------------------------------|-----------|----|
| Sustainable Sites | 8 | 14 |
| Water Efficiency | 4 | 5 |
| Energy and Atmosphere | 6 | 17 |
| Materials and Resources | 6 | 13 |
| Indoor Environmental Quality | 11 | 15 |
| Innovation and Design | 5 | 5 |
| | 40 | 69 |

GREEN FACTS

- 39%** water savings from low flow fixtures, dual flush toilets, and waterless urinals
- 59%** wood from Forest Stewardship Council (FSC) sustainably managed forests
- 100%** green power purchase for more than two years

The GSA solicitation required a 68,000 square foot building and LEED certification at the silver level, making it the first LEED building in the state of Nebraska. The lease construction project, completed in 2004, exceeded expectations and actually achieved a LEED Gold rating. Features contributing to its success include extensive use of daylight, self sufficient landscaping, a rain garden or bioretention pond, under floor air distribution and sustainable material choices throughout the three story building.

Starting with the building envelope, the design team selected pre cast panels with a high insulation value and a reflective, light colored, single ply thermoplastic roof to lower energy costs. In addition, the panels reduced





left: NORTH FACING WINDOWS OVERLOOK THE ENVIRONMENTALLY APPROPRIATE LANDSCAPING.

above: STAINED AND POLISHED CONCRETE FLOORS BLEND WITH NATURAL STONE IN THE LOBBY.

overall material costs, serving both as interior and exterior walls. The interior also features low maintenance exposed structural concrete.

The use and prominent placement of local materials is evident throughout the project, including the Kansas limestone in the lobby, quarried within 500 miles of Omaha. In all, 35% of project materials were manufactured locally, and 17% were extracted from local sources. The designers specified paint rather than wall covering and stained concrete floors instead of tile or carpet in areas of high traffic, reducing both material use and maintenance costs. The carpet covering the raised floor tiles is a low profile, uncut loop carpet tile, making it easier to clean and more adaptable over the life of the building.

Almost 60% of the wood used for the project, including the maple trim and millwork, are Forest Stewardship Council (FSC) certified, which provides a full chain of custody and guarantees global forest practices that exceed industry best practices. In addition, 12% of the project materials by cost contain recycled content, from the restroom lavatory countertops to the carpet. Furniture systems and seating are GREENGUARD IAQ certified for low emissions and all of the carpet, adhesives, sealants, and paints meet the low volatile organic compound (VOC) requirements of Green Seal Standard GS 11 and the South Coast Air Quality Management District Rule 1113, ensuring better air quality and a healthier working environment for building occupants. The furniture is also adaptable and can be reconfigured, recovered, and painted to suit changing needs over the life of the building.

In summary, the project serves as a shining example of how material selection strategies can support sustainable design, adaptability, and a healthy workplace, while reinforcing the mission and image of the National Park Service.



O&M DELIVERS THE PROMISE OF GOOD DESIGN

Designing and building a high-performance green facility is of little use if it is not operated and maintained in a manner consistent with the principles of sustainability. Operations and maintenance (O&M) include the day-to-day activities necessary to meet an existing building's functional requirements, its routine maintenance, repair of the building and its systems, cleaning, care of the grounds, and all those services and activities necessary to preserve the value of the asset. Viewed from the perspective of sustainability, O&M's ultimate goal is to perform these activities and services efficiently and with as little impact as possible on the occupants of the building, the personnel performing the work, and the environment itself.

Operations and maintenance procedures are important for the building and facility managers; however, the O&M planning preferably begins during the design phase as part of a fully integrated, whole building approach and continues throughout the life of the building. An O&M plan, or Building Operating Plan, is required for each facility and must cover the overall goals, procedures and schedules as well as describe the strategies for ongoing site issues, construction and renovation procedures as they effect the building's systems and materials, occupant health, comfort and enjoyment, and cost considerations. A checklist is a good operational tool for managing regular inspections, maintenance and repairs.

In this O&M chapter, the discussion is focused on what can be accomplished during the operation of a building and the implications for renovation. To provide an overview of operations and maintenance in one chapter, we have summarized at a high level the details contained in the chapters on energy, materials, indoor environmental quality, and site.

left: ENVIRONMENTAL INITIATIVES AT THE SAM NUNN ATLANTA FEDERAL CENTER RESULTED IN GREEN PURCHASING, INCREASED RECYCLING, AND AN ENERGY STAR SCORE OF 81.



SITE

The operation and maintenance of the exterior begins with evaluating the site, including the landscape and hardscape (any non-plant element such as paving, walkways, walls and fences). The preferred strategies for managing the grounds and the building's exterior are those that have the lowest possible environmental impact. They include heat island effect reduction, stormwater management, light pollution, integrated pest management, transportation issues and responsible grounds upkeep.

An important aspect of site O&M management is minimizing the impact of the heat island effect—the term used to describe an increase in urban temperatures as a result of the absorption of the sun's energy by a building and its hardscape. For non-roof areas, the use of light-colored/high-albedo materials will reflect, rather than absorb, the sun's heat, but care must be taken as they may also contribute to annoying excess glare. Replacing asphalt surfaces in parking lots with permeable and/or open grid pavers will also reduce heat absorption. Shading devices are another effective solution for parking areas, and may include solar panels (although this is, admittedly, an initially expensive option). Improving the landscape by planting trees is a simple way to lower temperatures during the summer, reduce the heat island effect and provide shaded outdoor areas for the building's occupants to enjoy.

When renovating roof areas, the heat island effect can be reduced by choosing only ENERGY STAR roofing materials or by installing a planted roof (refer to the Site and Water chapter for details). Also, roofing products are available, including biobased coatings, which can be sprayed as a topcoat to provide a higher reflectance value. The "Cool Roof" guidelines published by DOE provide multiple options and solid advice.



left: TREES AND LIGHT-COLORED PAVEMENT
REDUCE HEAT GAIN IN THE CENTRAL PLAZA
OF THE PATENT AND TRADEMARK COMPLEX
IN ALEXANDRIA, VIRGINIA.

above: BIKE RACKS AT THE SEATTLE COURTHOUSE
ENCOURAGE BUILDING USERS TO BICYCLE
TO WORK RATHER THAN DRIVE.

O&M site management should consider a variety of innovative techniques to manage stormwater. Implement strategies that allow stormwater to filter slowly into the ground by using rain gardens, catchments, or swales. Rainwater can be captured and used for irrigation or flushing toilets. Look for ways to keep water away from the building, by redirecting downspouts, curbs and gutters to drain into retention areas.

Light pollution is defined as site and building lighting that spills onto adjacent properties and degrades the night sky. Lighting sources should provide only enough illumination to maintain safe lighting levels without trespassing on other areas of the site, or adjacent properties. Many manufacturers make fixture models that meet these objectives and additional resources are available from the International Dark-Sky Association.

Integrated pest management (IPM) provides for the management of outdoor pests—be they plants, insects, or animal—without endangering human health and the surrounding environment. IPM improves economic returns through the use of minimum application rates, selection of the least-toxic chemical pesticides and herbicides, and localized applications for targeted species. As with most O&M practices, IPM requires routine inspection and monitoring.

Transportation impacts are usually addressed during the site selection process rather than as an ongoing operations issue, but an alert building manager can often discover ways to support preferred tenant behaviors. These include offering preferred parking to carpools and alternative fuel vehicles, and encouraging the use of bicycles by providing secured bike racks and shower facilities. Also, promoting the use of public transportation through commuter benefit plans helps to defray tenants' costs and reduce parking demands.

INFO: Cool Roofs – http://www1.eere.energy.gov/femp/procurement/eep_roof_products.html

INFO: International Dark-Sky Association – www.darksky.org

Operations and Maintenance



It is important for the Building Operating Plan to include everyday maintenance and seasonal procedures such as using biodegradable cleaning agents and salt-free snow and ice removal. Choosing fuel-efficient maintenance equipment that operates at low sound levels—preferably fewer than 70 decibels—diminishes the excess noise that is damaging to the equipment operator and annoying for the employees of the building or nearby neighbors.

WATER

Executive Order 13423 requires Federal agencies to reduce their water consumption by 2% per year based on their 2007 baseline. To help achieve this requirement, building managers should inventory all plumbing fixtures to determine if they meet the Energy Policy Act 1992 water requirements. A plan should then be developed to replace or improve fixture performance to meet agency goals. In addition, consider the use of sensors, aerators, waterless urinals, high-efficiency toilets and other strategies described in the Site and Water chapter.

ENERGY

Reduced energy use through operations and maintenance initiatives is one of the best ways to meet agency energy goals in existing buildings. Include a narrative in the Building Operating Plan describing the building's mechanical system, its operation, sequence of events, and predictive and preventive maintenance schedules to enhance overall energy efficiency. The plan, outlining energy design intent, should be made available to everyone on staff to ensure that the building is operated as its designers intended.



Using a systematic process, the plan defines the operation of the building's major energy systems, options for optimizing the building's energy performance, and strategies to achieve energy savings. It should include items like mechanical set points, equipment run times, occupancy schedules, and lighting levels. Building Automation Systems (BAS) are an effective way to implement the plan with minimal effect on the workload of the O&M staff. If feasible, BAS should control all equipment and as much lighting as possible; if not, install individual controls. Building managers should also analyze energy bills and initiate periodic energy audits.

Executive Order 13423 requires that all Federal agencies reduce their energy use 3% per year based on 2003 baselines. Once individual building baselines are established, ENERGY STAR's Target Finder tool can assist with setting the targets outlined in the EO or aim for at least a 30% reduction by 2015. These achievements can be verified by submitting the documentation necessary for an ENERGY STAR building label. Refer to the Duncan Federal Building case study at the end of this chapter for an example of the process.

A plan for retro-commissioning, re-commissioning, or ongoing commissioning will produce considerable savings by implementing both minor improvements and identifying planned capital projects, ensuring that the building's major energy-using systems undergo repair, operation, and maintenance to optimize energy performance. Commissioning can also be used to address changes in building occupancy and use as well as identify periodic adjustments and procedures essential for optimal energy efficiency. Once new adjustments and procedures are in place, building managers should review and update the Building Operating Plan.

left: **INDIGENOUS PLANTINGS REDUCE WATER CONSUMPTION AND MAINTENANCE AT THE DEPARTMENT OF TRANSPORTATION, LAKEWOOD, COLORADO.**

above: **RE-COMMISSIONING OF MECHANICAL SYSTEMS ENSURES THEY ARE OPERATING TO MAXIMUM EFFICIENCY.**

Many chillers in existing buildings still contain ozone-depleting compounds such as CFC-based refrigerants. Identify equipment using these refrigerants and plan for replacement if a financial analysis shows that a simple payback can be achieved within 10 years. If replacement is not feasible, then consider the use of suitable alternative refrigerants. In the meantime, implement measures to control leakage of CFC-based refrigerant to less than 5% per year as directed by the Clean Air Act. One strategy is to visually check valves rather than by pressure testing, which causes refrigerant to escape. Finally, manage all halogenated hydrocarbons per The Montreal Protocol on Substances that Deplete the Ozone Layer.

