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California Public Employees' Retirement System (CalPERS) Headquarters Complex

GENERAL INFORMATION

Bird's eye view looking west with sculptural entrance pavilion at left.
Photo: Peter Aaron/Esto

Building Name: California Public Employees' Retirement System (CalPERS) Headquarters Complex
Building Location:
City: Sacramento
State: California
Country: USA
Project Size (ft², m²): 1.1 million gross square feet
Building Type(s): Mixed-use office building composed of 2 U-shaped buildings of 4 and 6 floors that form a public courtyard
Project Type: New Construction
Delivery Method: Design / Bid / Build
Total Building Costs: Construction cost–$192M; Project budget–$265M
Cost/ft² or Cost/m²: Because the project was divided into multiple bid packages, it was not possible to track costs per square foot.
Owner: California Public Employees' Retirement System (CalPERS)
Building Architect/Project Team:

Design Architect
Pickard Chilton
980 Chapel Street
New Haven, CT 06510

Landscape Architect
Hart / Howerton
One Union Street, 3rd floor
San Francisco, CA 94111

Associate Architect
Kendall/Heaton Associates, Inc.
3050 Post Oak Boulevard. Suite 1000
Houston, TX 77056

Interior Design
Interior Architects, Inc.
350 California Street, Suite 1500
San Francisco, CA 94104

Structural Engineer
CYS Structural Engineers Inc.
1760 Creekside Oaks Dr, #280
Sacramento, CA 95833

Sustainable Design
Simon & Associates, Inc.
200 Brannan Street #204
San Francisco, CA 94107

MEP, Façade & Entry Pavilion Structure Concept Engineer
Arup
901 Market Street, Suite 260
San Francisco, CA 94103

General Contractor
Hensel Phelps Construction Company
1718 3rd Street, Suite 201
Sacramento, CA 95814

Project Contact Person: Anthony Markese, AIA, LEED-AP & Pickard Chilton(mailto:amarkese@pickardchilton.com), 203.786.8609

DESCRIPTION

The California Public Employees' Retirement System (CalPERS) Headquarters Complex is a mixed-use development integrating corporate office space, retail space and below-grade parking. The site comprises two contiguous blocks located in Sacramento's downtown adjacent to their existing headquarters. The building's design is a response to both Sacramento's urban fabric and to CalPERS' sustainable design goals.

The Complex is composed of 2 U-shaped buildings of 4 and 6 floors that form a public courtyard. The structures are linked by exterior walkways and bisected by a public plaza and a mews for pedestrians and vehicles. A grand trellis-covered veranda embraces a 6-story sculptured glass Entry Pavilion, the Complex's iconic centerpiece and its new main entry.

View looking east with sculptural entrance pavilion at center.
Photo: Peter Aaron/Esto

The design for CalPERS' new headquarters is cohesive and integrated in its architecture and high-quality work environment. Spaces encourage easy orientation and movement and an open exchange among employees and members.

Exemplifying a fully integrated approach to sustainability, this complex achieved a LEED New Construction (NC) Gold rating in 2005. The exterior skin incorporates sunshades, light shelves, and planters, helping the building exceed California's aggressive energy efficiency requirements. The clear glass curtain wall integrates canopies and trellises to effectively blend interior and exterior space. In addition, the building's fenestration changes from street to street in response to sun orientation, internal program requirements, and neighborhood adjacencies. Underground rather than the required surface parking reduces the project's urban heat island effect and minimized its footprint. A central courtyard offers both employees and the public a sheltered urban retreat, while a dramatic multi-story glass atrium brings light into the core of the building.

Overall Project Goal/Philosophy

Pickard Chilton was commissioned to design CalPERS' new headquarters and was tasked to create a complex that would:

- be a building of enduring beauty;
- be a recognizable symbol for CalPERS;
- serve as a model for sustainable design;
- complement and enhance Lincoln Plaza, and
- be an integral and meaningful part of the city.

Detail view of façade at southwest corner with sunshades.
Photo: Peter Aaron/Esto

SECURE/SAFE GOAL

The safety and security of CalPERS' employees, members and neighbors figured prominently throughout all aspects of the design and construction of the headquarters. Since it is located in a dense urban area, the project also complies with construction standards set by the Federal Emergency Management Agency (FEMA) in respect to floodplains and wetlands. The public plaza and mews for pedestrians and vehicles was carefully designed for maximum enjoyment but for security as well.

SUSTAINABLE GOAL

Early in the process, the entire team participated in a green building workshop to prioritize the green strategies necessary to achieve the client's goals of setting a new standard of environmental sustainability for a large-scale headquarters building. The building's orientation, massing and façade maximize daylight while minimizing solar gain. The façade features shading projections, light shelves, floor-to-ceiling clear glass, and integrated planters. Multiple outdoor terraces offer occupants easy direct access to sunlight, fresh air and native plantings.

Detail of roof courtyard.
Photo: Peter Aaron/Esto

Other sustainable elements include indigenous landscape materials, an evaporative cooling system and landscaped terraces. The project incorporates plantings and an 87-kilowatt photovoltaic (PV) array on the roof surface, and water is heated with recovered waste heat. Green materials include bamboo flooring, recycled-content and regionally manufactured materials and FSC-certified woods. More than 90% of construction waste was recycled and the project implemented nearly all of the LEED Indoor Environmental Quality strategies.

The building was designed to use 38% less energy than a comparable building designed in minimal compliance with ASHRAE 90.1-1999(/references/ihs_l.php?d=ashrae%2090.1) and Title 24-1998 requirements. The LEED-NC Gold project realizes energy savings of approximately 38% beyond state requirements and has reduced water consumption for irrigation by 50%.

FUNCTIONAL GOAL

One of project programming's primary goals was to optimally distribute CalPERS' various business groups between the two buildings. Three core competencies (operations, customer service, and executive/strategic management) were defined and were distributed both horizontally, so that people from all of these groups would go in both buildings, and vertically, putting customer service employees on the ground floor, operations people in the middle floors, and the executive strategic management and traders on top. The building's large open floor plates allow for flexible work environments and easy workspace reconfigurations.

View of landscaped courtyard with exterior walkways and entrance pavilion.
Photo: Peter Aaron/Esto

ACCESSIBLE GOAL

The architects were sensitive to accessibility and to how people would interact and circulate within the building and the Complex as a whole. Spaces encourage easy orientation and movement and an open exchange among employees, members and visitors. They also carefully considered how people would approach the building from the surrounding streets.

In addition to the large central courtyard, the facility also features other landscaping gestures in a series of indoor and outdoor spaces, including an outdoor play area for employees' children, as well as quieter, more contemplative gardens. The park-like setting of the grounds and the buildings was designed to embrace the community and feel very permeable.

AESTHETIC GOAL

The Complex's design is cohesive and integrated in its architecture and high-quality work environment. The building's fenestration is modulated in response to sun orientation, internal program and neighborhood adjacencies. A central courtyard offers a sheltered urban oasis, while a dramatic multi-story glass atrium floods the core of the west building with daylight. A six-story entry pavilion serves as an iconic centerpiece of the campus and signals CalPERS new main entrance. Its tree-like shape was inspired by the idea that Sacramento has historically been called "The City of Trees."

Left: Landscaped public courtyard with artist-designed fountain and exterior walkways; and Right: Landscaped public courtyard with fountain and exterior walkways beyond.
Photos: Peter Aaron/Esto

To make the buildings pedestrian-friendly and reduce their overall mass, keeping them in scale with other buildings in the neighborhood, on-site parking was submerged below ground. The two structures are bisected by a public plaza and a mews for pedestrians and vehicles.

COST-EFFECTIVE GOAL

As a State of California project with a pre-determined budget, cost maintenance and control were carefully and monitored throughout the design and construction of the project. Team-wide charrettes at the onset of the project outlined and defined cost strategies that were implemented during the design and construction, thus minimizing unanticipated costs. Additionally, CalPERS took advantage of available incentives in an effort to minimize the cost impact of green features such as the photovoltaic panels on the project budget. The selection of "green" and durable materials supported the effort to create a building that would last and increase in value. The resulting project is a very efficient and durable building that will serve CalPERS' employees and members for at least the next decade.

HISTORIC PRESERVATION GOAL

The design of the Headquarters Complex was inspired by and respects to CalPERS's existing home, Lincoln Plaza North, which was completed in 1986. Featuring raised floors, extensive daylighting, and roof terraces, Lincoln Plaza confirmed for CalPERS the potential value of green design. To create a seamless transition from one building to the other, characteristics of the original structure were interpreted in new ways. Additionally, the look and feel of the new interiors were designed to harmonize with those of the existing building. The idea was to create a building that would be equal in quality and character to the original, yet be of its time architecturally and technologically.

PRODUCTIVE GOAL

CalPERS's has a demonstrated history of providing a healthy and attractive work environment for its personnel. The new Headquarters Complex provides a humane, healthy, daylight and fresh air-filled work environment and even further enhances employees' quality of life with expanded on-site day care and a fully equipped fitness center.


Left: View of daylit open interior atrium at core of building; and Right: Detail view of stair and other surfaces with FSC-certified woods.
Photos: Peter Aaron/Esto

The Complex's central courtyard offers a sheltered urban oasis, while a dramatic multi-story glass atrium floods the core of the west building with daylight. A series of canopies and trellises blends interior with exterior space. Multiple outdoor terraces distributed throughout the complex offer occupants easy direct access to sunlight, fresh air, and lush planting. Interior finishes provide a uniform degree of warmth, light and comfort throughout. State of the art lighting, patterned glass office fronts, centrally located conference and break rooms, and clearly defined circulation serve to encourage employee collaboration and productivity.

Other Significant Aspects of the Project

Some of the significant aspects of the CalPERS project included the adoption of the R Street Corridor Plan; and extensive community outreach and involvement throughout the design process. Additionally, drawing on California's rich history of combining craft and building, CalPERS' art program features an impressive collection by three of California's foremost artists: painter Nathan Oliveira and sculptors Mark di Suvero and Maria Porges.

PROCESS

Overview of Process

The California Public Employees' Retirement System (CalPERS) is the nation's largest public pension fund with assets over $244 billion. Based in Sacramento, CalPERS provides benefits to more than 1.5 million public employees, retirees and their families. As one of the largest investors in high performance buildings, CalPERS is a proponent of the value of good design and affirms that, as an investment, good sustainable design results in buildings that last and increase in value.

In 1998, with their existing headquarters Lincoln Plaza at capacity, CalPERS bought an adjacent parallel site for their expansion. The design of their new headquarters presented CalPERS with the opportunity to create a new standard and national model for environmental sustainability and energy efficiency for large-scale headquarter buildings. In 1999, after a national search, Pickard Chilton was commissioned to design CalPERS' new headquarters and was tasked to create a complex that would:

- be a building of enduring beauty;
- be a recognizable symbol for CalPERS;
- serve as a model for sustainable design;
- complement and enhance Lincoln Plaza, and
- be an integral and meaningful part of the city.

PRE-DESIGN/PLANNING ACTIVITIES

At the start of the project, Pickard Chilton embarked on an intensive design and community engagement process, working for 18 months in close collaboration with a geographically diverse design team within a politically complicated city and community environment. We worked with neighborhood leaders, community activists, the city, the R Street Subcommittee and CalPERS employees who lived and worked in the area. This collaboration yielded the thoughtful and well coordinated strategies, both architectural and sustainable, necessary to realize CalPERS' expectations and vision.

The project team's resounding success with effective community and city engagement was recognized by state and local leaders as the benchmark all projects were encouraged to follow.