Another resource, the ENERGY STAR program, lists over 50 categories of products that deliver equal or better performance than non-labeled goods while using less energy. Major categories of rated products include appliances, heating and cooling, electronics, office equipment, lighting, and commercial food service.

MATERIALS

Materials issues must be considered in facility alterations typically made during the normal course of a building's life. As part of their responsibility, building and facility managers must comply with the requirements of EO 13423 as well as the requirements and best practices used in new buildings outlined in GSA's Facilities Standards for the Public Buildings Service.

Material management in the operations and maintenance of a building requires persistence, coordination and familiarity with new products and processes. EO 13423 calls for Federal agencies to acquire goods and services that follow sustainable environmental practices, including bio-based, recycled-

SAM NUNN FEDERAL CENTER
ATLANTA, GEORGIA



In 2003, the Sam Nunn Federal Center in Atlanta implemented a retro commissioning project for a total cost of about \$120,000 that now generates annual cost savings of approximately \$250,000. GSA, DOE, and EPA worked together to establish a comprehensive program to address high energy usage in the 1.6 million square foot facility. The partnership leveraged resources and skills to retro commission the entire building, with the goal of having the building qualify for ENERGY STAR certification after 12 months of demonstrated savings.

The team met regularly to analyze energy use and identify simple, low cost energy reduction modifications. These measures included metering, de lighting excessively lit areas, installing motion sensors, repairing improperly installed or broken equipment, and devising an after hours setback mode so that air handlers no longer ran around the clock. They also initiated occupant focused energy awareness programs. The retro commissioning effort reduced cooling loads, increased the efficiency of the central plant, and saved almost 12 *billion* Btu in 2003 alone enough energy to power 228 homes for a year. The team is now retro commissioning additional buildings based on the successful Atlanta Federal Center model.



content, environmentally friendly, energy-efficient and water-efficient products. A soy-based roof coating is a good example of a material with multiple sustainable attributes.

Understanding Federal purchasing requirements may appear difficult but it is no less important than meeting tenant service calls or energy efficiency targets. There are, however, helpful resources such as EPA's Environmentally Preferable Purchasing (EPP) program, which assists building and facility managers to "buy green" by offering guidance and product listings that meet Federal requirements. The program also provides calculators for cost benefit analysis and a mechanism for managing green purchasing. Ensuring that tenants know about these resources should be a part of the regular tenant communications, especially since the Energy Policy Act of 2005 requires GSA's tenants to follow the same purchasing rules when buying devices for themselves, such as light bulbs for desk lamps.

Building Standards

Establishing building standards that can be inserted into service and construction contracts is another way for building managers to encourage the purchase and use of sustainable materials. The standards may include minimum recycled content for ceiling tiles and carpet; use of high-efficiency lighting, appliances, and office equipment; reuse of furniture and other recycled or recyclable building materials; use of low-emitting paints and sealants; and wood from responsibly managed forests.

A standard to guide the purchasing and the disposal of fluorescent lamps is an example. Fluorescents are an energy-efficient light source but require



the use of mercury to function and, therefore, contaminate the waste stream at the end of their lives. Building and facility managers must take care in selecting replacement lamps to ensure low mercury content in fluorescent tubes and compact fluorescent lamps; there are a large number of products meeting this requirement. They should also match a specified color temperature to avoid a hodgepodge look over time.

Although the National Electrical Manufacturer's Association has announced a voluntary commitment to cap the amount of mercury allowed in CFLs, and mercury levels in tube lamps have been significantly reduced, the disposal of all fluorescents is still an issue. EPA imposes fines for the improper disposal of mercury-containing lamps and each building must have a hazardous waste disposal plan in place and follow it diligently.

Waste Disposal

Understanding what makes up a building's trash—differentiating between those products that are truly waste, those that are recyclable, and hazardous waste—is key to managing the waste stream. An O&M plan should require a waste stream audit as the best way to gather this information. Once completed, a tenant education program will encourage active occupant participation, increase recycling and reduce waste. In areas where recycling programs do not exist, the audit can, perhaps, spur new community action or private industry initiative by showing a need for such efforts.

left: DURABLE FINISHES ALLOW EASY MAINTENANCE OF THE PUBLIC AREA OF THE DEPARTMENT OF HOMELAND SECURITY, INS FACILITY IN OMAHA, NEBRASKA.

above: HIGH-EFFICIENCY LIGHTING IS REQUIRED IN ALL FEDERAL BUILDINGS.

FEDERAL BUILDING
RICHMOND, VIRGINIA



Small Steps To Operational Improvement

Like many older buildings the 368,588 square foot Federal Building in Richmond, Virginia, built in 1962, suffered from poor performance. From 1985 to 1994, the facility averaged 81,000 Btu/gsf/yr. After a major renovation of the HVAC system completed in 1997, energy use started to increase and by 1998, consumption was up 27% over the previous ten year average, peaking in 2000 at 152,500 Btu/sf/yr, an 88% increase. A multi year incremental renovation focused on improved operations, maintenance and equipment upgrades the result: GSA now enjoys reduced energy costs and an ENERGY STAR building.

In 2003, an operational assessment of the Energy Management Control System revealed the causes of the poor performance:

- Faulty scheduling had equipment running at night, on the weekends, and during other times when it was assumed to be off.
- System was operated above or below set points, or did not meet the load.
- Control hardware malfunctions for the air and water side economizers.
- Control loops did not function optimally.
- Building operators had permanently overridden controls.
- Interaction between the heating and cooling system was problematic.

Making Incremental Improvements

In 2004, the management team set out to resolve issues and bring the system under control. Their efforts included putting the bathroom exhaust back on schedule, lowering heating water loop temperatures, reducing HVAC system operation by one to two hours per day, trimming weekend operation, and resetting the supply air temperature to the original design of 55 F. These no cost items immediately reduced energy usage by 17.4% and saved \$25,000 per year.

In 2005, initiatives included correcting the water side economizer operation while extending hours of its use, adjusting the boiler outside air temperature set point and eliminating the overlap between simultaneous heating and cooling. These control actions reduced energy usage by 33.7% from the previous year and saved \$109,000 per year.

In 2006, the purchase of new upgraded control equipment allowed for the optimization of the overall system. The new equipment included direct digital controls with internet accessibility, custom programming and energy recovery air coils with a circulated glycol loop for the bathroom exhaust. Additionally, the steam supply pipes to the penthouse were isolated from ductwork so as not to preheat the outside air to the air handlers. Optimization of the controls included more run time of the air side economizers for the dedicated ventilation units. The reduction of energy usage was 17.6% from the previous year and provided a net \$15,000 per year savings even with the cost upgrades of \$120,000.

Efforts continued into 2007 and at year end, the total energy usage was 49,300 Btu/gsf/yr, a 19.8% reduction from the previous year. 2007 also brought an additional \$134,000 per year saved. These annual reductions are impressive improvement in the building's operations budget, but the impact is beneficial to all of GSA. EISA 2007 and EO 13423 both require energy use reduction based on the agency's 2003 baseline. The Richmond Federal Building reduced energy usage by 62% compared to its 2003 baseline, demonstrating that a steady but consistent operations and maintenance improvement plan can help GSA meet energy reduction goals and save money.



Building and facility managers should consider alternative disposal strategies for durable goods such as computers, free-standing and systems furniture, and appliances, not only because they are a burden on landfills, but also needlessly waste potentially reusable products. Several manufacturers have “take back” programs that are worth considering and in many areas of the country programs exist to recycle durable goods. Tenants can be encouraged to reuse discarded items that are still in good condition by providing a designated room or location for drop off or claiming such items. Lists of items available for reuse can be posted in the building or made available to charities in the community.

EPA's Comprehensive Procurement Guidelines (CPG) is part of the government's “buy-recycled” program. Buying products with recycled content, from carpeting and insulation to office paper helps “close the recycling loop” by reusing materials collected through recycling programs. EPA also provides Recovered Materials Advisory Notices (RMAN), which recommend recycled-content levels for CPG items.

Demolition from facility alterations should adhere to construction waste management strategies. EO 13423, for example, requires the recycling or salvage of at least 50% of construction and demolition waste. No matter how large or small the project, construction waste can be diverted from landfills through recycling or reuse. In order to assist building managers in compliance, the Whole Building Design Guide has a database of companies that haul, collect, and process recyclable debris from construction projects.



INDOOR ENVIRONMENTAL QUALITY

Indoor environmental quality (IEQ) is the final component of a successful, sustainable O&M program, and the one with the greatest potential for increasing the comfort, protecting the health and increasing the productivity of those who work in the building.

To ensure the health and well-being of a building's occupants, O&M practices should include a minimum indoor air quality performance requirement. Although ASHRAE Standard 62.1 is the standard for ventilation rates, many older buildings and equipment cannot comply. In such cases, building managers should try to achieve at least 10 cfm of outdoor air per occupant. Installing an air intake measurement device can help ensure that a sufficient amount of outdoor air enters the system. Air intakes must remain clear of debris, and be positioned away from loading dock truck exhaust, trash containers, or designated smoking areas (which should be at least 25 feet from any opening in the building's envelope).

Properly maintained filters, with a high MERV value, are also very important in meeting air quality standards. Building managers can also use EPA's Indoor Air Quality Building Education and Assessment Model (I-BEAM) a comprehensive state-of-the-art tool for managing IAQ in commercial buildings. Finally, CO₂ sensors are useful, especially in densely occupied areas, in identifying the need for more outside air. To be effective they must be placed to take measurements at human, not ceiling, height.

left: GREEN HOUSEKEEPING PRACTICES ARE ESSENTIAL IN CHILD CARE CENTERS SUCH AS THIS SSA FACILITY IN WOODLAWN, MARYLAND.

above: EXPANSIVE FLOOR SPACE AND UNDER-FLOOR AIR DISTRIBUTION ENHANCE THE FLEXIBILITY OF THE IRS PROCESSING CENTER IN KANSAS CITY, MISSOURI.