DESIGN ACTIVITIES

In response to the project's sheer size, the design team divided the project into two U-shaped buildings that face one another. This decision not only allowed daylight to reach further into the buildings' interiors, but also accommodated an existing street bisecting the site and provided for a public courtyard. The design responded to how people would interact and circulate within the building and the Complex as a whole. The project's interiors were designed to maximize daylighting throughout.

Unique to the design process was the early inclusion of CalPERS' Building Operations Team in all project meetings. Both the CalPERS Chief of Plant Operations and the project's green building consultant were embedded in the design process from the beginning. This involvement helped the team maintain "a consciousness of operations and maintenance" throughout the design and construction process.

CONSTRUCTION ACTIVITIES

The construction phase of the project began in November 2000 with the decontamination and demolition of the buildings on the existing site. This included the removal and disposal of asbestos-containing materials, loose and peeling lead-based paint, refrigerant-containing air conditioning units, hydraulic lifts, and other potentially hazardous material.

This work was completed in March 2001.

The site clearing and soil remediation began in April 2001 and was completed in October 2001 allowing for new construction to begin.

Groundbreaking for the new CalPERS Headquarters Complex took place on October 15, 2001. Members of CalPERS Board of Administration and executive staff were joined by Sacramento City staff, community officials, and neighbors to officially kick-off the construction phase.

Mass excavation and construction of the slurry wall started in October 2001 was completed May 2002. A permanent site barrier eliminating the parking and sidewalks around the entire two blocks was installed. Contract work also included the removal of existing concrete slabs, loading docks, foundations, hydraulic lifts, pavement, railroad tracks, and excavation and disposal of contaminated soil.

The project posed many construction challenges, most notably the two-level basement, the first ever constructed in Sacramento because of its high groundwater table. Prior to foundation work, the two-square-block site was covered with a cement bentonite cut-off wall to protect the project from the underground water flow from a branch of the Sacramento River.

Erection of structural steel began in September 2003 and the construction of the foundation and parking garage was completed in November 2003.

During the construction phase, the design team conducted extensive reviews and evaluations of locally-sourced and recycled-content materials.

All design and construction work was completed in Fall 2005.

OPERATIONS/MAINTENANCE ACTIVITIES

The CalPERS project required extensive building commissioning services. These required the close coordination between CalPERS' Building Operations Team, the sustainable design consultant and the contractor.

POST-OCCUPANCY EVALUATION ACTIVITIES

The owner coordinated a series of reviews with the new occupants. Additionally, CalPERS increased its community outreach efforts through tours, educational programs and public events in order to welcome community members and residents.

INFORMATION AND TOOLS

The Design Team used AutoCAD, 3ds Max, and Lightscape to design, draft, model, and analyze the project. *Oasys VENT* and *Oasys ROOM*, Arup's proprietary software, were used for numerous advanced mechanical systems studies. *EQuest* was used for creating the DoE Building Energy Model which the design team used extensively in simulating and refining the exterior enclosure system.

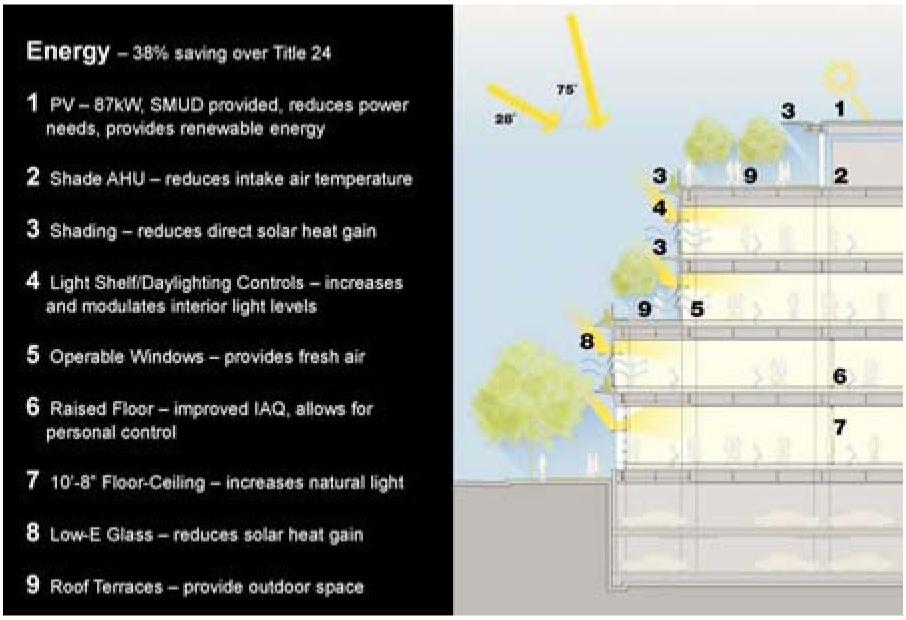
PRODUCTS AND SYSTEMS

The CalPERS Headquarters Complex exemplifies a fully integrated approach to sustainable design. The following materials, systems and products were incorporated to achieve CalPERS aesthetic and sustainable goals for the project: FSC-certified woods; low-e glass; an evaporative cooling system in the Entry Pavilion; an 87-kilowatt photovoltaic (PV) array on the roof obtained through SMUD grant; reduced irrigation water consumption by 50%; raised floor systems.

INDOOR ENVIRONMENT

Indoor Environment Approach

The quality of the indoor environment was considered throughout the design and construction process. The project included multiple outdoor terraces distributed throughout the complex to offer occupants easy direct access to sunlight and fresh air. Nearly all of the LEED Indoor Environmental Quality strategies were implemented, including the use of low-emitting materials, views to the outside, construction IAQ management, thermal comfort controls, and increased ventilation effectiveness through under-floor air distribution.



PROJECT RESULTS

A. Lessons Learned

Having a LEED professional as a fully integrated and active member of the design team at the onset of the project allowed the design team to achieve the client's sustainable design goals by evaluating sustainable technologies and materials and making appropriate decisions from the very beginning. It also ensured that LEED documentation was prepared during construction.

Additionally, having CalPERS' Chief of Plant Operations participate as a member of the project team from the beginning of design provided invaluable insight and advice, in particular with regards to long-term building maintenance and management. The collaborative efforts of the entire team greatly enhanced the project's overall design process and promoted LEED efforts while also meeting CalPERS' needs. Although the commissioning agent was brought on during construction, for improved performance in future projects, we would suggest that an agent be brought on during the design phase.

B. Ratings

This complex achieved a LEED New Construction (NC) Gold rating in 2005. It is anticipated that it will receive a LEED-EB rating in 2009.

C. Awards

- *Beyond Green Award*, Sustainable Buildings Industry Council, 2009
- *Award of Honor*, Savings by Design Energy Efficiency Integration Awards, 2007
- *Green Honor Award*, AIA Central Valley, 2006
- *Pollution Prevention Award*, Sacramento County, 2006
- *Environmental Recognition Award*, Sacramento Environmental Commission, 2006
- *Best Overall Award*, Flex Your Power, 2006
- *Institutional/Industrial Award*, Cemex Building Awards, 2006

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Center for Neighborhood Technology

GENERAL INFORMATION

Building Name: Center for Neighborhood Technology
Building Location:
City: Chicago
State: Illinois
Country: USA
Project Size (ft², m²): 13,800 square feet
Building Type(s): Institutional
Project Type: Renovation
Delivery Method: Building contractor working with Project Team consisting of LEED® Accredited Professional and Engineer, Architect, Center for Neighborhood Technology
Total Building Costs: $993,600 +/-
Cost/ft²: $72 per square foot
Owner: Center for Neighborhood Technology
Building Architect/Project Team: Jonathan Boyer, AIA, Farr Associates Architecture and Urban Design(http://www.farrside.com/)
Project Contact Person: Elizabeth Lindau, Marketing Coordinator

Front entry of the CNT on North Avenue

DESCRIPTION

The Center for Neighborhood Technology (CNT)(http://www.cnt.org) has a unique mission: to invent and implement new tools and methods that create livable urban communities for everyone. For more than 20 years, CNT has been working at the cutting edge of sustainable development, long before the term was coined. In cooperation with its partners, CNT invents programs and strategies that simultaneously achieve environmental goals and build strong communities. The CNT promotes livable, sustainable communities where the undervalued resources and inherent advantages of the urban environment, both built and natural, are captured to benefit everyone–individuals, communities and regions. Such programs include I-GO Car-Sharing, the Location Efficient Mortgage(http://www.locationefficiency.com), and the Community Energy Cooperative(http://www.energycooperative.org).

Place, the built and natural environments that shape and sustain our lives, has always been an important idea for CNT for over 25 years, and it is in the context of urban places that CNT understands assets. Even the most outwardly depressed places have real assets, both tangible and intangible–density, good public transit, existing infrastructure, strong community institutions, and the people who live and work there. Assets like these are often improperly valued; in low- and moderate-income communities this is especially true, and hidden and/or undervalued assets abound. Transforming these common assets, CNT believes is the key to solving many of the problems facing regions today. CNT has three interrelated strategies for this transformation:

- Analyzing, framing, and delivering information about the underlying network of systems, particularly economic, that undervalue assets;
- Promoting public policies that build and enhance assets; and
- Creating new ways to capture the value of assets.

In 1987, the Center for Neighborhood Technology decided to move from a leased space in downtown Chicago to a more affordable location in Wicker Park, a transit-friendly neighborhood. Wicker Park has emerged from an artist's haven into one of the most desirable places to live in Chicago. With its heart at Damen and Milwaukee Avenues, Wicker Park is bound by North and Division, and Ashland and Western Avenues. The community is comprised of a blend of tree-lined streets, apartments, and rejuvenated houses and flats. There are a large variety of homes, from stately Victorians to modern low-rise buildings. It offers a mix of small businesses, chic boutiques, galleries, and trendy restaurants. The result is a vibrant, dynamic destination for visitors and residents alike. With a bohemian and European heritage, Wicker Park is one of the city's most desirable destinations for culture and entertainment. Wicker Park maintains an emphasis on performance art, music and theater. It also has many independent art galleries—particularly in the Flat Iron Building–and sculptors, painters, and mixed-media artists. For commuters (many of whom do not need a car), the CTA's Blue Line and the train are only a few blocks away giving them 10-minute access to the Loop, as well as easy access to O'Hare International Airport and the suburbs.


The native garden provides shading and cooling.

The building was originally selected for the location and other desirable features including the open space next to it, the available parking, and the many amenities within walking distance for the employees. An internal survey also determined that the building was at the nexus of travel patterns of the majority of employees.

CNT eventually purchased the 13,800 square-foot abandoned light industrial building that dates back to the 1920s when it originally served as a textile factory. In 2000, the organization was running out of space, and was faced with a difficult decision. They could sell the building at a profit–but the property would almost certainly be bought by a developer and turned into high-end condos, further fueling the neighborhood's regentrification. Or they could stay and expand into the first floor. CNT not only chose to stay and expand, but to renovate in a manner that would earn it a LEED certification from the U.S. Green Building Council(http://www.usgbc.org). The renovation of an existing historic building also gave CNT an opportunity to "practice what it preaches." CNT's green building project sought to put in place the standard green building elements that LEED outlines, however the outcomes were unique in that their rehab of a former industrial building was completed in a relatively inexpensive manner–even while incorporating demonstration technologies like a new high-efficiency ventilation system and cooling system; and also resulted in a warm and friendly space. The renovation project was completed in October 2003 for $72/sf when the average cost for a new building in Chicago at the time was $160/sf.