SUSTAINABLE FACILITY MANAGEMENT: THE BENEFITS

The International Facility Management Association identifies sustainable building practices that help facility managers upgrade and operate their buildings to achieve a long term human and ecosystem balance. Financial, environmental and social benefits result from:

- Lower energy and water costs
- Lower waste disposal costs
- Lower environmental and emissions costs
- Lower operations and maintenance costs
- Increased productivity of building occupants
- Increased health of building occupants
- Higher building valuation
- Positive impacts on the local and global environment from reductions in resource use, emissions, water use and waste disposal

The impact of the facility management community on the environment is profound. As stewards of the built environment, facility managers are critical to the adoption of more energy and environmental solutions.



Green cleaning is an excellent way to reduce exposure from potentially hazardous contaminants. Unlike a traditional cleaning program, green cleaning is a holistic approach to cleaning that goes beyond simple appearances and focuses on human health and environmental impacts. At a minimum, contractors can reduce exposures by limiting the amount and level of toxic and hazardous chemicals used.

Products and practices employed should follow guidelines such as Environmentally Preferable Purchasing, the Green Seal Environmental Standard for Cleaning Services, and the California Code of Regulations for maximum allowable VOC levels for each product category. Based on the Centers for Disease Control and Prevention determination, soap should not contain antimicrobial agents unless required by health codes and regulations for food service and health/fitness equipment.

All cleaning equipment should similarly follow a green standard as well as minimize the use of energy and water. Vacuums and extraction cleaners should meet the Carpet & Rug Institute “Green Label” Testing Program and have a maximum noise level of 70 decibels.

Finally, one of the simplest strategies for maintaining a clean building is to provide “walk off” areas at all entrances to the building. Such areas should have at least 10 walkable feet to remove particulates from shoes. Ideally, walk off areas will include grates, grills, or carpet mats. All must be regularly cleaned and properly maintained to remain effective. It may be necessary to change the mats depending on the season or weather conditions.

above: THE BYRON ROGERS COURTHOUSE IN DENVER, COLORADO, EARNED GSA'S FIRST LEED FOR EXISTING BUILDINGS GOLD RATING FOR OPERATIONS AND MAINTENANCE PRACTICES.

7-POINT CHALLENGE

In 2007, the Building Owners and Managers Association (BOMA) created a *7 Point Challenge* to reduce use of natural resources, non renewable energy sources, and waste production and work in coordination with building management, ownership, and tenants:

- 1 Continue to work toward a goal to decrease energy consumption by 30% across portfolios by 2012;
- 2 Benchmark energy performance and water usage through EPA's ENERGY STAR benchmarking tool;
- 3 Provide education to building managers, building owners and operators, engineers, and others involved in building operations, to ensure that equipment is properly maintained and utilized;
- 4 Perform an energy audit and/or retro commissioning of buildings and implement low risk, low cost strategies to improve energy efficiency with high returns;
- 5 Extend equipment life by improving the operations and maintenance of building systems and ensure equipment is operating as designed;
- 6 Through leadership, positively impact your community and your planet by helping to reduce your industry's role in global warming; and
- 7 Position yourself and the industry as leaders and solution providers to owners and tenants seeking environmental and operational excellence.

CONCLUSION

The impact of O&M practices and policies now extends far beyond the mechanical room and includes a very broad range of practices that a building manager can implement to achieve environmentally responsible goals. Because EO 13423 mandates that 15% of all Federal agencies' portfolios meet the requirements of the Guiding Principles for High Performance and Sustainable Buildings by 2015, the importance of sustainable O&M practices can only increase.

What's more, as many existing buildings are not likely to be renovated in the near future, the most sensible approach may be the slow but steady returns of an O&M program focusing on continual improvement. The use of new planning techniques, such as integrated design charrettes, have helped building and facility managers devise and implement successful O&M strategies that balance cost and tenant satisfaction with environmental responsibility.



right: ATTRACTIVE AMENITIES IN A COURTYARD OF THE IRS CAMPUS IN KANSAS CITY, MISSOURI, EXPAND THE FACILITY'S USABLE SPACE TO OUTDOORS.



JOHN J. DUNCAN
FEDERAL BUILDING
710 LOCUST

CASE STUDY: OPERATIONS AND MAINTENANCE

John J. Duncan Federal Building

AN EXISTING BUILDING: ACHIEVING SUSTAINABLE EXCELLENCE

The John J. Duncan Federal Building in downtown Knoxville, Tennessee, is a six story, 172,683 square foot structure with two underground parking decks. The building houses seventeen Federal agencies and the Knoxville Satellite Office of GSA's Nashville Service Center manages the building. Although it was not designed and constructed as a green building in 1988, the Duncan Federal Building is an excellent example of achieving sustainable excellence through operations and maintenance.

GSA LEED BUILDING

**JOHN J. DUNCAN
FEDERAL BUILDING**
KNOXVILLE, TN

LEED EB rated: Jan 4, 2007

CERTIFIED

| | | |
|------------------------------|-----------|-----------|
| Sustainable Sites | 6 | 14 |
| Water Efficiency | 2 | 5 |
| Energy and Atmosphere | 15 | 23 |
| Materials and Resources | 3 | 16 |
| Indoor Environmental Quality | 5 | 22 |
| Innovation and Design | 3 | 5 |
| | 34 | 85 |

GREEN FACTS

95% Energy Star score

50% water use reduction

100% occupancy rate after
renovations

This building was an average energy and water performer until the building's manager, Johnathan Sitzlar, set out to meet both the requirements of Executive Order 13123 and GSA's 2005 fiscal year energy targets. The first step was putting together a diverse team of professionals, GSA associates and contractors. Together they developed a master plan for the building that started with an energy audit, continued with a careful analysis of its findings, and then proceeded to prioritized implementation.

The Duncan Building team exceeded 2005 energy reduction goals by 33%, achieved an ENERGY STAR rating of 94, and began to utilize green energy sources for electricity in place of coal. In addition, they reduced water usage by 400,000 gallons per year.

A parallel challenge – LEED for Existing Buildings (EB) certification – proved to be a formidable one. The team had to draw on the diverse creativity of its members to achieve the desired rating. However, working through the LEED EB process caused them to broaden their environmental initiatives, better engage the tenant agencies, and in the end, provide superior workplaces. The success of the approach is evident in the building's 100% occupancy rate, and in its 91% customer satisfaction score. The fundamental steps used by the Duncan team are an instructive lesson in greening an existing building.



Energy

GSA, the Department of Energy's Atlanta office, Oak Ridge National Laboratory, the University of Tennessee Energy, and the Environmental Resource Center used a team approach to conduct energy audits. Executive Order 13123 required GSA to reduce 2005 energy usage by 30% below 1985 levels. For the Duncan Building, this meant a target of 52,499 Btu/gsf. Actual usage was 35,693 Btu/gsf in 2005, exceeding the Executive Order goal by 33%. Further, GSA also purchases renewable energy in blocks from the Tennessee Valley Authority and the Knoxville Utility Board to provide Green Power derived from wind, solar and methane.

Retro-commissioning

The Duncan team quickly saw that their best opportunity at complying with Executive order mandates was through a comprehensive retro commissioning of the building's operating systems and the procurement of a new Building Control System (BCS). The BCS is the computerized central system responsible for maximizing energy efficiency, controllable from a single on site location. In particular, the maintenance staff uses the system to maximize efficiency of the HVAC system, establish cost effective machine run times, use outside air to meet the demands of the building, immediately pinpoint problems in all systems, and produce numbers for trend data analysis in order to improve operating decisions.

Systems that were retro-commissioned and connected to the BCS include: lighting on all floors, all variable frequency drives, chillers, boilers, cooling towers, garage exhausts, restroom exhausts, air handling units, the building economizer,



and all package and split units, as well as the domestic hot water loop. The BCS itself is tied into two real-time local utility meters that provide time-specific energy load data. Furthermore, an Internet portal allows the system to be integrated into the region's enterprise-wide management system, allowing for continuous monitoring and remote support to ensure its sustained performance.

Lighting Upgrades

Pre retrofit lighting consisted of magnetic ballasts and F40 bulbs. Favorable life cycle cost analysis enabled GSA to obtain funding for upgrading the building's 1,536 lighting fixtures to electronic ballasts and T 8 bulbs, and to replace incandescent lamps with compact fluorescents. Also, motion detectors control the lighting in restrooms, conference rooms and other non regularly occupied spaces.

Water Conservation

By installing secondary meters on the exterior landscaping water lines, GSA demonstrated to the local utility company that water was being diverted from the waste stream and the agency was able to reduce its sewage utility bills. Fourteen waterless urinals installed in the restrooms provide water free usage. The team also changed all 2.5 gallon per minute (gpm) faucet aerators to those using 0.5 gpm.

Equipment Replacement

In order to further reduce energy and water consumption, it was necessary to identify the most environmentally sound means of upgrading the building's existing cooling tower, already scheduled for replacement. The existing cooling tower used two 15 horsepower motors and lost excessive amounts of



left: THE DUNCAN RENOVATION INCLUDED REPLACING THE COOLING TOWER WITH A SUPER EFFICIENT CHILLER HALF THE SIZE.

above: SUSTAINABLE OPERATIONS AND MAINTENANCE PRACTICES EXTEND BEYOND THE BUILDING TO ENHANCE A NEIGHBORHOOD PARK.

water due to overspray. The new tower incorporates premium efficiency fill, and uses two premium efficiency 7.5 horsepower motors. Together, they have significantly reduced total operating time, and thus the load on the building.

Recycling

Through office waste recycling programs, construction material recycling, and educational programs for the tenants, the Knoxville team reduced waste destined for landfills by 40%. In 2005, the team diverted 13.75 tons of white paper and over 300 pounds of aluminum from the landfills. Through a joint effort between the University of Tennessee and GSA, moving boxes and telephone books given to the local school system provide additional funding to the school system through their recycling efforts. They also diverted nearly 12,000 square feet of carpet removed from renovated tenant spaces from the landfill. Using new technology, a local contractor was able to convert the old carpet into reusable carpet tiles for the local Knox County School System, saving the school system nearly \$24,000 and saving GSA construction waste fees.

Green Space

The site includes a large amount of green space, providing one of the nicest courtyards in downtown Knoxville, and heat island reduction for the city's center. As part of its plan, the team installed recycled, post consumer plastic benches under the canopy and the landscapers used recycled tire mulch in place of wood based mulch. (Recycled tire mulch diverts tires from the landfill and does not fade or deteriorate.) A cost analysis confirmed savings of \$30,000 to \$35,000 over the nine year contract.

Compared to an average building, this building saves the equivalent of about 91,000 gallons of gasoline per year, or the amount of fuel required to drive 216 million automobile miles per year. Another perspective would be to say that, compared to an average building, savings here is the electricity equivalent of 18 train cars of coal if their contents were burned to make electricity.

JIM POWELL, REGIONAL DIRECTOR,
DEPARTMENT OF ENERGY

Institutionalization

Within GSA Region 4, energy reduction measures in this facility now serve as best practices for a variety of common agency contracts.

Maintenance

By working closely with contractors and tenants, GSA proposed green cleaning and integrated pest management as a no cost enhancement of its services. Additionally, the region developed maintenance contract language that called for more stringent maintenance schedules, more sustainable processes in building renovation, and the use of more environmentally sound building materials. This language now serves as the model for new maintenance contracts throughout the region.

Tenant Meetings

The team took particular care to ensure that the tenants were educated about the changes going on in the building. Regularly scheduled meetings serve as change management sessions and address such issues as:

- material reuse and recycling
- safety issues
- energy conservation – turning off lights, discouraging the use of personal heaters, unplugging equipment
- green cleaning with biodegradable products that lack both the side effects of standard commercial cleaners and the perfumes that many people associate with clean



ENERGY SAVINGS

Baseline Usage (FY 2004):

1,931,040 kWh/year

Electric Usage (FY2005):

1,640,880 kWh/year

Annual KWH Savings:

290,160 kWh/year (15% Decrease)

Total Energy Savings:

1,177 MMBtu including gas

Annual Energy Cost Savings: \$15,570

WATER SAVINGS

Savings: 400,000 gal/year \$22,619/year

Meter data not available

ENVIRONMENTAL BENEFITS

Recycling: 40% waste diversion from landfill

Renewable Energy: 97,200 kWh per year

equivalent to 27 acres of trees,

recycling 432,864 aluminum cans,

or recycling 47,682 pounds of paper

CO₂ Reduction: 1,452,759 kg

SO₂ Reduction: 4,296 kg

SO_x Reduction: 3,049 kg

SIMPLE PAYBACK

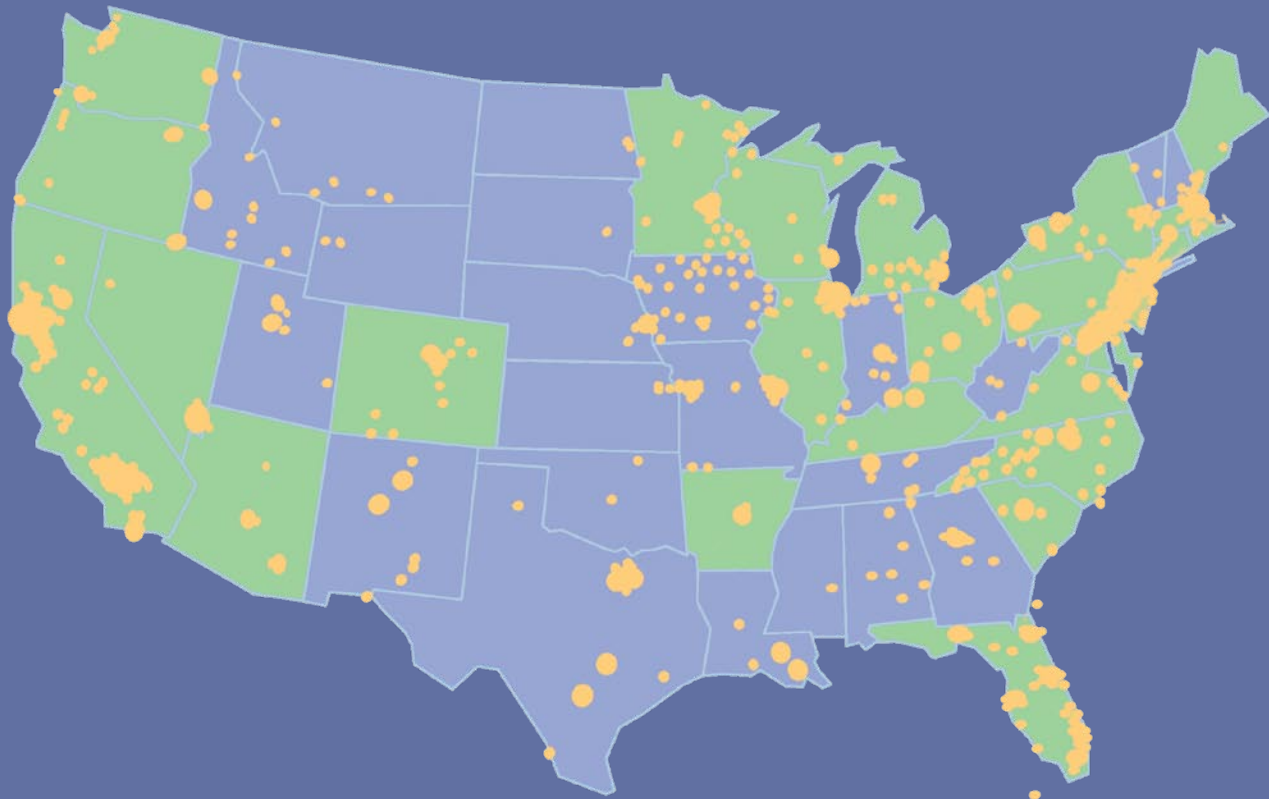
3.7 years on \$142,000 cost for

water and energy measures

The meetings also promote new ideas such as alternative modes of transportation, electrical outlets for alternative fuel vehicles, and bicycle racks as well as valuable public relations and employee benefit initiatives. In 2005, to maximize the use of public transportation, the team arranged for the Knoxville Area Transit Authority (KAT) to provide a free ride share program. Now, tenants can ride the KAT buses for free from different locations throughout Knox County.

CONCLUSION

The GSA Duncan building team succeeded by taking a holistic approach toward reducing the environmental impact of their facility, and in so doing, exceeded the objectives of Executive Order 13123. They also received a Federal Building Showcase Designation, and LEED EB certification.



- Municipalities that signed U.S. Conference of Mayors Climate Protection Agreement
- States with signed green building legislation

Beyond GSA: The Greening of America

THE PROLIFERATION OF GREEN

Aristotle said, “We are what we repeatedly do.” If this is so then the United States is edging ever closer to becoming a green nation. Environmentalism is proliferating—in buildings, the popular media, state and local governments, non-government organizations (NGOs), corporations and industry.

Consider these private sector initiatives as just a few recent examples.

- CB Richard Ellis announced it would become carbon neutral by 2010 at the more than 5 million square feet it occupies worldwide.
- Wal-Mart, the world’s largest retailer, has asked its 60,000 suppliers to reduce packaging by 5%, avoiding millions of pounds of trash in landfills and 667,000 metric tons of carbon dioxide in the atmosphere.
- Home Depot, another retailing giant, launched EcoOptions to identify environmentally preferable products. More than 2,500 products are labeled.
- PNC is the first U.S. bank to apply green building standards to all newly constructed or renovated retail branch offices and has more certified “green” buildings than any other company in the world.
- Delta Airlines offers passengers the option to buy carbon offsets for their trips at the same time that they buy their tickets through a donation to The Conservation Fund’s tree-planting program.

EARLY INFLUENCERS

Our national focus, triggered by global warming awareness and the desire to become energy independent, may be a recent phenomenon, but its roots can be traced back to multiple sources over many decades. Prominent among them is the role of the Federal government, including EPA, DOE, GSA and the Executive orders, programs and policies mentioned throughout this book. However, other entities, both public and private, have played roles as well.

State and Local Governments

Local jurisdictions have been especially proactive in enacting green initiatives. Early adapters include the City of Austin, which founded its Green Builder Program in 1991 and the City of Seattle's inter-departmental committee, which partnered with municipal utilities to develop its Sustainable Building Action Plan in 1997. In New York City the Office of Sustainable Design published the High Performance Building Guidelines in 1999 that became a respected green building reference. Major U.S. cities, including Boston, San Francisco and Washington, DC, have recently mandated green commercial development.

An early adopter of green building policies and initiatives, Arlington County, Virginia, with its somewhat high density but well-managed smart growth, has served as a model for other communities looking to improve their environmental programs and achievements.

On the state level, the Maryland Environmental Service, established in 1970 to protect and enhance the state's air, land and water resources, has expanded and continues its work today. The Commonwealth of Pennsylvania established the Governor's Green Government Council by Executive order in 1998 to help the government and its agencies achieve environmental sustainability. California's low emission targets are influencing action in other states and its Collaborative for High Performance Schools, popularly known as CHPS, is a design guide that has found a national audience.



“My goal has always been for USGBC to make the term ‘green building’ redundant—because all buildings will be green.”

**RICK FEDRIZZI, CEO,
FOUNDING CHAIRMAN, USGBC**

Non-Government Organizations

Worldwide there are literally hundreds of thousands of non-government organizations (NGOs) advocating for environmental causes. Some, like Natural Resources Defense Fund, The Sierra Club, Greenpeace and the World Wildlife Fund are well known; others are more obscure. Several NGOs have made significant contributions to the built environment.

USGBC

As early as 2002, the *Wall Street Journal* attributed the tremendous rise in environmental consciousness to the work of the U.S. Green Building Council. Certainly before its founding in 1993, the term “green building” was not commonly recognized or used. Today, with more than 16,000 member companies and organizations and a diverse portfolio of LEED green building rating systems, USGBC provides the industry a national standard rating system for the development, operations and management of high-performance sustainable buildings. It has come to serve as the primary forum for ongoing consensus-based, industry-wide discussions of improvements to green building standards and the vetting of new—or controversial—issues. The Council’s annual Greenbuild conference is the world’s largest dedicated to green buildings; and 70 local chapters and affiliates support USGBC activities nationwide.

ASHRAE

Best known by its acronym, the American Society of Heating, Refrigerating, and Air-Conditioning Engineers influences the design and construction of buildings through the widespread use of its standards. Founded in 1894, ASHRAE is an international technical organization that provides research, knowledge and guidance to help ensure energy-efficient, comfortable and

left: ARLINGTON COUNTY, VIRGINIA, WAS ONE OF THE FIRST COUNTIES TO EMBRACE GREEN BUILDING PRACTICES IN BUILDINGS LIKE THE WALTER REED COMMUNITY CENTER.

INFO: U.S. Green Building Council – www.usgbc.org

safe indoor environments. The Society publishes the ASHRAE Standards for HVAC systems and refrigerants—which are widely used in building codes—as well as the *ASHRAE Handbook*, a four-volume resource manual, and the *ASHRAE Journal*, a monthly magazine with peer-reviewed articles. The *ASHRAE Green Guide* offers guidance on green design and tips on techniques, processes, measures and systems.