OVERALL PROJECT GOAL/PHILOSOPHY

CNT planned the green renovation as a model template and educational program to demonstrate to industry specialists, building professionals, and the general public that green renovation can be achieved, economically, efficiently, and without compromising aesthetics. Rather than pursuing state-of-the-art techniques and materials (which are often costly), CNT chose to integrate "state-of-the-shelf" technologies to affordably reduce the building's energy costs and to demonstrate to the community that simple choices can have substantial energy savings.


Natural daylight is optimized in the large conference room.

A significant goal of the project was to share the lessons and wisdom gained through this process. So CNT is planning an educational outreach campaign specifically targeted to those in the building industry most likely to influence supply and demand for sustainable building materials–from contractors and developers, to owners and architects–CNT hopes to increase awareness of the procedures, challenges, and benefits of greening an existing structure.

CNT used a two-prong approach to achieve a green building. First, through an integrated process, the project team conducted a great amount of research and planning–required for a green renovation on a budget of an existing structure. Goals were established through a "planning team" process consisting of the architect, contractor, LEED®

accredited professional, Sharon Feigon the building manager, the staff of the CNT, and an engineer. The team developed the goals and desired outcomes for the project through a series of meetings, charrettes, and questionnaires. The team thought holistically about the building solution up front as they wanted the final design to reflect the environmental values of the organization. The architect encouraged experimentation with materials, colors, and textures as a way to meet design goals. Among the many goals was the desire to create an open, fun, and community-like atmosphere to encourage creative thinking, access to the public, and interaction among the staff.

SECURE/SAFE GOAL

To create a safe, open environment in the context of a neighborhood in the process of regentrifying itself, but still allow for natural lighting into key spaces.

Employees enjoy the garden and shading in summer.

SUSTAINABLE GOAL

To create a green renovation of an existing building and achieve a LEED® Platinum rating on a limited budget by addressing the following: site issues, water efficiency, energy and atmosphere, indoor environmental air quality, materials and construction strategies with reduce, reuse, and recycle in mind, and innovation and design process.

FUNCTIONAL GOAL

To create an open space that encouraged interaction among the staff, accommodated a variety of work schedules and habits, and maximized access to the community. The main entrance to CNT was also intended to be on North Avenue in order for staff to walk from the parking lot directly to North Avenue. CNT owns a 13 foot right-of-way from the lot to North Avenue.

ACCESSIBLE GOAL

To design an atmosphere and spaces that provided access to the general public, staff, etc. while respecting the historic character of the structure.

AESTHETIC GOAL

To create a fun atmosphere that encourages creativity and innovation, which are in alignment with the company's mission, through the careful selection of materials and colors.

COST-EFFECTIVE GOAL

To make materials, systems, and design choices that would meet the limited budget by integrating "state-of-the-shelf" technologies to affordably reduce the building's energy costs and demonstrate to the community that simple choices can have substantial energy savings. The costs for the renovation were analyzed and reviewed over the short- and long-term. To utilize the equity they already had built into the property so they wouldn't have to take out large loans to undertake and complete the renovations. The equity served as the basis for the budget.

HISTORIC PRESERVATION GOAL

To renovate and utilize an existing historic structure without significantly altering its footprint. To highlight, integrate, and juxtapose the old and historic pieces of the building with the new for a visually rich experience.

PRODUCTIVE GOAL

To create a fun, innovative, creative, and flexible environment in which employees and visitors would thrive and be inspired. To optimize daylighting in order to maximize productivity and morale.

OTHER SIGNIFICANT ASPECTS OF THE PROJECT

N/A

PROCESS

Overview of Process

An integrated and informed team worked closely together throughout all the phases of the project. There were many instances where contractors and sub-contractors were educated along the way about the goals of the project and their processes supervised more closely or modified in order to meet the LEED® requirements and the unique aspects of renovating an older building. The whole team worked to achieve the goals of the project in the context of a "Mission Statement."

PRE-DESIGN/PLANNING ACTIVITIES

Development of a set of project goals and Mission Statement intended to facilitate interaction among staff and create a green renovation that would improve productivity among staff and add to the quality of life among staff and community. Careful research, review, and analysis of materials and systems choices. Regular meetings and communications with all parties to ensure understanding of goals, issues, and implementation of the design.

Work spaces receive daylight along the building's perimeter but also contribute to the daylight in the interior since office partitions are low.

DESIGN ACTIVITIES

The project team worked very closely with contractors and subcontractors during the design phase to ensure that the design intent would be implemented and understood by educating them on the standards and process that they would need to follow. An analysis of the various design options and their costs over the short- and long-term was conducted.

CONSTRUCTION ACTIVITIES

There were many activities included before and during the construction phase that were intended to engage and educate the appropriate and most qualified contractors/subcontractors for the job. Six contractors were interviewed, and they were required to be local. A GMC was selected with a guaranteed maximum price contract which meant they had to make a design that fit the budget. Initially, subs and contracts didn't know LEED® requirements intimately, so more administrative time was spent with those groups to educate them and make sure they fully understood their role in the process.

The building permit took a long time due to a transition of computer systems in the city. However, through Mayor Daley, the city is sympathetic and educated about sustainability, so the permit process was relatively easy with the exception of a misunderstanding about the ice storage tanks. The CNT ended up spending more money to bury the ice storage tanks, even though they were storing food grade materials, because the staff in permits was unknowledgeable and somewhat fearful about future toxic waste in the tanks should a different owner take over the property.

An intern was hired to research all local paint suppliers that carried low VOC paints. The information was included as part of the specification so that the paint contractor would fully understand their options and learn how to anticipate supply issues. Architect Jonathan Boyer worked closely with the woodworker, including making a few trips to Minnesota where he is based to make simple modifications to his shop. The woodworker didn't have the set up to craft the millwork according to LEED® standards such as the use of non-toxic glues and recycled or natural materials. Wheat board with melamine in it was chosen for the woodwork. Also, initially a lighting consultant was selected but discovered to be too expensive. So the architect worked directly with a lighting manufacturer's representative to redesign and solve lighting issues. They chose the most economic layout–a cloud system. The electrical was roughed in but the lighting needed to be done on site. The team valued this process as they documented and discovered empirical evidence on site that aided in the resolution of reflectivity and acoustics issues. Also the demolition contractor needed to be educated about proper sorting and the most efficient path and number of trips to a local recycling center.

OPERATIONS/MAINTENANCE ACTIVITIES

The engineer helped to set up all the warranties and manuals and brought representatives in from the various building systems and materials companies to explain how to operate equipment and even perform simple tasks like repainting a spot so as not to undermine the LEED® intent. There has been ongoing training of the maintenance person in the building who has to learn the nuances of the systems in order to run the building most efficiently.

POST-OCCUPANCY EVALUATION ACTIVITIES

There are a variety of educational signs throughout the building that are intended to remind employees of their role in the continued success of the project as well as educate the community and other building users of the various programs in place within the CNT. Energy and systems analyses are conducted regularly. Employees receive regular communications regarding the state of the air quality and/or system issues so they can actively participate in the building's operations to achieve optimal air quality, etc. There is a "green office committee" on staff that is charged with paying attention to the building systems and other air quality issues. They utilize an Intranet to inform or alert employees of systems changes or problems.

INFORMATION AND TOOLS

- ASHRAE-based spreadsheets for load calculations, ductwork sizing, and ADPI calculations
- Lumen Micro for lighting design
- Energy Simulation Software used: VisualDOE 3.1

PRODUCTS AND SYSTEMS

MECHANICAL

- Thermal ice storage system lowers cooling costs
- Conventional plumbing with low flow fixtures (composting toilets were cost-prohibitive and against code)
- Light sensors placed only in bathrooms where most effective. In common areas, three bulb lights were wired so one, two, or three bulbs can be used as needed
- Reflective ENERGY STAR rooftop covering and roof insulation with an average R-3, fiberglass batts + 2 inches of rigid board insulation
- High efficiency water heater with 90% sealed combustion heater
- High efficiency lights with t-8 electronic ballasts
- Kitchen appliances, as well as copiers, printers, and computers all have high ENERGY STAR® ratings for efficient performance.

ARCHITECTURAL FINISHES

- Carpeting is manufacturer seconds that would have gone to a landfill. Creative use of remnants created design feature; tiling allows only worn areas to be replaced which contributes to a significant cost savings over time. The average cost for new carpeting was estimated at $20/square yard. The seconds saved $15-17/ square yard.
- Ceiling not covered entirely with acoustical tile, reducing material cost and creating a more visually appealing space
- Open floor plan and low partitions allow for more sharing of light resources

LANDSCAPING

- Indigenous plants are more affordable and don't require watering
- Recycled brick
- Permeable green parking lot
- Native garden includes a storm water rain garden and rain barrels for capturing roof runoff which is rerouted to flow into garden swale instead of the gutter
- Open space was left as is
- Reduction of light pollution achieved by shielding outside lights
- Provided designated parking for hybrid cars, I-Go car-share cars, and carpooling (12% of building occupants provided with preferred carpool parking)


Indigenous planting in the garden is cost-effective since the plants were more affordable and require no

FURNISHINGS

- Recycled file cabinets, chairs, and marble tables (from bathroom stalls)
- Simple and repetitive office fixtures minimized construction waste
- Wheatboard, cork millwork for office furniture

ENERGY ISSUES

watering.

Energy Use Description

Expected Electricity Use	Energy Use (kWh/yr)	Electric Costs ($/yr)
ASHRAE	184,814	$16,063
CNT	94,450	$10,187
Savings	90,364	$5,876

Expected Gas Use	Energy Use (therms/yr)	Gas Costs ($/yr)
ASHRAE	7,643	$6,428
CNT	2,875	$2,418
Savings	4,768	$4,010

INDOOR ENVIRONMENT

Indoor environment approach

The goal of the project was to create a healthy indoor environment through the use of air and daylight. Ninety percent of the spaces have access to daylight and views. It is a non-smoking building with CO2 monitoring. The ductwork was sealed during construction to control contaminants. The printing and copying machines are segregated from the rest of the building. Low and no-VOC paints, adhesives, finishes, and carpeting were utilized. The CNT maximized the controllability of systems through zones and switches. Permanent monitoring of the HVAC system and ventilation is in place. An indoor garden is in place within the CNT. Air quality testing determined acceptable levels of indoor air quality. Insulated window shades with R-value of 0.67 contribute to $143 energy savings annually. High efficiency cooling was provided for the server room with waste heat going to the greenhouse. Hybrid ventilation was provided through the use of operable windows.

PROJECT RESULTS

Lessons Learned

By involving all parties early on in the process, thoroughly researching alternatives, and striving to use simple solutions that provide the biggest "bang for the buck," CNT was able to complete a LEED® Platinum level renovation on a conventional construction budget. CNT is proud to be able to demonstrate to the community that a green renovation, which reduces both energy consumption and operating costs, is possible to achieve affordably and without compromising aesthetics or comfort of the workplace. Post-project costs are still being documented by the CNT and will be used to make modifications and improvements over time. There have been a few difficulties with the heating and cooling systems which they hope to monitor and resolve through careful management.

The reuse of an existing building in an older urban neighborhood resulted in maintaining 100% of the structural elements and 90% of the building shell elements. Twenty-nine tons of waste were diverted from landfills through careful reuse and recycling. Additionally 31% of materials were manufactured locally and 50% were harvested locally. Thirteen percent of the materials are renewables including the wheatboard, cork millwork.