ASHRAE, in partnership with USGBC and the Illuminating Engineering Society of North America (IESNA) is developing a code-enforceable minimum guideline for green buildings. The Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings (Standard 189.1) is an effort to establish a set of code-enforceable minimum guidelines for the sustainable design, construction and operation of buildings. It is not a rating system. It will impact LEED and other rating systems and may well become a prerequisite.

AIA/COTE

The Committee on the Environment (COTE), operating as an arm of the American Institute of Architects (AIA), provides programs and services to enhance green design practices and protect the natural environment. AIA/COTE has asserted its role in green design with its annual listing of the Top Ten Green Projects, a juried competition that recognizes the best in sustainable design. The Wayne L. Morse U.S. Courthouse in Eugene, Oregon, and the IRS campus in Kansas City, Missouri are among the winners.

BOMA International

The Building Owners and Managers Association (BOMA) is an international organization founded in 1907 as a primary source of information on office



Sustainable development:
“Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”

UN REPORT OF THE WORLD
COMMISSION ON ENVIRONMENT
AND DEVELOPMENT
OUR COMMON FUTURE (1987)

building development, leasing, operating costs, energy use, codes, regulations and legislation. It has become proactive in combating the environmental and economic risks of global warming by introducing a Market Transformation Energy Plan and 7-Point Challenge, which urge building management, ownership and tenants to work in coordination with each other to reduce their use of natural resources, non-renewable energy sources and waste production.

World Business Council for Sustainable Development (WBCSD)

The World Business Council for Sustainable Development (WBCSD) is a coalition of 175 international companies united by a shared commitment to sustainable development via the three pillars of economic growth, ecological balance and social progress. This group is leading the development of the international standard for greenhouse gas measurement. The EPA uses this standard for the U.S. under its Climate Leaders program.

RECOMMENDED READING

When Rachel Carson wrote *Silent Spring* in 1962, awareness of the environmental effects of business practices was almost completely absent. In *The Ecology of Commerce* (1993) Paul Hawken predicted, “If every company on the planet were to adopt the best environmental practices of the ‘leading’ companies...the world would still be moving toward sure degradation and collapse.” By discussing environmental practices in business terms Hawken created an economic argument that has influenced change in dozens of businesses.

Reading Paul Hawken’s book, Ray Anderson, as CEO of Interface, one of the world’s largest interior furnishings companies, developed the first “how-to” plan for industry. In *Mid-Course Correction*, published in 1998, Anderson

“Sustainability, like quality, doesn’t cost; it pays. In all my business experience, I have never seen a more powerful differentiator in the marketplace.”

RAY ANDERSON, FOUNDER AND
CHAIRMAN OF INTERFACE, INC.

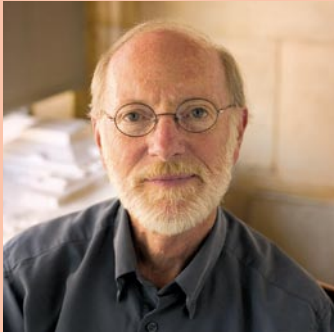
describes his company's climb up “Mount Sustainability” and its seven faces: waste elimination; benign emissions; renewable energy; closed loop material flows; resource-efficient transportation; sensitizing employees, customers, suppliers, and communities; and ultimately reinventing commerce.

The environmental movement is rich with those who have led and inspired. They include Amory Lovins, William McDonough, David Suzuki, Janine Benyus and the countless others who have contributed to the existing body of knowledge. Paul Hawken, in his latest book, *Blessed Unrest: How the Largest Movement in the World Came into Being and Why No One Saw It Coming*, looks at the continuing and serious woes affecting our planet, but its focus is on what’s right in this world. It is an examination of the movement—the “coherent, organic, self-organized congregations involving tens of millions of people dedicated to change.”

Buckminster Fuller said, “When individuals join in a cooperative venture, the power generated far exceeds what they could have accomplished acting individually.” GSA is part of and a valuable contributor to a vibrant community of players who are learning, every day, from each other. We conclude this look outside with two interviews giving a personal view of how the practice of building has changed over the past few decades.

Conversations and Reflections

BY PENNY BONDA, FASID



BOB BERKEBILE, FAIA

Things are different now in the private sector according to one of the nation's most respected green architects. Bob Berkebile, a founding principal of BNIM in Kansas City, is a leading authority in the field of sustainable design. As a true pioneer, and drawing from more than 37 years experience in architecture, Bob Berkebile is imminently qualified to assess the green building industry's best practices and recommend how GSA can learn from the private sector to better inform its own procedures.

During a recent conversation, he did just that, reflecting first on the changing nature of his own firm.

“We used to spend a lot of time at the outset of projects interviewing and educating our clients to see if we could lift their goals. Increasingly clients now call us, from all sectors—government, private, institutional—already motivated and looking for help in reaching a higher standard beyond LEED platinum. Each defines it differently but it's pretty common to be asked for help in delivering the triple bottom line—a balance between economic, ecological and social objectives. Or, clients want us to create a planning strategy for a living community or building with exemplary performance.

“The conversation is no longer just about the LEED cost premium as it once was. Clients are still interested in defining the initial increase in capital cost necessary to get a truly high performance project and how long it will take to recover their investments; however, all stakeholders—clients, architects, engineers, contractors, and suppliers—have more experience and green building cost premiums are coming down. Design teams, owners and contractors are incorporating integrated design concepts early on, which are proving to be far more efficient and economical and produce much better results.

Beyond GSA: The Greening of America



above, below: BNIM'S LEWIS AND CLARK STATE OFFICE BUILDING, MISSOURI DEPARTMENT OF NATURAL RESOURCES, IN JEFFERSON CITY, MISSOURI, RECEIVED A LEED PLATINUM RATING WITHIN A CONVENTIONAL OFFICE BUILDING BUDGET.

“GSA and other government agencies still have a barrier because, in many cases, the contractor is not part of the initial decision-making process that is creating the innovations that are going to reduce costs and increase performance. Without ownership, an adversarial relationship may develop due to a lack of alignment of goals between the construction team, the design team and the client.

“In order to optimize chances for success it’s time for GSA to reconsider its rules of engagement. Ten-year leases, for example, encourage developers to cash out at the end of the term and there’s an impact on the overall quality, durability and performance of the project. Just by considering a longer term, I believe GSA would see significant improvements in what they’re purchasing. I’d also encourage more specific performance standards that require integrated thinking, better systems and more durable materials. This would cause developers to rethink their economic models because their buildings would retain their value longer.

“We just broke ground in upstate New York on what will be our first living building and there are three more in various stages of design. A living building is one that has no net impact on the environment. It produces more energy than it consumes, purifies more air and water than it pollutes, and uses locally sourced materials so it’s not doing damage elsewhere. My vision is that the next refinement of LEED will be based on these principles of regenerative solutions and move the LEED program to beyond platinum. Since GSA was such an important leader in the early going of LEED I hope they will have a great role in taking it to the next level.”



BOB FOX, AIA

Any conversation with Bob Fox is likely to include discussions of the highly innovative green building strategies and advanced thinking that has made his firm, Cook+Fox Architects, one of the most admired in the green building industry. Many of their projects are breaking new ground, such as the Bank of America Tower in New York City, which is slated to be the first high-rise to achieve the LEED Platinum. After 43 years in practice, Fox has been witness to an evolving profession.

“There’s been a dramatic change in the practice of sustainable design that I believe can be attributed to the remarkable growth of the U.S. Green Building Council. It’s changed the language of architecture and the way architects are approaching their work.

“Our process, however, is different from that of many firms who use the LEED checklist as a road map for how to do green building. We use LEED on all of our projects but as a measure of how well we’ve done in creating the most high-performance building possible. Our approach is to educate our clients and assemble the best possible collaborative team at the earliest possible stage.

“Rick Cook and I joined with Bill Browning to create Terrapin, a green think tank, to work on our projects as well as those for others—developers, government agencies, not-for-profits. We begin by organizing a one- to two-day charrette where we explore all the possibilities of a project with the right consultants, such as landscape architects, mechanical engineers, lighting

designers and others—people who are at the top of their game. We try hard to bring the builder in at this early stage. It starts things off right and gets us to the best possible building.

“Here’s an example of the innovative and integrated thinking that results from the charrette process. At the Bank of America building we were exploring ways with the mechanical and structural engineers to capture all of the storm water—four feet of rain and snow per year—by using the core structure of the building, a combination of a steel frame and two-foot thick concrete shear walls. The cellar beneath the ground floor is 85 feet deep, or three floors, and the elevator pits extend down only to the first floor of the cellar; below that there’s nothing—essentially air—surrounded by these very thick concrete walls. By using that space, we got a huge water storage tank—water that can be used for the cooling tower and flushing toilets—for free!

“Terrapin was hired by Gale International to work on a new city of office/residential/retail buildings in South Korea that is to be a model of sustainability and technological innovation. One of our first challenges was the poor condition of the soil and we thought we were going to have to pour giant 15-foot thick concrete mats in order to support the structures. Instead we proposed using large ice storage tanks buried in the foundation. Because they’re filled with liquid or ice all the time, they’re quite heavy and would take the place of the concrete in the mats. This would save a fair amount on the foundation work, cleverly create a space large enough for on-site ice storage, and eliminate the CO₂ that comes from cement manufacture.





“It’s a cool solution that came directly out of the charrette experience. It’s so inexpensive to do this kind of thinking up front, whereas the chances of integrating a great idea like this six months into the project are slim—you’re too far in. The secret is to get the right people in the room without their egos who are willing to share ideas and collaborate. Internalizing the concept and the process means asking, what can I do with that idea that would use less material, less energy and somehow integrate it into the building?”

“Clearly, in history there were architects who were incredible leaders and made great changes from what had been the standard. It seems we need that kind of thinking now and maybe USGBC is leading the way. GSA, to its great credit, has been a leader as well by requiring LEED certification in its buildings. When an agency with that much influence has that much foresight, this is a good thing.”



Moving Forward: The Challenges Ahead

ON THE BRINK OF CHANGE

As one of the largest public real estate organizations in the world, GSA's Public Buildings Service has the responsibility to demonstrate an intelligent approach to design, construction and operation of our buildings that can reduce our environmental impacts while creating effective places for people to work and for the government to conduct its business.

Perhaps of greater importance is our obligation to provide the leadership for the building industry—in this case to deeper shades of green. Documented and compelling evidence supports our need to do this. Buildings in the United States account for 68% of all electricity consumed, 39% of all energy used, 38% of carbon dioxide emissions and 12% of the total water consumption. Building-related waste from construction and demolition accounts for nearly 60% of all non-industrial waste (136 million tons annually). These numbers oblige us to recognize that changing the way buildings are created and operated can make a huge and immediate impact in addressing important global issues including the threats of climate change.