By saving on building operational and maintenance costs, CNT is able to use more of its raised dollars on programming and less on its facility. In addition to conserving natural resources, the organization saves close to $10,000 a year on utilities.

The team believes that through close coordination, cooperation, and effective communication, the project was successful. They also believe that the educational process is essential to achieving success in a green project, but is time well spent on the front side of a project before major decisions get made and implemented. The additional effort required to get contractors and sub-contractors up to speed on LEED® issues added additional administrative time to the contract, but ultimately saved money during construction and over the life of the building. The team also believes that coordinating the scale of the project to the scale of the professionals involved with the project is necessary. A smaller project benefits from the involvement of smaller firms and contractors.

To view the renovation process, please visit the CNT Web site(http://building.cnt.org/).

Ratings

LEED® Platinum Rating

Awards

City of Chicago's Mayor Daley's GreenWorks Award for "Outstanding Non-residential Project" May 2004

First Place: SBIC(http://www.sbicouncil.org) 2004 Awards Program: Exemplary Sustainable Building Awards

Publishing

Center for Neighborhood Technology(http://www.cnt.org)
Eden's Lost & Found – How Ordinary Citizens are Restoring Our Great American Cities(http://www.edenslostandfound.org/home/book.php)
Midwest Construction Magazine(http://midwest.construction.com/features/archive/0410_feature8.asp)

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Emerson Global Data Center

GENERAL INFORMATION

Building Name: Emerson Global Data Center
Building Location:
  City: St. Louis
  State: Missouri
  Country: USA
Project Size (ft², m²): 35,000 ft²
Building Type(s): Mission-critical global data center
Project Type: New construction on an existing site
Total Building Costs: $50 Million **Cost/ft²:** $1,428.27
Owner: Emerson Electric Co.
Building Architect/Project Team: Fox Architects/Emerson
Project Contact Person: John Berendzen

DESCRIPTION

Emerson began construction of a global data center on the campus of the company's St. Louis headquarters in early 2008. The data center supports the company's initiative to consolidate its global network—comprised of more than 100 data centers worldwide—into just four facilities, while leveraging innovative architectural and building designs and IT infrastructure technologies to optimize energy and operational efficiency.

The facility's cutting-edge architectural design complements an efficient technology infrastructure to trigger energy savings of up to 31 percent over a traditional enterprise data center. The facility is fully equipped with a host of unique energy-saving attributes, including daylighting features, a reduced building footprint and one of the largest rooftop solar arrays used by a data center. These design and construction features were enhanced by internally-developed strategies addressing the three most critical constraints faced by data center managers today—power, cooling and space.

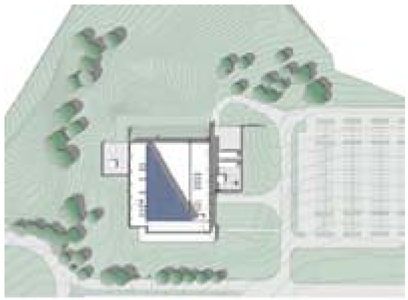
To complete the project, Emerson enlisted an estimated 150 workers and leveraged the expertise of several design and construction partners, including Fox Architects, Musick Construction, Clive Samuels & Associates and Technology Site Planners. Principal construction on the 35,000 sq. ft., $50 million facility (including all Phase I equipment) was completed in July 2009.

Overall Project Goal/Philosophy

Achieving energy efficiency without impacting performance has been a longtime challenge for U.S. data centers. According to the Environmental Protection Agency, in 2006 the industry consumed nearly as much electricity as 5.8 million U.S. households. Without energy efficiency improvements, conventional data centers' energy consumption could nearly double in five years, driving unacceptable increases in energy and a corresponding rise in greenhouse gas emissions. With these facts in mind, Emerson began construction of a global data center on the campus of the company's St. Louis headquarters in early 2008. In addition to consolidating Emerson's global network, the project was intended to serve as an architectural reference point for sustainable data center design.

Understanding the need to achieve specific sustainability and availability requirements dictated before construction even began, Emerson approached the project with the philosophy that the IT and facility design teams should be seamlessly integrated in addressing all aspects of the facility's design and construction. By taking this approach, it was ensured that performance requirements and operational benefits across would be weighed equally. This collaborative approach to the facility's design also enabled the design team to leverage its collective expertise to develop innovative solutions—such as the data center's roof-mounted condenser configuration—that may not have been otherwise realized.

SUSTAINABLE GOAL


Data Center Site Topography

Emerson wanted to ensure the project would represent sustainable best practices, both during and after completion of principal construction. To meet this goal, Emerson would optimize the potential of an existing site on its St. Louis campus by triangulating the facility with existing assets, minimizing the project's required footprint. The use of locally-procured and recycled materials enabled Emerson to significantly minimize the use of fossil fuels and the diversion of the majority of the project's waste from landfills further minimized the project's environmental impact. Emerson also stressed the importance of leveraging the latest sustainable technologies to support the facility's infrastructure. Through the use of photovoltaic technology and natural daylighting for the entire facility, Emerson maximized the use of renewable energy without seriously impacting the facility's ROI. In addition, through the installation of efficient fixtures and implementing an environmentally friendly natural drainage system, Emerson was able to take extensive steps to protect and conserve water.

ACCESSIBLE GOAL

The single-story facility is designed to ensure equal use of the building for all. In addition, expandable raised-floor space ensures the facility maintains flexibility for future expansion.

AESTHETIC GOAL

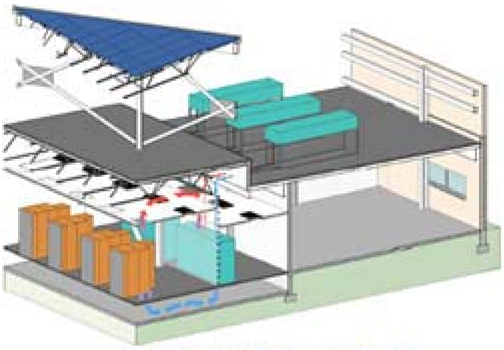
Data centers, by default, are rarely lauded for their aesthetic appeal and have traditionally been characterized as "bunkers" that are primarily utilitarian in design. In designing the building interior, exterior and surrounding landscaping, Emerson paid special attention to reflecting the high-tech nuance of the surrounding campus while still recognizing that aesthetic design should support the nature of the building.

COST-EFFECTIVE GOAL

When considering post-consumer materials to make up the data center's structural framework, Emerson carefully selected cost-efficient building elements that offered the desired life-cycle payback without compromising the required strength and hardening qualities required for a mission-critical facility.

FUNCTIONAL GOAL

In considering space needed to successfully support Emerson's global consolidation effort, the facility was designed to ensure scalable growth. Special attention was paid to anticipating changes in information technology (IT) and other building systems and equipment to ensure that infrastructure changes could be made down the road without an extensive "fork-lift" upgrade.



Data Center Cutaway Model

PRODUCTIVE GOAL

Through the use of high-performance/redundant external glazing systems, the facility offers natural daylighting—a feature typically not found in enterprise data centers due to the structural vulnerabilities caused by external windows. The enhanced lighting is intended to improve employee efficiency and productivity, reduce human error and enhance employee recruitment and retention.

SECURE/SAFE GOAL

Because it is a mission-critical facility designed to support an "always-on" global network, the data center was designed to withstand a variety of natural and man-made disaster scenarios, including earthquakes, telecom fiber cuts, tornadoes, flooding and fires. From a structural perspective, the data center is designed to withstand up to an F3 tornado or an earthquake up to 8.0 on the Richter scale. In addition, the glass used on the front of the building is rated to withstand hurricane-force winds. Three separate fire protection systems also were incorporated to provide protection in the event of an emergency, including a pre-action dry pipe, a traditional wet system and a clean chemical system.

Additional Achievements

The project initially was projected to achieve a 17.5 percent reduction in energy consumption compared to conventional data centers. Based on the expectation, Emerson anticipated the project would achieve LEED Silver certification —becoming the first data center in the Midwest to earn the rigorous accreditation. However, thanks to additional anticipated innovation credits and an increased estimated energy savings of 31 percent at project completion, the facility was awarded LEED Gold certification in 2010.

PROCESS

Team Assembly and Site Selection

Emerson assembled a unique ownership group for its design and construction partners. Comprised of its own internal IT and facility management experts, the group was brought on for counsel at the project's inception and played a critical role in laying out a fundamental roadmap for the project, from initial construction to the rigorous data center provisioning process following the completion of the initial build.

In selecting a site for the data center, Emerson chose an existing parking area on its campus to serve as the site of the project. Because of its triangulated configuration with other buildings on Emerson's campus, the site offered convenient access to electrical sub stations as well as water and fiber optic loops. Existing office space and parking also enabled Emerson to considerably condense the building's required footprint and preserve green space that otherwise may have been enveloped in the project.

Choosing a Sustainable Energy Source

During the design process, Emerson faced several tradeoffs that ultimately would impact the facility's efficiency attributes. When analysis the site's existing topography and tree line eliminated the possibility of reliable wind power, Emerson decided upon a roof-mounted array. In addition to offering the best available concentration of natural light to generate 100kW of power, the data center's 7,800-square-foot rooftop solar array also minimizes the project's site footprint.

Designing an Efficient, Mission-Critical IT Infrastructure

When constructing a "green" data center, the IT building blocks inside the walls of the facility become a fundamental element in the building's overall design. To maximize efficiency without compromising reliability, Emerson implemented 10 prioritized best practices outlined in its *Energy Logic* roadmap intended to optimize energy use and minimize critical resource constraints. The roadmap was developed through extensive research and modeling of "the cascade effect"—which specifies that one Watt saved at the processor level can save an average total of 2.84 Watts in energy consumption.

Implementing Environmentally Responsible Construction Practices

Emerson also took steps to maximize the project's overall sustainability during construction and long-term after completion. Emerson's construction partners sought materials that would be sustainable while still facilitating the greatest building life cycle payback.

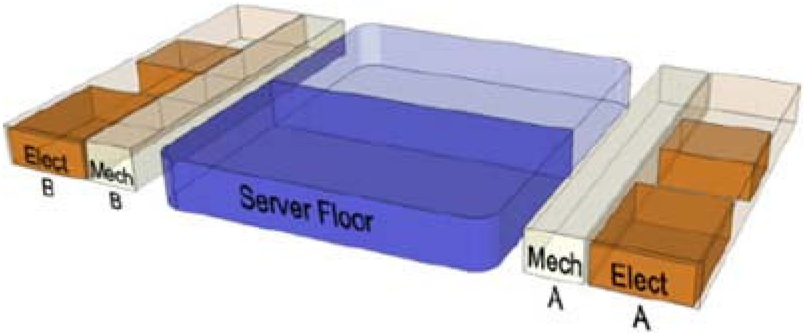
To meet these unique needs, the facility's frame was assembled from recycled steel procured and refined locally to minimize the energy required to transport it to the construction site. In whole, nearly 20 percent of materials used to assemble the building were comprised of post-consumer materials. In addition, 80 percent of waste resulting from the construction was diverted from landfills and locally recycled to further minimize project's carbon footprint. To further reduce the facility's impact on the surrounding environment, all impervious surfaces were designed to contribute to a natural drainage system that filters waste water before it reenters natural water sources.

INFORMATION AND TOOLS

From the project's inception, the building's designers meticulously consulted U.S. Green Building Council guidelines for achieving a predetermined LEED certification. The designers also relied heavily on the use of building information modeling (BIM) software throughout the building's construction. In addition to providing three dimensional renderings of concepts and/or progress to the owners, contractors and subcontractors, the use of BIM also played a critical role in modeling the facility's supplemental cooling systems and server rack configuration.

PRODUCTS AND SYSTEMS

At its core, the data center offered 6,000 sq. ft. of available raised floor space—expandable up to 12,000 sq. ft. to accommodate up to 5,000 servers—and was designed to use only as much physical space as needed, while still allowing for easy expansion. The facility's IT infrastructure was comprised in large part of locally-available data center power, cooling, and monitoring technologies from Emerson Network Power, which enabled Emerson to achieve the necessary levels of efficiency and reliability without having to enlist an outside vendor.



The facility's HVAC and lighting control systems were designed with a host of sustainable attributes. To enhance the efficiency of the HVAC systems, a Computational Fluid Dynamics (CFD) model was run to simulate space loads within the data center. Air devices then were located to ensure optimal system performance and a high performance environment for the equipment. The data center's intelligent lighting control system also accounts for both artificial lighting inside the facility and daylight available outside the facility. The lighting control system automatically reduces artificial lighting whenever sufficient daylight is available, further reducing the facility's electricity consumption. Overall site design for the data center also incorporated unique cost-reduction attributes, including a high-efficiency building envelope and water-efficient landscaping and fixtures.

INDOOR ENVIRONMENT

The facility features new building materials that direct natural daylight into the building's core, reducing power consumption. These materials, including hurricane-proof glass in the windows, maintain the building's structural integrity and make it strong enough to withstand an F-3 tornado. The natural daylighting also is expected to improve employee efficiency and productivity, reduce human error and enhance employee recruitment and retention.

PROJECT RESULTS

A. Lessons Learned

While Emerson set out on the construction of its data center with very specific sustainability goals, a synergy of energy efficient design and long-term ROI became increasingly evident throughout the construction process. After evaluating the costs and benefits of energy efficient strategies implemented, Emerson learned that every step taken toward sustainability and LEED certification was justified directly by the expedited ROI it ultimately would provide.

From a project management perspective, there also were significant lessons learned with regard to the integration of internal/owner project teams and outside contractors. While the assembly of an integrated team represented one of the most positive aspects of the project, the procurement and bidding process unfortunately prevented the participation of several contracting parties, including electrical and mechanical personnel. Because of the owners' involvement in the technical aspects of the preliminary design process, many of these teams had to be brought on board after initial plans for the project already had been finalized and agreed upon, making the bidding process significantly more challenging for the contractors.

B. Ratings

United States Green Building Council LEED Gold, 2009

C. Awards

Sustainable Building Industry Council Beyond Green Awards, High Performance Building Citation: Innovative Solution for a Niche Market Application

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Empire State Building Retrofit

GENERAL INFORMATION

Building Name: Empire State Building
Building Location:
City: New York
State: New York
Country: USA
Project Size (ft², m²): 2.1 million square feet
Building Type(s): Historic skyscraper office building
Project Type: Historic retrofit
Total Building Costs: $20M
Owner: Anthony Malkin
Client: Empire State Building Company
Services: Peer reviewer and design partner
Building Architect/Project Team: Rocky Mountain Institute, Jones Lang LaSalle, Clinton Climate Initiative, Johnson Controls
Project Contact Person: Carolyn Fluhrer, Rocky Mountain Institute

DESCRIPTION

The Empire State Building Retrofit modernizes the iconic skyscraper, allowing the building owner to offer state-of-the-art office amenities in a historic building while greatly reducing both energy use and carbon emissions. The retrofit is now is serving as a model and template for other multi-tenant, multi-story retrofits that promote sustainability.

The project is a model of integrated design and whole-system thinking. On the advice of the design team, the contractor is removing the building's 6,514 windows' sashes and glass, cleaning the glass, and adding a low emissivity (low-E) film and gas mixture between the reused panes. This project prompted cascading energy savings; as a result of the lower SHGC and increased r-value of the windows, the chiller plant could be retrofit and downsized instead of replaced and upsized, saving considerable capital and operating costs.

In addition to upgrading the windows, the team recommended upgrading or replacing major building systems and identified seven more economically viable projects that provide an overall 3-year payback and a 38% energy use reduction. The recommended measures also reduce cooling load requirements by 33 percent (1,600 tons) and peak electrical demand by 3.5 megawatts, benefitting both the building and the utility. The measures also improve indoor environmental quality for tenants by way of enhanced thermal comfort from better windows, radiative barriers, and superior controls; they improve indoor air quality through tenant demand-controlled ventilation; and they create better lighting conditions that coordinate ambient and task lighting. The measures include projects related to:

- Window Retrofit
- Direct Digital Controls (DDC)
- Tenant Lighting, Daylighting, and Plugs
- Variable Air Volume (VAV) Air-Handling Units (AHUs)
- Retrofit Chiller Plant
- Tenant Energy Management Program
- Radiative Barrier, and
- Tenant Demand Control Ventilation (DCV)

Project completion date: 12/2013

Overall Project Goal/Philosophy

One of the major goals of the Empire State Building retrofit was to ensure the process to achieve comprehensive energy savings would be transparent and replicable for other commercial properties.

COST-EFFECTIVE GOAL

Recommendations capitalized on the pre-existing capital improvement plan.

HISTORIC PRESERVATION GOAL

Providing state of the art office building amenities in a historic building. The building and its street floor interior are designated landmarks of the New York City Landmarks Preservation Commission and it was designated as a National Historic Landmark in 1986.

PROCESS

RMI's Eight (or so) Steps to a Deep Retrofit

In the course of RMI's work retrofitting the Empire State Building and other projects, RMI created a deep process for retrofitting existing buildings. The process, in comparison to atypical retrofit process, appears in the chart below.

Typical Retrofit	Deep Retrofit
0. Signed project development agreement w/ ESCO 1. Review planned capital projects 2. Investment grade audit 3. — 4. No outreach to tenants 5. 5-10 lighting & HVAC measures examined 6. Spreadsheet analysis of savings on a measure-by-measure basis 7. Recommendations to ownership based on simple payback	0. Kick-off discussion and initial goal setting 1. Walk throughs and creation of project baseline (planned capital & O&M spend) 2. Investment grade +++ audit 3. Calibrated energy model 4. Tenant interviews/workshop, sample/standard designs 5. 80+ measures examined with theoretical minimum exercise 6. Optimization of packages of Energy Efficiency Measures using energy model and Life Cycle Cost Analysis (LCAA) 7. Recommendations to ownership based on LCCA (includes follow-on support through contract & implementation phase)

INFORMATION AND TOOLS

In close collaboration with RMI, JCI ran energy analyses using DOE-2.2 (eQUEST interface), a building energy simulation tool that allows for the comparative analysis of building designs and technologies. By inputting weather files, building geometry, material properties, equipment schedules, and system components, the program computes building loads and outputs building energy use.

Once preliminary energy savings estimates for individual measures were provided, the team turned to the financial model (developed by RMI specifically for this project) to determine how to create packages of measures that maximized greenhouse gas savings while providing reasonable economic benefits. Iterations between these models helped the ESB team make final recommendations to ESB ownership regarding specific short-term and long-term projects and programs they can implement.

PRODUCTS AND SYSTEMS

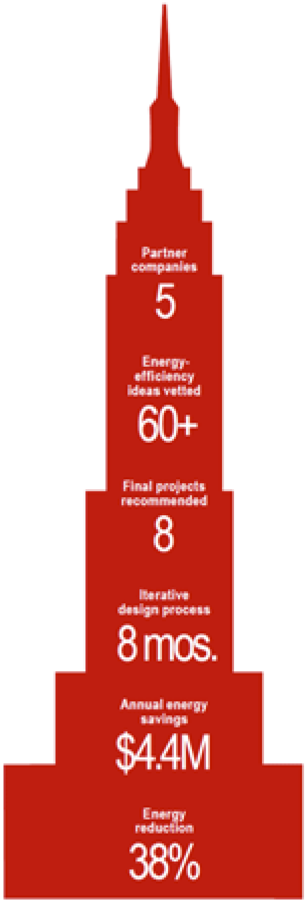
The project is a model of integrated design and whole-system thinking. On the advice of the design team, the contractor is removing the building's 6,514 windows' sashes and glass, cleaning the glass, and adding a low emissivity (low-E) film and gas mixture between the reused panes. This project prompted cascading energy savings; as a result of the lower SHGC and increased r-value of the windows, the chiller plant could be retrofit and downsized instead of replaced and upsized, saving considerable capital and operating costs.

In addition to upgrading the windows, the team recommended upgrading or replacing major building systems and identified seven more economically viable projects that provide an overall 3-year payback and a 38% energy use reduction. The recommended measures also reduce cooling load requirements by 33 percent (1,600 tons) and peak electrical demand by 3.5 megawatts, benefitting both the building and the utility.

ENERGY ISSUES

Energy Use Description

While retrofits typically reduce energy consumption by 10-20 percent, RMI proposed an integrated approach to realize savings of almost 40 percent.



INDOOR ENVIRONMENT

Indoor Environment Approach

The team designed a space on the 42nd floor of the Empire State Building to use in marketing space to prospective tenants. Key design features include a low-pressure drop HVAC system, and indirect layered lighting system (ambient-task-accent lighting), new high performance glazing, light sleeves and blinds, and local, high-recycled content construction materials. The retrofit overall will result in increased thermal comfort for tenants from better windows, radiative barriers, and superior controls; they improve indoor air quality through demand controlled ventilation; and they create better lighting conditions that coordinate ambient and task lighting.

PROJECT RESULTS

A. Lessons Learned

Developing robust solutions requires dynamic, multi-year models and collaborative efforts. The implementation team would need to anticipate and address changes in tenant profiles, vacancy rates and technology as well as building renovations and the possibility of tenant disruptions. Maintaining flexibility and collaboration in the team would ensure the success of the program.

Delivering the maximum cost-effective CO2 reduction requires a whole-system and life-cycle view. A proactive, long-term plan is required to maximize CO2 and financial benefits. One reason is that the most cost-effective efficiency upgrades would have to be linked to major capital upgrade projects. In addition, the team's assessment showed that rapid acceleration of efficiency implementation produced significant extra cost without providing a similarly large benefit.

The results reinforce the need to address the natural tension between business value and CO2 reductions. The scenario that maximized business value would avoid more than half of the CO2 reduction opportunity. Even the recommended program merely balanced cost and benefit at a point where the greatest benefit could be achieved for the lowest cost, rather than pursuing every viable CO2 reduction measure without regard to cost. In order to make the business case, perceived needs and industry norms needed to align with energy-efficiency levers.

Rapid dissemination and adoption of the results requires development of an efficient process to reduce time and costs. To drive speed and effectiveness, the team recommended development and use of tools to diagnose and categorize a portfolio of buildings; to rapidly develop a "first cut" answer; and to navigate through the iterative process between energy and financial modeling at the project level. Empire State Building Company accepted the team's proposed solution in its entirety (final project scope TBD), allowing the team to move forward immediately on implementation. The thorough and collaborative process had resulted in a strong consensus backed by transparent information. Tools were developed to measure and give feedback on building-wide and tenant improvements. The team now had a mandate and a plan to move forward swiftly and with confidence that the framework for decisions would continue to yield positive results, ultimately serving the goals of the Empire State Building owners and tenants as well as overall environmental goals.