GSA has a long history of investing in energy-efficient building solutions and we have historically met or exceeded our energy reduction goals. Now, energy reduction is necessary but not enough. As we have learned, mechanical systems and efficient building operations are important facets but not the whole solution to energy efficiency. Similarly, energy efficiency alone does not answer the quest for sustainable solutions in the built environment.

left: METAL RAIN SCREEN WALLS SURROUND
A COURTYARD OF BIO-SWALES THAT FILTER
STORMWATER AND CLEAN SUPPLY AIR AT
THE LAND PORT OF ENTRY IN CALAIS, MAINE.



This sentiment has become widely acknowledged and as this publication neared completion, Congress passed and the President signed into law on December 19, 2007, the Energy Independence and Security Act of 2007. This new law sets ambitious goals for Federal agencies and the building industry as a whole, not just in the area of energy efficiency but in other related resource areas as well. The mandates for Federal agencies present immediate and identified challenges in sustainable design, lighting efficiency, energy efficient products, renewable energy, energy reduction, and demonstration projects to name a few. Significantly, Federal buildings designed in 2030 will be required to be carbon neutral. Mandates for GSA include a requirement to establish the Office of Federal High-Performance Green Buildings to set standards for, coordinate activities and publicize information related to high-performance green buildings across the government.

As the singular focus of simply reducing energy consumption evolves toward goals for using non-fossil fuel energy, developing and using renewable energy, and achieving sustainable high-performing buildings, our approach must expand to consider building design holistically. Successful strategies to address energy, water and other resources must integrate location and use factors. These include building orientation, climate considerations, envelope characteristics, mechanical, and lighting systems and the mission and work requirements of our customers. Though we have begun this effort with considerable success, we must increase our commitment to bring the entire building delivery team—client, designers, engineers, project managers, and building operators—into an integrated design process at the outset. In addition, we must agree on a set of performance metrics at the outset that will be verified at building delivery and on an ongoing basis after occupancy.



MOVING FORWARD

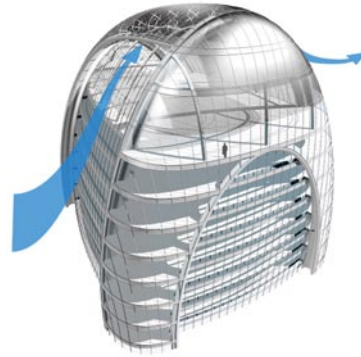
In moving forward, listing requirements and platitudes to do better is simply a mental exercise. The more important challenge is communicating data that are persuasive and incontrovertibly demonstrate that green buildings are, in fact, better, and that high-performing green buildings are the inevitable future of the building industry.

Initial data speak to energy performance, and as found in a 2007 study by the New Buildings Institute of 121 buildings nationwide, LEED Certified buildings perform 25–30% better than average non-LEED buildings, LEED Silver perform 35% better, and LEED Gold and Platinum buildings perform 45% better.

Similarly, GSA conducted a study in 2007 of 14 GSA buildings, both owned and leased, located in half of its regions to compare energy, water, maintenance and operations, waste, recycling, transportation, and occupant satisfaction metrics against industry-standard performance. This whole building performance approach examined actual measured data from several years of operation. GSA's sustainably designed buildings investigated under the study cost less to operate, have excellent energy performance, and have occupants who are more satisfied with the overall building than the occupants in typical commercial buildings. Several of GSA's early LEED buildings were not designed from an integrated design perspective and interestingly, were not energy efficient. It is not clear if one condition followed the other; however, observations from the study confirmed common beliefs, such as buildings that intentionally incorporate energy considerations into design deliver better energy performance.

left: LAND PORT OF ENTRY, WARROAD, MINNESOTA AND OTHER BORDER STATIONS MUST CONSIDER SUSTAINABLE DESIGN SOLUTIONS SUCH AS ON-SITE RENEWABLE POWER, RAINWATER COLLECTION, AND WASTEWATER TREATMENT.

above: A DOUBLE GLASS WALL AND A LIVING GREEN SCREEN ARE ORIENTATION-SPECIFIC TREATMENTS UNDER STUDY TO REPLACE THE FAÇADE OF THE EDITH GREEN/WENDELL WYATT FEDERAL BUILDING IN PORTLAND, OREGON.



BUILDING FORM IS USED TO HARNESS THE POWER OF THE WIND AND SUN TO CREATE A CARBON NEUTRAL BUILDING IN SMITH+GILL'S CLEAN TECHNOLOGY TOWER, CHICAGO, ILLINOIS.

This study is only one piece of a larger body of research and data that need to be pursued by the building industry and communicated to the real estate community and its stakeholders. Efforts to continue such exploration are not only encouraged but applauded; and in the new Energy Independence and Security Act of 2007, the research is mandated.

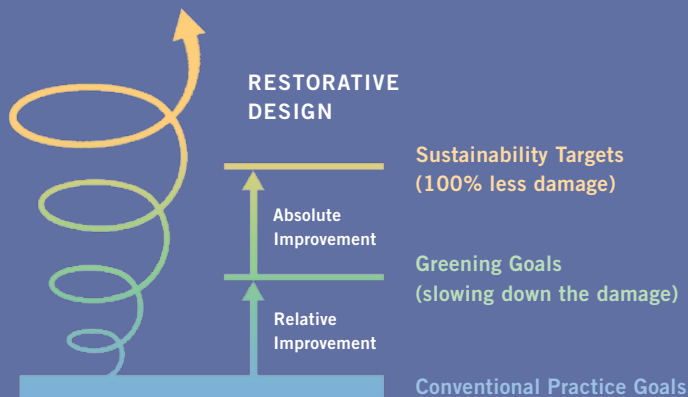
As perceptions of building performance widen, we must find performance data addressing infrastructure, customer needs, and human health and comfort. Measuring the performance of recently constructed projects must include metrics ranging from workplaces, through innovative technologies and practices, to whole building performance.

While not an answer to the on-going debate on how much “green” costs, the data gathered will help us relate the value of the investment in sustainable design to the benefits realized. As a corollary, we can better determine those design features that offer the best return on investment and value to GSA. This should drive us to better, more holistic designs for new buildings and renovations—even at the expense of perhaps doing fewer numbers of projects. And the trade-off that conventional thinking would push for (better technology costs more, so less is built) needs to be countered with creative design, creative procurement methods, and creative financing. Then, a wealth of possibilities open.

For GSA, as both a property developer and a property manager, designing and constructing sustainable buildings is just the first step. To fully realize the performance of a green building we must improve our operational practices. Continued research will provide data that can help advance green building design/construction features and practices so that we can optimize building operations and maintenance.

REGENERATIVE CAPABILITY

Continuous Improvement?



CONCEPT BY BILL REED AND REGENESIS

Current green building goals are typically characterized in terms of relative improvement over conventional practice, as in 30% energy savings compared with an ASHRAE 90.1 baseline. Beyond this relative improvement model is a vaguely understood idea of sustainability, where any negative impacts from our projects are somehow within the capacity of natural systems to absorb and mitigate indefinitely. But even that goal has two questionable implications: 1) that the current state of natural systems is good enough, and should be sustained; and 2) that the built environment will always exist in opposition to natural systems. Are we really constrained by these implications?

FROM *EXPANDING OUR APPROACH TO SUSTAINABLE DESIGN: AN INVITATION*, GSA 2006

A NEW VISION

In April 2005, GSA, with support from the Rockefeller Brothers Fund, convened a workshop composed of leading sustainable design practitioners and thinkers. Participants explored avenues in the building process and in the integrated design process that could inspire and propel revolutionary change. The following two excerpts from a GSA publication, *Expanding Our Approach to Sustainable Design: An Invitation*, set the stage for examining the larger context and posing deeper questions for project teams.

“Our current approaches are focused on reducing negative impacts. They can be characterized as ‘doing less damage’ or ‘doing damage less quickly.’ They beg the question, is achieving even 100 percent less damage good enough?”

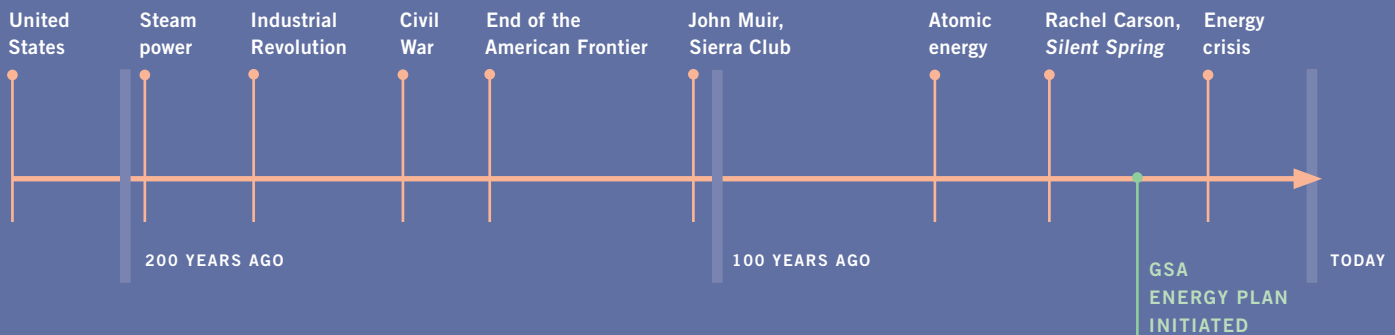
“As practices evolve, we need to be looking further ahead toward a vision for the built environment that is not limited by the paradigms of the current building industry. This vision must expand beyond the idea of a building as a fixed end-point, toward a more fluid understanding of project design, construction, and operation as they relate to sustainability and regenerative relationships.”

It is easy to leave the reader to ponder this vision of the built environment, the natural environment and the human environments not only coexisting, but also contributing to one another. It is harder to ask each person, each customer, each GSA associate to embrace the vision of a sustainable future. Yet, that is what we are asking and we implore each reader—in the words of Mahatma Gandhi, “You must be the change you wish to see in the world.”