A LOOK FORWARD

The analytical process was merely the first step toward achieving an optimal energy and sustainability profile at the Empire State Building, but it was of critical importance to the ultimate success of the program. The strategies selected from this process will not only have a significant impact on the building's carbon footprint but will open doors to additional cost-effective avenues of financing the project.

The Empire State Building is just one drop in an ocean of commercial buildings that must undergo some form of rational energy and sustainability retrofit in the next several years if we as a society are committed to reducing the impact of buildings on the environment. It is hoped that by making available documentation and information such as this report, the Empire State Building sustainability team can clear a path for thousands of other buildings to follow.

B. Publishing

- Empire State Building: Leadership in American Progress in 

(http://www.esbsustainability.com/) Sustainability(http://www.esbsustainability.com/)
- Retrofitting America's Favorite Skyscraper(http://www.rmi.org/rmi/RMI+Retrofits+America's+Favorite+Skyscraper), *Solutions Journal*, Spring 2009

WBDG a program of the National Institute of Building Sciences
(/index.php)

EPA New England Regional Laboratory

GENERAL INFORMATION

Building Name: U.S. Environmental Protection Agency, New England Regional Laboratory
Building Location: 11 Technology Drive, Chelmsford, Massachusetts, USA
Project Size (ft², m²):
- **Gross Square Feet:** app. 72,000 on 11.97 acres
- **Rentable Square Feet:** 68,950
- **Net Usable Square Feet:** 49,962

Building Type(s): Single story laboratory and administrative office and support space, with hazardous materials storage building and boat storage
Project Type: New Construction
Delivery Method: Lease/Build
Total Building Costs: $18.3 million
Owner: U.S. EPA New England
Building Architect/Project Team:
- ***Developer:*** Acquest Development
- ***Architect:*** Bernard Johnson Young & Carol Johnson Assoc.
- ***Contractor:*** Erland Construction, Inc.

Project Contact Person:
- ***GSA Contact:*** John Buckley, john.buckley@gsa.gov(mailto:john.buckley@gsa.gov)
- ***EPA Contact:*** Bob Beane, beane.bob@epa.gov(mailto:beane.bob@epa.gov)

DESCRIPTION

A. Project Description

The EPA's New England Regional Laboratory (NERL), a project constructed by Acquest Development Company in Chelmsford, Massachusetts has been an industry leader in its Construction Waste Management (CWM) program since its completion in June of 2001. From conception the project was charged to "make use of the best commercially-available materials and technologies to minimize consumption of energy and resources and maximize use of natural, recycled and non-toxic materials." During design, a large number of building products with high recycled content were specified, diverting large quantities of otherwise waste by-products from becoming landfill. Finally, exemplary construction waste management on site, throughout construction has surpassed current building practice and set a new standard for the industry.

The building contains 24 laboratories with laboratory support space, administrative office and support space, conference rooms, training rooms, a computer room, lunch room, and a library.

Building features include:

- Building Integrated Photovoltaic Array
- 100% "Green Power" purchase
- Modular boilers
- Chiller upgrade, Screw chiller with cooling tower
- Daylighting, solar tubes, borrowed light, light shelves to be added
- Xeriscaping
- Use of collected rainwater to recharge adjoining wetlands
- Advanced construction waste management
- Extensive use of recycled materials

Lab interior with fume cabinet.

- High efficiency motors and pumps with variable speed drives
- VAV air handling systems
- Low VOC , indoor air quality monitoring
- Alternative fuel recharging station
- Occupancy sensors and daylighting controls
- Low flow water fixtures
- Vortechnics unit to pre-treat storm water surface runoff
- Extensive building commissioning

B. Project Goals

OVERALL PROJECT GOAL/PHILOSOPHY

To construct a safe, efficient, economical state-of-the-art lab using sustainable principles. To be flexible as well as expandable.

ACCESSIBLE GOAL

Fully accessible

AESTHETIC GOAL

To be consistent with the mission of the EPA

COST-EFFECTIVE GOAL

Within Budget

FUNCTIONAL GOAL

Efficient, flexible state-of-the-art lab

HISTORIC PRESERVATION GOAL

N/A

PRODUCTIVE GOAL

Efficient, flexible, state-of-the-art lab

SECURE/SAFE GOAL

Level 3

SUSTAINABLE GOAL

LEED® Gold

OTHER SIGNIFICANT ASPECTS OF THE PROJECT

The genesis for the design of the facility began in the early 1990's and as such, much of the initial design specifications for the building hadn't included major energy efficient or green provisions. The team members, (mindful of Executive Orders 13101: Greening the Government through Waste Prevention, Recycling and Federal Acquisition and 13123: Greening the Government through Efficient Energy Management) were in agreement. They would do whatever they could to modify the design, to take advantage of new technologies, to include new, innovative, and improved construction materials and techniques. The EPA NERL would be as energy efficient and incorporate as many environmentally friendly or green features as possible within budgetary constraints. Their shared vision was to make this a state-of-the-art environmental analysis laboratory which would also serve as a showplace where both EPA and GSA could demonstrate that they "walk the talk". The team chose to achieve the lofty goal of being) the first laboratory facility to earn at least a Silver rating from the U.S. Green Building Council's "Leadership in Energy and Environmental Design" (LEED®) rating (program). This is a significant accomplishment as laboratories are notoriously energy inefficient and as such do not normally lend themselves to a LEED® rating.

PROCESS

Overview Of Process

As a design/build lease project multiple design options/offers were evaluated prior to award. The Source Selection Panel selected the best offer based on evaluation factors of price, experience, and technical excellence. Post Award, the use of an interactive, collaborative process helped to redefine the project as an innovative, energy efficient model. The Government hired a LEED® consultant to generate options for the mechanical systems and provide LCCA for each option. The Developer hired the AE firm of Vanderweil Associates and solicited support from the local utility via the Energy 2000 program. The Team utilized Web-Based Project Management to allow constant, interactive communication. The team evaluated options, trade-offs ultimately selecting the most viable options for inclusion in the final design.

PRE-DESIGN/PLANNING ACTIVITIES

The production of the Solicitation For Offers, (SFO), Source Selection Activities including multiple reviews of each offer.

DESIGN ACTIVITIES

This basically became a Fast Track design/build Project. Options were constantly evaluated by the team with considerable input from the General Contractor and selected for implementation based on the impact on ongoing construction activities, budget, and schedule. As a result of this process some desirable options could not be included as the window of opportunity had closed.

CONSTRUCTION ACTIVITIES

Advanced Construction Waste Management, on-site rock crushing for fill, stockpiling of topsoil for landscaping. Extensive use of recycled materials.

OPERATIONS/MAINTENANCE ACTIVITIES

Extensive Commissioning, on-site property manager. Computer based O&M program.

POST-OCCUPANCY EVALUATION ACTIVITIES

Re-commissioning, benchmarking, and measurement of water use, energy use.

Construction waste management for the Laboratory began prior to construction. In pre-design, site planning utilized the resources naturally available on the site, such as solar, natural shading, and drainage to avoid the generation of unnecessary debris and minimize site demolition. The Laboratory was situated to take maximum advantage of the natural topography. The hilltop location provides positive drainage away from the building, and benefits from the natural cooling effects of prevailing winds. Existing trees and natural areas were maintained as much as possible to shelter and shade the building and natural outcroppings were left throughout the site to enhance the natural setting.

Prior to the commencement of site clearing operations, erosion control measures including a combined straw bale/silt fence system were set in place. This enhanced detail served to protect both the large wetland in the SW corner of the site and to ensure that no soil migrated off site on the steep north edge. In areas where site disturbance was necessary for construction, every effort was made to stockpile any reusable debris. In particular, all soil and gravel within the limit of work was stockpiled and graded for later reuse as fill or loam. Collected gravel was used as base of concrete pavement, sub-base for bituminous concrete pavement, backfill for footings and structure, pipe bedding and backfill, and under-drain filter aggregate. Soil was screened to meet the specifications of loam for lawns and plantings or otherwise reused as general fill. Reuse of on-site material was sufficient to complete the landscaping and fill work with only a minimal amount of fine grading material (sand) brought on-site for finish grading.

In the schematic design stage, building materials with high recycled content were sought and specified to seamlessly integrate into the design of NERL. Building materials with recycled content contain feedstock material recovered from consumer or industrial waste streams. Using these recycled or recovered waste products reduces the use of virgin materials, reduces solid waste streams, and encourages recycling within the industry.

During the construction stage of the project an aggressive construction waste management plan was set in place. Construction activities naturally generate solid waste (an estimated 28% of the landfill material in the U.S.), yet much of this waste is "clean waste" and easily recyclable. For NERL, Graham Waste Services was identified and hired as a licensed hauler and processor of recyclables and other waste materials. In a letter dated 3/22/2000, Robert Schwartz stated, "Graham Waste Services will provide separate containers as requested for materials including but not limited to, the following: cardboard, metals, plastic, glass, gypsum board, carpet, wood, non-recyclable construction and demolition material, concrete, brick, asphalt, land clearing debris, and beverage containers. Materials that can be recycled will be disposed of at appropriate recycling facilities ... In addition, Graham Waste Services will work with Erland to ensure that clean dimensional wood, plastic, glass, gypsum board, and carpet are recycled, and will evaluate the cost effectiveness of recycling rigid foam insulation, engineered wood products, and other materials."

A concerted effort was made by all members of the design and construction team to first minimize all waste and then maximize recycling and reuse of the material going into the waste stream. According to the Foreman of Erland Construction, "All the subs were pretty helpful about getting on-board with recycling. At first some of the laborers didn't understand why we were doing it, but once you got them in the rhythm, it was easy. We just had to stay on them early. Now it's no problem and everything runs smoothly." From start to finish, reduction of waste through efficient design and at the source–on the job site–was emphasized. Whatever waste was generated during construction was carefully sorted and properly disposed of in the recycling bins. These bins were located initially on the south side and later relocated to the west side of the building and were clearly marked for designated recycling materials. The result was that over half the solid waste generated from construction was diverted from landfill and, instead, recycled.

INFORMATION AND TOOLS

Websites

- Energy Star–Business Improvement
- Energy Star–New Homes(http://www.energystar.gov/index.cfm?c=new_homes.hm_index)
- OIKOS Green Building Source(http://oikos.com/green_products/index.php)
- U.S. Environmental Protection Agency–Indoor Air Quality(http://www.epa.gov/iaq/)
- U.S. Green Building Council's LEED® Rating System(http://www.usgbc.org/DisplayPage.aspx?CategoryID=19)
- U.S. Park Service Green Database(http://www.fs.fed.us/eng/pubs/htmlpubs/htm99712307/)

Software

- U.S. Environmental Protection Agency–Labs for the 21st Century(http://www.labs21century.gov/)

PRODUCTS AND SYSTEMS

The Team spent many hours in planning and negotiating tradeoffs with the developer to achieve a green building. This started with the initiation of an advanced construction site recycling program (at a cost savings of over $10,000) and continued with the onsite crushing of approximately 17,500 tons of blasted rock for use onsite; saving disposal costs and reducing truck traffic. Specified building shell CMU backup was exchanged for metal stud and gypsum with added insulation to increase R value and recycled material content. This option resulted in a $22,000 credit used by the team to offset other costs.

NERL used a high, fly-ash content in its concrete. Fly-ash is a by-product of industrial coal combustion and its disposal causes problems in the form of land use, health hazards, and environmental dangers. A mitigating reuse of fly-ash is to use it as a supplement in concrete mix. This both reduces the amount of concrete necessary for new construction as well as diverts large quantities of fly-ash away from landfills. In the construction of the New England Regional Laboratory to date, the total quantity of fly-ash used is 243,286lbs. The projected total for the project is 251,582lbs. The result is saving approximately 126 tons of fly-ash from becoming part of the waste stream.

The following Table estimates recycled content of some of the materials used in the EPA's New England Regional Laboratory. By using such a large number of recycled products and building materials, an estimated 200 tons were reused in building construction rather than sent to a landfill.

Building Material	Percentage Recycled Content
Concrete	20% Fly-Ash Content
Reinforcing Steel in Concrete	95%-100% recycled scrap steel
Framing Steel	85% recycled steel

Gypsum Board	10% recycled or synthetic
Facing Paper for Gypsum	100% recycled newsprint
Acoustic Ceiling Panels	60% recycled material
Fiberglass Insulation	20% recycled glass cullet
Ceiling Suspension Systems	60% recycled material
Hydromulch	100% recovered materials

The following table shows the volume of material diverted to date from the waste stream and recycled by Graham Waste Services.

Materials	Size (Cu. Yd.)	Percent of Waste Stream (by Volume)	Cost ($) per 30 Cu. Yd. Container	Cost ($) Savings
Clean Wood	330	21%	325	$2200
Cardboard	100	6%	450	$250
Wallboard	210	13%	325	$1400
Metal	90	6%	325	$600
Concrete	80	5%	675	-$400
General Refuse	780	49%	525	$0
Total Recycled Material	810	51%		Total Savings: $4,050

Typically in new construction, new building materials are ordered and sized appropriately minimizing construction scrap. Carpet and gypsum board are major exceptions, generating a high volume of scrap. On site, scraps of carpet and gypsum were carefully segregated and recycled. In fact, recycling programs for gypsum in the vicinity have been so successful, that one difficulty encountered by Graham Waste Service during the project was that the local recycling facility for gypsum had reached capacity. As a result, it was necessary for Graham Waste Service to temporarily store the recycling bins of gypsum off site while they relocated to an alternative facility.

A great percentage of waste is generated from shipping and packing materials as well as materials used for temporary construction. Attention was paid by the construction team to recycle packing and shipping materials when shipments were received. In the damp New England climate, however, it was difficult to reuse the wood used in temporary construction. Finished construction mandates the use of fire-rated wood. Fire-rated wood is very sensitive to moisture and is significantly damaged or warped beneath construction grade when used in temporary, exterior applications. Nonfire-rated wood was, therefore, used and then recycled in all temporary construction for the project.


Water and fluid system

In addition to the capabilities available in the previous facility in Lexington, several new chemical analytical capabilities were added to this facility including a metals clean room suite incorporating class 100 clean room design and enabling the quantifying of metals in the part per trillion range in ambient water; a liquid chromatography and gas chromatography laboratory allowing the analysis of such non-traditional organics as endocrine disrupting chemicals and pharmaceuticals; and a partial containment and high resolution mass spectrometry lab specifically designed with the capability of addressing high hazard materials such as dioxin. Automated flow-through sediment toxicity and aquatic culturing laboratories were also designed augmenting the Lab's biological testing capabilities.

ENERGY ISSUES

Energy Use Description

Confronted with an initial design concept that failed to not incorporate many of the desired energy efficient and sustainable design features green items required to support their vision, the Team (comprised of members from EPA's New England Regional Office, EPA's Engineering, Architectural, and Real Estate Branch and GSA's New England Office) worked tirelessly to make it happen. The Team was able to incorporate several energy saving mechanical systems through normal funding and by working with GSA to secure credits through the local power utility. The systems included gas-fired modular boilers, water-cooled chillers, daylight dimmers, occupancy sensors, energy efficient light ballasts, high-efficiency motors and variable flow pumping systems, variable volume heating and cooling systems with night and low occupancy setbacks, low-E windows, daylighting through transom windows, skylights and solar tubes, and a state-of-the-art building management system. Taken all together, these will make the building at least 35% more efficient than comparable buildings. These energy efficient efforts were highlighted as part of EPA and DOE's "You Have the Power" campaign for saving EPA over $100,000 annually in energy costs.


Modular boilers

While this was a good start, the Team realized that although they couldn't reduce the facility's energy demands much further, they could reduce the amount of pollution generated from powering it. To this end, the Team worked to secure green power for its energy needs. This was accomplished by EPA agreeing to pay a "power premium" for purchasing wind-powered electricity generated in Vermont and New York which matches the electrical consumption of the new facility, estimated at close to 2 million kilowatt hours annually. Based on estimates of CO2 production for electricity generation in 2000 in New England, this amounts to a reduction in CO2 emissions of approximately 3.4 million pounds per year.

Another energy initiative was the incorporation of building integrated photovoltaic awning shades on the west and south office areas to reduce glare and heat gain while producing electricity which is put back into the power grid. These photovoltaic shades were funded by GSA's Energy Center of Expertise as part of their "Green Building" commitment, another example of the close working relationship and shared vision of the Team.


Solar panels used as shading devices

Additional green features include ultra-low VOC paint, sealants, and adhesives; electronic sensors on the plumbing fixtures in the restrooms; use of an on-site well for minimal laboratory make-up water and minimal start up irrigation needs; use of a portion of the roof runoff for wetland augmentation; and xeriscape design using native plants and grasses to minimize water, fertilizer, and pesticide use.

INDOOR ENVIRONMENT

Indoor Environment Approach

The following indoor environmental strategies were implemented in this project:

- Circulation/ventilation effectiveness-single pass system forces 100 percent outside air
- Transoms allow more natural light deeper into the building
- Low VOC paints, adhesives, and sealants

PROJECT RESULTS

A. Lessons Learned

The New England Regional Laboratory Design and Construction Team worked for over four years to ensure that the new facility, which came online September, 2001, would incorporate state-of-the-art environmental testing capabilities while providing an energy efficient and environmentally responsible laboratory setting. This Team comprised members from EPA's New England Regional Office, EPA's Engineering, Architectural and Real Estate Branch and GSA's New England Office.

Over time, laboratories invariably need to be reconfigured or expanded to meet changing research needs. The Chelmsford laboratory was designed and constructed with the following features to enable quick, cost- and material-effective modifications with minimal disruption to the rest of the building. Electrical and mechanical systems, including waste piping, are fed down two central spines and continued past the last module to allow easy extension into expansion space without taking other labs off line. Foundation walls were extended beyond the end walls and feature detailing to facilitate expansion without disrupting laboratory operations. Generic 11' by 26' modular laboratory units were used which are flexible enough in arrangement, layout, HVAC, plumbing and electrical capacity and distribution, to adapt to new programs and requirements without major alterations or expense. At the end of its useful life, the majority of the building construction materials can be captured, separated, and recycled at demolition, "cradle to cradle".

As noted earlier, most of the energy efficient and environmentally friendly features came from the vision of the Team and only achieved through their hard work and dedication. The Team has been approached by many groups for tours of the facility; both for its cutting edge environmental science capabilities as well as its energy efficient and environmentally friendly aspects.

In general, the foreman felt that recycling on site presented, "no problems". Graham Waste Service was helpful and responsive. Moreover, the advanced recycling program provided by Graham Waste Service has been a great selling point for them. They market themselves as having experience with Green Building design and have found members of the construction industry to be very responsive.

The EPA's New England Regional Laboratory remains committed to recycling and diverting waste from the waste stream. The project underwent LEED® certification from the U.S. Green Building Council, and expected to earn a Silver rating, and instead achieved a Gold Rating. When outfitting the building both during construction and upon completion many products, furnishing, and equipment were scheduled to be taken from the existing EPA Laboratory building for reuse or re-appropriation at the new Chelmsford facility. These included refrigerators, a Buck boost transformer, and miscellaneous lab equipment.

Finally, the building will continue to have a recycling program throughout its lifetime. Central recycling rooms and facilities have been part of the project design from the start, a commitment of dedicated square footage to ensure recycling efforts continue. The loading dock was designed to accommodate a baler ordered by the EPA, again to compact materials and reduce the volume of the waste stream. The EPA's New England Regional Laboratory has taken and will continue to take large steps towards conservation and sustainability through an advanced recycling and Construction Waste Management Program.

The Regional Administrator wrote: "We hope the benefits of the North Chelmsford Lab will extend beyond the site itself, providing inspiration and a concrete example that others can follow and improve on as new technologies become available."

This collaborative effort epitomizes intergovernmental cooperation and demonstrates how EPA and GSA "walk the talk" with regard to energy conservation and reducing the Lab's environmental footprint.

B. Ratings

Gold Rating(../media/pdf/cs_epalab_LEEDscorecard.pdf), Leadership in Energy and Environmental Design Program (LEED) Version 1.0, 4/2003

C. Awards

1. GSA Environmental Award, 4/2002
2. Real Property Innovation Award, 10/2002
3. Associated Builders and Contractors: Excellence in Construction Award, 11/2001, Category: New Construction under $25,000,000
4. GSA Demolition Derby: Model facility and non-hazardous waste, 4/2002
5. GSA Meritorious Team Award, 5/2002
6. 2002 White House Closing the Circle Award, 6/2002 Category: Model Facility
7. EPA Regional Bronze Medal, 11/2002
8. Industrial Designers Society of America Gold Medal Award for industrial design excellence of solar shades, 2001
9. Association of General Contractors: Build Massachusetts Merit Award, 10/2003

D. Publishing

WEBSITES

- Listed on the U.S. Green Building Council website: www.usgbc.org(http://www.usgbc.org)
- Listed on the GSA Real Property website: www.gsa.gov(http://www.gsa.gov)

PERIODICALS

- "Smarter Solutions", an article in www.green@work(http://www.greenatworkmag.com/), March/April 2003 issue
- "Solar Power, Thanks to Plug-n-Play" an article in "Save with Solar and Wind"(../pdfs/32081_summer02.pdf) a technical bulletin for Federal solar and wind energy champions, summer 2002 edition
- "Building Design and Construction" magazine, November 2003 issue
- "New England Real Estate/Construction Journal," January 2004 issue

OTHER

- The lab was featured by FEMP in 2002 in the "You Have the Power" poster.

(/index.php)

EPA Region 8 Headquarters

GENERAL INFORMATION

Building Name: EPA Region 8 Headquarters
Building Location: Denver, Colorado USA
Project Size (ft², m²): 248,849 RSF
Building Type(s): Leased Office Building
Project Type: New Construction
Delivery Method: Two Phase SFO - Design/Build
Total Building Costs: $90 million
Site Costs: $12.5 M
Building Architect/Project Team/Contacts:

- ***Developer:*** Opus Northwest, LLC
- ***Tenant:*** U.S. Environmental Protection Agency
- ***Design Architect:*** Zimmer Gunsul Frasca Architects LLP
- ***Architect of Record:*** OPUS A&E
- ***Consulting Architect:*** Shears Adkins Architects, LLC
- ***Mechanical/Electrical/Plumbing:*** Syska Hennessey Group, Inc.
- ***Blast Engineer:*** Hinman Consulting Engineers, Inc.
- ***Structural Engineer:*** KPFF Consulting Engineers, Inc.
- ***Security Consultant:*** Kroll, Inc.
- ***EPA's LEED® Review Consultant:*** Ensar/RMI
- ***LEED® Consultant:*** Architectural Energy Corporation
- ***Project Contact Person:*** Cathy Berlow, EPA


North façade and view of upper curtain wall

DESCRIPTION

A. Project Description

The design and construction of the new Environmental Protection Agency (EPA) Region 8 Headquarters in Denver, Colorado came as a result of outgrowing a leased space and having staff displaced over 23 floors in two separated towers, in the Denver Place building in downtown Denver. Additionally, the previous situation presented security risks and the building's character did not reinforce EPA's core mission of sustainability. Moving to a new building created the opportunity to consolidate EPA's staff on fewer floors, increase building security, and emphasize sustainability through the building's design, construction, and operations. The new Headquarters is located at a prominent location in the Lower Downtown (LoDo) Historic District on the 16th Street Mall, a bustling pedestrian avenue, and across from Union Station—currently being renovated as an intermodal transportation hub for Denver. The site, chosen from offers for 5 sites, provided a prominent location and access to both the 16th St. shuttle and light rail. The site was formerly a post office, and a postal annex that still remained on the site that was demolished in order for the project to proceed. GSA secured an assignable option for this site for one year which gave GSA one year to award the project to a developer, who would then be mandated to purchase the assignable option. The project was completed in November 2006.