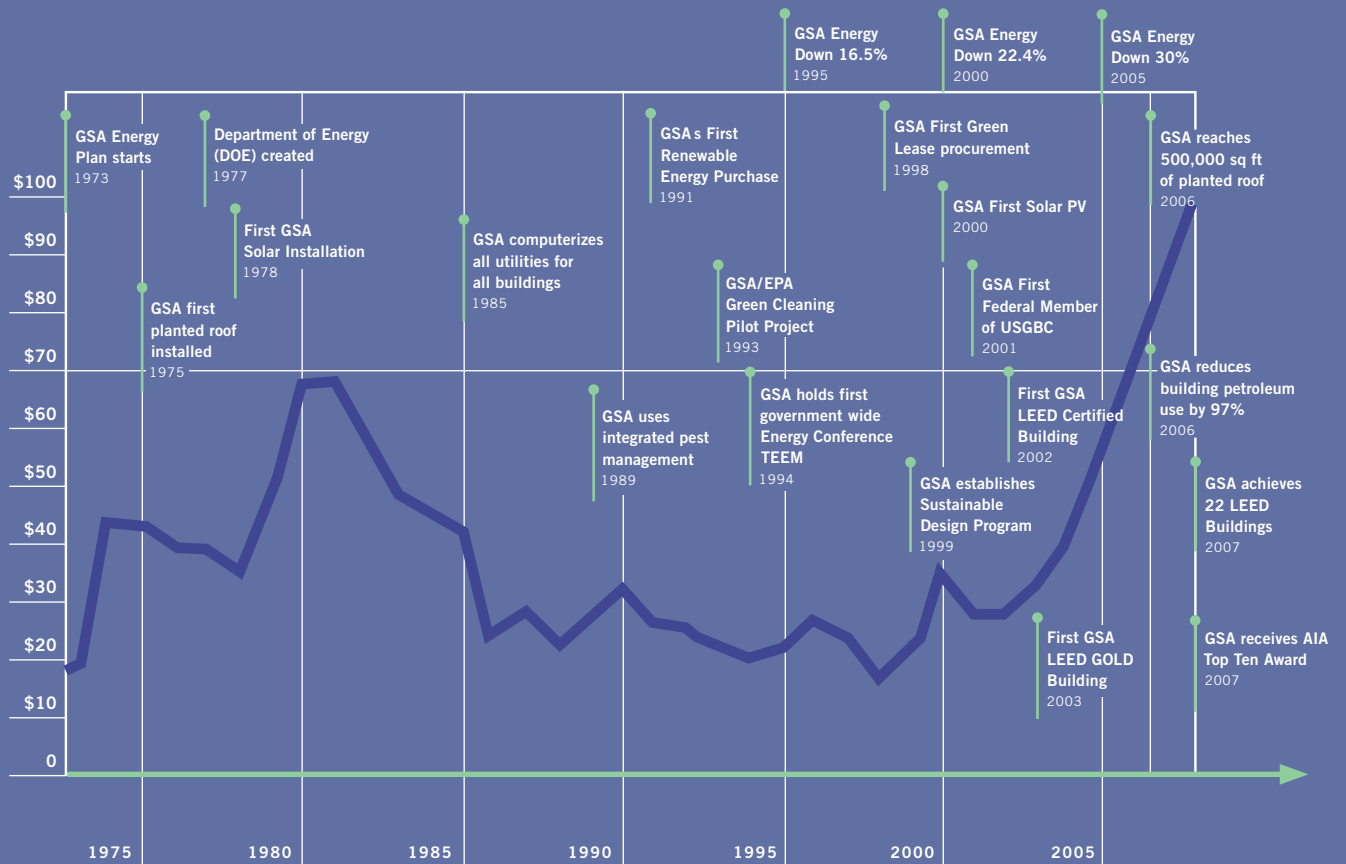
ENERGY AND ENVIRONMENTAL CONCERNS EMERGE

In the 1800s, steam power heralded the modern industrial revolution, and was followed closely by electrical power and electric driven machines. Populations moved from farms to cities. Factories brought an increase in pollution, crowded living, and the spread of disease. By the turn of the century, there was a growing concern in health issues and the environment.

The continuous demand for automobiles brought about the superhighway in the 1950s. The use of petroleum products continued to rise, causing an energy crisis by 1980. At current consumption, the known reserves of crude oil will be gone by 2039.



GSA'S ROLE IN SUSTAINABILITY LEADERSHIP



THE GRAPH SHOWS THE FLUCTUATION IN COST OF A BARREL OF CRUDE OIL, WITH A PRICE UNDER \$20 IN 1970 AND A PRICE OVER \$100 IN 2007.

GSA LEED BUILDINGS



**SOCIAL SECURITY
ADMINISTRATION ANNEX**
WOODLAWN, MD

LEED NC rated: Nov 19 2002

CERTIFIED

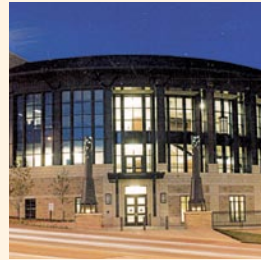
| | | |
|------------------------------|-----------|----|
| Sustainable Sites | 4 | 14 |
| Water Efficiency | 2 | 5 |
| Energy and Atmosphere | 8 | 17 |
| Materials and Resources | 5 | 13 |
| Indoor Environmental Quality | 5 | 15 |
| Innovation and Design | 2 | 5 |
| | 26 | 69 |

GREEN FACTS

25% energy usage reduction
using thermal ice storage

41% materials locally manufactured,
reducing transportation impacts

77% reuse of existing building shell



**NATHANIEL R. JONES FEDERAL
BUILDING AND U.S. COURTHOUSE**
YOUNGSTOWN, OH

LEED NC rated: Nov 25 2002

CERTIFIED

| | | |
|------------------------------|-----------|----|
| Sustainable Sites | 10 | 14 |
| Water Efficiency | 2 | 5 |
| Energy and Atmosphere | 1 | 17 |
| Materials and Resources | 4 | 13 |
| Indoor Environmental Quality | 8 | 15 |
| Innovation and Design | 2 | 5 |
| | 27 | 69 |

GREEN FACTS

73% construction waste diverted
from landfills

62% materials locally manufactured,
reducing transportation impacts

90% spaces have views of outdoors



**SOCIAL SECURITY ADMINISTRATION
CHILD CARE CENTER**
WOODLAWN, MD

LEED NC rated: Feb 27 2003

CERTIFIED

| | | |
|------------------------------|-----------|----|
| Sustainable Sites | 6 | 14 |
| Water Efficiency | 2 | 5 |
| Energy and Atmosphere | 5 | 17 |
| Materials and Resources | 6 | 13 |
| Indoor Environmental Quality | 7 | 15 |
| Innovation and Design | 2 | 5 |
| | 28 | 69 |

GREEN FACTS

98% spaces have views outdoors

58% recycled content in materials

33% energy performance
improvement over baseline



**EPA NEW ENGLAND
REGIONAL LABORATORY**
CHELMSFORD, MA

LEED NC rated: Mar 31 2003

GOLD

| | | |
|------------------------------|-----------|----|
| Sustainable Sites | 7 | 11 |
| Energy Efficiency | 6 | 11 |
| Materials and Resources | 6 | 12 |
| Indoor Environmental Quality | 6 | 7 |
| Safeguarding Water | 5 | 8 |
| Design Excellence | 1 | 1 |
| | 31 | 50 |

GREEN FACTS

35% open space maintained on-site

35% energy performance
improvement over baseline

57% materials were
manufactured locally



EPA SCIENCE AND TECHNOLOGY CENTER
KANSAS CITY, KS

LEED NC rated: Jul 30 2003

GOLD

| | | |
|------------------------------|-----------|----|
| Sustainable Sites | 11 | 14 |
| Water Efficiency | 5 | 5 |
| Energy and Atmosphere | 3 | 17 |
| Materials and Resources | 6 | 13 |
| Indoor Environmental Quality | 9 | 15 |
| Innovation and Design | 5 | 5 |
| | 39 | 69 |

GREEN FACTS

- 43%** stormwater reduction through pervious surfaces and rainwater capture
- 40%** water use reduction from flushing toilets with rainwater
- 99%** roof surface is covered with an Energy Star rated roof



UNITED STATES DEPARTMENT OF TRANSPORTATION FACILITY
LAKEWOOD, CO

LEED NC rated: Oct 4 2004

SILVER

| | | |
|------------------------------|-----------|----|
| Sustainable Sites | 8 | 14 |
| Water Efficiency | 1 | 5 |
| Energy and Atmosphere | 8 | 17 |
| Materials and Resources | 6 | 13 |
| Indoor Environmental Quality | 7 | 15 |
| Innovation and Design | 5 | 5 |
| | 35 | 69 |

GREEN FACTS

- 33%** energy performance improvement over baseline
- 50%** water reduction from drought-tolerant plants and high-efficiency irrigation
- 76%** construction waste diverted from landfills



UNITED STATES AND CANADIAN SHARED PORT OF ENTRY
SWEET GRASS, MT

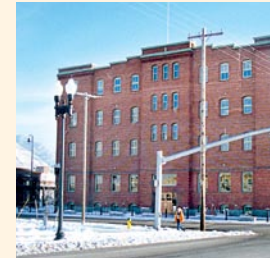
LEED NC rated: May 20 2005

CERTIFIED

| | | |
|------------------------------|-----------|----|
| Sustainable Sites | 6 | 14 |
| Water Efficiency | 3 | 5 |
| Energy and Atmosphere | 1 | 17 |
| Materials and Resources | 4 | 13 |
| Indoor Environmental Quality | 9 | 15 |
| Innovation and Design | 4 | 5 |
| | 27 | 69 |

GREEN FACTS

- 4%** electric fork-lift trucks purchased for use on site
- 100%** drought-tolerant, native-species plants
- 98%** construction waste diverted from landfills



SCOWCROFT BUILDING, INTERNAL REVENUE SERVICE
OGDEN, UT

LEED NC rated: Nov 4 2005

SILVER

| | | |
|------------------------------|-----------|----|
| Sustainable Sites | 6 | 14 |
| Water Efficiency | 2 | 5 |
| Energy and Atmosphere | 7 | 17 |
| Materials and Resources | 6 | 13 |
| Indoor Environmental Quality | 9 | 15 |
| Innovation and Design | 3 | 5 |
| | 33 | 69 |

GREEN FACTS

- 100%** historic building reuse—exterior
- 50%** historic building reuse—interior
- 30%** energy performance improvement over baseline

GSA LEED BUILDINGS



**OSHA SALT LAKE
TECHNICAL CENTER**
SANDY, UT

LEED NC rated: Jan 12 2005

SILVER

| | | |
|------------------------------|-----------|----|
| Sustainable Sites | 6 | 14 |
| Water Efficiency | 1 | 5 |
| Energy and Atmosphere | 10 | 17 |
| Materials and Resources | 4 | 13 |
| Indoor Environmental Quality | 9 | 15 |
| Innovation and Design | 3 | 5 |
| | 33 | 69 |

GREEN FACTS

- 31%** recycled content in materials
- 47%** energy performance improvement over baseline
- 79%** occupied spaces have a daylight factor of 2%



**EPA NATIONAL
COMPUTER CENTER**
RESEARCH TRIANGLE PARK, NC

LEED NC rated: Feb 26 2005

SILVER

| | | |
|------------------------------|-----------|----|
| Sustainable Sites | 7 | 14 |
| Water Efficiency | 2 | 5 |
| Energy and Atmosphere | 6 | 17 |
| Materials and Resources | 6 | 13 |
| Indoor Environmental Quality | 9 | 15 |
| Innovation and Design | 5 | 5 |
| | 35 | 69 |

GREEN FACTS

- 90%** site area is undisturbed or restored
- 94** kilowatts produced by solar roof
- 100%** biomass electricity fuel mix



**NATIONAL PARK SERVICE MIDWEST
REGIONAL HEADQUARTERS**
OMAHA, NE

LEED NC rated: May 3 2005

GOLD

| | | |
|------------------------------|-----------|----|
| Sustainable Sites | 8 | 14 |
| Water Efficiency | 4 | 5 |
| Energy and Atmosphere | 6 | 17 |
| Materials and Resources | 6 | 13 |
| Indoor Environmental Quality | 11 | 15 |
| Innovation and Design | 5 | 5 |
| | 40 | 69 |

GREEN FACTS

- 39%** water savings from low-flow fixtures, dual-flush toilets, and waterless urinals
- 59%** wood from Forest Stewardship Council (FSC) sustainably managed forests
- 100%** green power purchase for more than two years



**DEPARTMENT OF
HOMELAND SECURITY / INS**
OMAHA, NE

LEED NC rated: Apr 17 2006

GOLD

| | | |
|------------------------------|-----------|----|
| Sustainable Sites | 6 | 14 |
| Water Efficiency | 3 | 5 |
| Energy and Atmosphere | 13 | 17 |
| Materials and Resources | 6 | 13 |
| Indoor Environmental Quality | 9 | 15 |
| Innovation and Design | 5 | 5 |
| | 42 | 69 |

GREEN FACTS

- 100%** rainwater harvesting to reduce potable water use
- 100%** furniture is indoor air quality certified by GreenGuard
- 66%** energy performance improvement over baseline



**HOWARD M. METZENBAUM
U.S. COURTHOUSE**
CLEVELAND, OH

LEED NC rated: Apr 19 2006

CERTIFIED

| | | |
|------------------------------|-----------|----|
| Sustainable Sites | 6 | 14 |
| Water Efficiency | 4 | 5 |
| Energy and Atmosphere | 3 | 17 |
| Materials and Resources | 6 | 13 |
| Indoor Environmental Quality | 7 | 15 |
| Innovation and Design | 3 | 5 |
| | 29 | 69 |

GREEN FACTS

- 32%** water use reduction
- 95%** reuse of historic building shell
green housekeeping
procedures employed



**CENTER FOR
IMMIGRATION SERVICES**
LINCOLN, NE

LEED NC rated: Jun 9 2006

SILVER

| | | |
|------------------------------|-----------|----|
| Sustainable Sites | 5 | 14 |
| Water Efficiency | 3 | 5 |
| Energy and Atmosphere | 3 | 17 |
| Materials and Resources | 7 | 13 |
| Indoor Environmental Quality | 11 | 15 |
| Innovation and Design | 4 | 5 |
| | 33 | 69 |

GREEN FACTS

- 24%** water use reduction
- 21%** materials are from
within 500 miles
- 100%** energy is supplied
by green power



**ONE
POTOMAC YARD, EPA**
ARLINGTON, VA

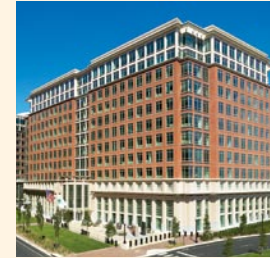
LEED NC rated: Jun 19 2006

GOLD

| | | |
|------------------------------|-----------|----|
| Sustainable Sites | 10 | 14 |
| Water Efficiency | 4 | 5 |
| Energy and Atmosphere | 7 | 17 |
| Materials and Resources | 6 | 13 |
| Indoor Environmental Quality | 11 | 15 |
| Innovation and Design | 5 | 5 |
| | 43 | 69 |

GREEN FACTS

- 72%** construction waste diverted
- 83%** certified wood used
throughout building
- 50%** power supplied by green power



**TWO
POTOMAC YARD, EPA**
ARLINGTON, VA

LEED NC rated: Jun 19 2006

GOLD

| | | |
|------------------------------|-----------|----|
| Sustainable Sites | 11 | 14 |
| Water Efficiency | 4 | 5 |
| Energy and Atmosphere | 5 | 17 |
| Materials and Resources | 6 | 13 |
| Indoor Environmental Quality | 11 | 15 |
| Innovation and Design | 5 | 5 |
| | 42 | 69 |

GREEN FACTS

- 90%** regularly occupied spaces
have views outdoors
- 63%** materials are from within
500 miles of site
- 4** mass transit stations nearby

GSA LEED BUILDINGS



**BYRON G. ROGERS
U.S. COURTHOUSE**

DENVER, CO

LEED EB rated: Sep 21 2006

GOLD

| | | |
|------------------------------|-----------|----|
| Sustainable Sites | 11 | 16 |
| Water Efficiency | 2 | 5 |
| Energy and Atmosphere | 15 | 22 |
| Materials and Resources | 2 | 10 |
| Indoor Environmental Quality | 10 | 18 |
| Innovation and Design | 4 | 5 |
| | 44 | 76 |

GREEN FACTS

- 100%** building is powered by wind
- 51%** materials used on the project have recycled content
- 50%** water savings for exterior plantings



**WAYNE L. MORSE
U.S. COURTHOUSE**

EUGENE, OR

LEED NC rated: Nov 10 2006

GOLD

| | | |
|------------------------------|-----------|----|
| Sustainable Sites | 8 | 14 |
| Water Efficiency | 3 | 5 |
| Energy and Atmosphere | 8 | 17 |
| Materials and Resources | 6 | 13 |
| Indoor Environmental Quality | 9 | 15 |
| Innovation and Design | 5 | 5 |
| | 39 | 69 |

GREEN FACTS

- 43%** water use reduction from low-flow fixtures and waterless urinals
- 30%** energy performance improvement over baseline
- 90%** construction waste diverted from landfills



**JOHN J. DUNCAN
FEDERAL BUILDING**

KNOXVILLE, TN

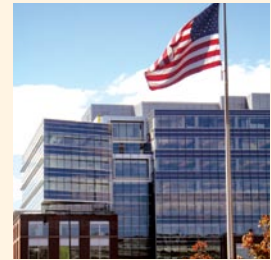
LEED EB rated: Jan 4 2007

CERTIFIED

| | | |
|------------------------------|-----------|----|
| Sustainable Sites | 6 | 14 |
| Water Efficiency | 2 | 5 |
| Energy and Atmosphere | 15 | 23 |
| Materials and Resources | 3 | 16 |
| Indoor Environmental Quality | 5 | 22 |
| Innovation and Design | 3 | 5 |
| | 34 | 85 |

GREEN FACTS

- 95%** Energy Star score
- 50%** water use reduction
- 100%** occupancy rate after renovations



**EPA REGION 8
HEADQUARTERS**

DENVER, CO

LEED NC rated: Sep 17 2007

GOLD

| | | |
|------------------------------|-----------|----|
| Sustainable Sites | 9 | 14 |
| Water Efficiency | 4 | 5 |
| Energy and Atmosphere | 9 | 17 |
| Materials and Resources | 7 | 13 |
| Indoor Environmental Quality | 6 | 15 |
| Innovation and Design | 5 | 5 |
| | 40 | 69 |

GREEN FACTS

- 40%** water use reduction
- 100%** energy is supplied by green power
- 1st** planted roof in downtown Denver



**SOCIAL SECURITY ADMINISTRATION
TELESERVICE CENTER**
AUBURN, WA
LEED NC rated: Oct 22 2007

SILVER

| | | |
|------------------------------|-----------|----|
| Sustainable Sites | 4 | 14 |
| Water Efficiency | 3 | 5 |
| Energy and Atmosphere | 9 | 17 |
| Materials and Resources | 6 | 13 |
| Indoor Environmental Quality | 10 | 15 |
| Innovation and Design | 4 | 5 |
| | 36 | 69 |

GREEN FACTS

- 42% water use reduction
- 16% recycled content value of the total materials
- 77% reuse of existing shell



**NOAA SATELLITE
OPERATIONS FACILITY**
SUITLAND, MD
LEED NC rated: Oct 26 2007

GOLD

| | | |
|------------------------------|-----------|----|
| Sustainable Sites | 10 | 14 |
| Water Efficiency | 3 | 5 |
| Energy and Atmosphere | 6 | 17 |
| Materials and Resources | 5 | 13 |
| Indoor Environmental Quality | 11 | 15 |
| Innovation and Design | 5 | 5 |
| | 40 | 69 |

GREEN FACTS

- 84% site area restored with native and adaptive plants
- 99.9% non-equipment roof area planted
- 100% landscape is not irrigated



**U.S. DEPARTMENT
OF AGRICULTURE**
MANHATTAN, KS
LEED NC rated: Jan 2 2008

SILVER

| | | |
|------------------------------|-----------|----|
| Sustainable Sites | 5 | 14 |
| Water Efficiency | 4 | 5 |
| Energy and Atmosphere | 2 | 17 |
| Materials and Resources | 4 | 13 |
| Indoor Environmental Quality | 13 | 15 |
| Innovation and Design | 5 | 5 |
| | 33 | 69 |

GREEN FACTS

- 30% recycled content value of the total materials
- 100% white reflective roof
- 90% spaces with views to the outside



**VETERANS AFFAIRS
REGIONAL OFFICE**
RENO, NV
LEED NC rated: Feb 7 2008

SILVER

| | | |
|------------------------------|-----------|----|
| Sustainable Sites | 6 | 14 |
| Water Efficiency | 3 | 5 |
| Energy and Atmosphere | 9 | 17 |
| Materials and Resources | 4 | 13 |
| Indoor Environmental Quality | 10 | 15 |
| Innovation and Design | 3 | 5 |
| | 35 | 69 |

GREEN FACTS

- 79% exterior water use reduction
- 30% materials were manufactured locally
- 43% interior water use reduction

PHOTOGRAPHS

COURTESY OF THE ADVANCED BUILDING
SYSTEMS INTEGRATION COUNCIL
Page 131 (graphic)

RON BLUNT PHOTOGRAPHY
COURTESY OF RTKL ASSOCIATES, INC.
Page 184

COURTESY OF BNIM
Page 189

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