B. Project Goals

OVERALL PROJECT GOAL/PHILOSOPHY

At the time of award, it was intended and required that the new Headquarters building achieve a LEED Silver certification and an Energy Star rating, and follow EPA's comprehensive procurement guidelines. Selection criteria were established for various phases of the project. The first step in the selection process was to identify and secure a site located in the Central Business District, sufficient in size and close proximity to mass transit. The second phase was broken into two parts, team qualifications and then short-listed team building design. The SFO included detailed lease terms, technical specifications for architectural, mechanical, and electrical components, and a detailed program of requirements. This included and required 300,000 gsf of space with approximately 248,849 rsf of office space, 40 secured parking spaces, and 70 secured bike spaces, as well as ground level retail space and a loading dock, with a minimum 25,000 sf floorplate. The Region's criteria for the second phase were sustainability, security, and schedule. These requirements also addressed design, achieving a better workplace, building operations, and price.

EPA Denver's location in the LoDo district near the pedestrian avenue and public transportation

SECURE/SAFE GOAL

Increase security features and blast resistance in the context of sustainable design features to meet GSA medium level security, blast-proof envelope. Utilize Crime Prevention through Environmental Design (CEPTD) principles, especially along the historic streetscape.

SUSTAINABLE GOAL

The developer and his team were required to achieve a minimum LEED Silver level and Energy Star certification within 14 months of reaching 95% occupancy. The developer is also required to maintain these certifications through out the lease term or be penalized with rent reductions until the certifications are attained. Best practices were sought for energy conservation, water conservation, resource conservation, and indoor air quality. EPA also pursued sustainability beyond the scale of the building by trying to reduce their reliance on paper and implementing an electronic equipment recycling program.

FUNCTIONAL GOAL

To respond to the neighborhood historic context and the urban environment, while respecting the local surroundings. Create a pleasant, cohesive, more productive, and well-lit office environment for the employees.

ACCESSIBLE GOAL

To meet or exceed all of the current accessibility codes; provide pedestrian-friendly access to the light rail system, buses, and bicycle riding opportunities located in LO-DO district.

AESTHETIC GOAL

To bridge between the Lower Downtown (LoDo) historic low-scale neighborhood to the south and the more modern development area to the north with modern lofts and commercial high-rise buildings. In addition, expressing the buildings' goals for sustainability to the public on the exterior and to tenants on the interior.

COST-EFFECTIVE GOAL

To construct the new facility within the costs established by the lease using a combination of age-old strategies for responding to the natural environment with state-of-the-art building systems to reduce energy use by 30%.

HISTORIC PRESERVATION GOAL

To effectively address and respond to the requirements and concerns of the Lower Downtown (LoDo) Design review Board for paving patterns, street furniture, cornice heights, fenestration, density, setbacks and ground level retail use requirements.

PRODUCTIVE GOAL

Design a building that would allow EPA to consolidate its 850 staff on fewer floors; enhance occupant health, well-being, and productivity. The SFO required 250,000 gsf with 231,281 to 232,000 rentable square feet.

OTHER SIGNIFICANT ASPECTS OF THE PROJECT

See the EPA Region 8 website.

PROCESS

Overview Of Process

Several teams were established for the project and each team developed a regular communication system in order to facilitate an efficient and effective outcome and to coordinate effectively. In addition to the design experts on the development team, GSA and EPA sought advice from the technical staff of EPA, a private sustainability consultant, and the National Renewable Energy Laboratory (NREL).


Building under construction

The core team consisted of Opus Northwest, LLC as developer, contractor, and owner, Zimmer Gunsul Frasca (ZGF) as the design architect and design LEED expert, Syska Hennessy as daylighting, energy, mechanical, electrical, and plumbing engineers, KPFF as structural engineer, Hinman Consulting as security and blast consultant and Architectural Energy Corporation (AEC) as the construction LEED expert and preparer of the final LEED documentation submittal to the U.S. Green Building Council (USGBC). Opus's strategy included the formation of a team in which every team member acted as a LEED design consultant. Shears Atkins, a local architecture firm with knowledge of LoDo's entitlement and design guidelines, was involved for the entitlement phase. Jim Blackledge of EPA's Region 8 was hired to manage the local activities for design, construction, and occupancy. Blackledge put together internal teams on a volunteer basis to make decisions on many aspects of the project. For example, a team of ten EPA staff conducted market research and environmental evaluation in order to make recommendations for furniture, weighing decisions such as wheatboard versus urea formaldehyde-free composite wood. EPA also created a mockup of a Herman Miller workstation in their existing office to solicit reactions from the staff. The reaction to the workstation size and materials was positive.

The project team's activities centered on communication of technical information as business benefit or cost-benefit scenarios. They conducted extensive research on opportunities and focused on remedying anticipated issues. The team pursued and was awarded a federal energy management grant from the U.S. Dept of Energy to advance the energy systems decisions.

One unique example was the proposed water-efficiency measures which required the cooperation of local agencies like the Department of Health and the Wastewater Management Division.

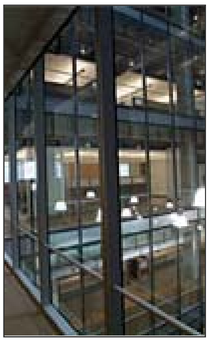
PRE-DESIGN/PLANNING ACTIVITIES

The team was required to register the project with USGBC during design development and provide an updated scorecard and energy calculations at each phase. Developer teams were required to present a complete conceptual design package including:


Denver EPA Headquarters, Conceptual rendering

- 1/8" floor plans, sections, and elevations, including material notations
- Exterior rendering, site, and landscape plan
- Materials board for exterior and common areas and list of core finishes
- Narrative and basis of design for building systems and how they will meet Energy Star criteria
- LEED scorecard showing at least 33 points and all prerequisites
- Construction waste management plan
- Explanation and analysis of how the design meets the SFO criteria and upgrades beyond the SFO standards.

DESIGN ACTIVITIES



The site offered several opportunities and constraints that shaped the design of the building and defined the design activities. It is a prominent corner site in a pedestrian-friendly historic district, across from a future public plaza and there were additional requirements and concerns of the Lower Downtown (LoDo) Design Review Board for paving patterns, street furniture, cornice heights, and fenestration detailing that needed to be addressed. Additionally, the urban setting required full buildout to the sidewalk and commercial and retail space on the ground floor as well as a desire to reflect the local pattern of a mid-block break, with alleys bisecting blocks.

The OPUS design team began by studying several massing options, all of which were 9 stories high and approximately 250,000 sf and had the same proportions of brick and glass for the exterior skin. Four massing options were modeled using Ecotect software to create rough energy calculations including heating and cooling per month. A sample level was studied to examine daylight distribution across the floorplate. A matrix of the results of the studies showed the advantages and disadvantages of each massing scheme, but with no clear winner. One scheme included an atrium which responded to the programmatic desire to accommodate EPA's all-hands meeting of 850 staff, while letting daylight into the center of the building. The atrium scheme was considered to offer the best combination of energy efficiency and daylighting.

Upon their selection of the basic concept of a square building surrounding an internal atrium, the team next looked more closely at the site and environmental influences. Because of the 45 degree rotation of the street grid in LoDo, the conditions were considered to be the most difficult for daylighting. A response to this and the prevailing winds from the north was a concept of two differently articulated L shapes wrapping an atrium. The southeast and southwest legs deal with the daylight and solar gain, while the northeast and northwest legs were designed for wind. The north leg is nine stories high and the south leg is eight which allows for a roof garden on the south leg that is sheltered from the wind. A break between the Ls at ground level created a corner entry facing the new plaza at Union Station. The building's glass upper stories rise out of a brick base, with detailing and cornices that respond to the historic context and respect the surroundings.

Interior office corridor overlooking atrium; Atrium sails control daylighting, solar gain, and glare

The curtain wall design was modified for each façade with an emphasis on responding to environmental conditions while managing the cost of the system. The team worked carefully to balance sustainability and construction costs, which were a prominent issue, according to John Breshears, since it is a developer building.

CONSTRUCTION ACTIVITIES

The team was required to provide plans for final commissioning, indoor air quality, and construction waste management at the completion of the construction documents phase. During construction, they had to provide information on the volatile organic compound levels for all interior finishes, a monthly Construction Waste Management (CWM) report, EPA Green report documentation, monthly construction photos, and quarterly reports on recycled content.

During weekly construction meetings, the schedule was reviewed and followed by onsite inspections with GSA and EPA. Monthly construction reports were provided to GSA updating status on schedule, weather conditions, LEED data collection status, and construction photos.

Additionally, biodiesel fuel was used to power construction equipment. It was the first construction site in Colorado to use an alternative fuel to power the equipment. The biodiesel fuel source was local Canola plant oil and was considered to address deterioration of air quality. The use of the fuel was acknowledged by local and national politicians who also promoted state agriculture, so there were additional benefits as a result of the extra attention brought to that effort.

OPERATIONS/MAINTENANCE ACTIVITIES
The team is required upon construction completion, to provide LEED documentation, final reports for CWM, operations plan, lead in drinking water testing, IAQ testing, and final commissioning.


Waste management onsite during construction

POST-OCCUPANCY EVALUATION ACTIVITIES
The developer will submit annual reports on recycling operations and quarterly energy use reports, and GSA will have read-only access to a graphical user interface for data collection.

INFORMATION AND TOOLS

Publications
ASHRAE 90.1(/references/ihs_l.php?d=ashrae%2090.1)

Software
Ecotect software(http://ecotect.com/)
eQuest(http://doe2.com/equest/)
Radiance(http://www.schorsch.com/rayfront/)

PRODUCTS AND SYSTEMS

Exterior sunshades were a combination of a horizontal 20" perforated metal shade with an 11" fin. This choice of metal was made in order to balance performance—enhancing daylight, preventing solar gain, and controlling low-angle glare in the morning and afternoon—with construction cost and blast security.

Interior light shelves were incorporated on the south façade.

The building's roof is an EPDM membrane with a high-emissivity acrylic coating. This particular coating holds up better and is preferred by the roofing companies that provide the roof warranty.


The building's modular green roof system is planted with sedum and will reduce storm water pollution, minimize heat-island effect, and absorb carbon dioxide.

The Green roof was created to address water quality and energy conservation using a modular built-up system consisting of 4" deep plastic trays that sit on top of the roof membrane. Although the system added cost to the roof assembly, it will allow for planting of a few varieties of sedum and experimentation is ongoing with other types of plants. The roof was created to primarily relate to the LEED credit for avoiding heat islands, but the team conducted extensive work to have it apply to the storm water management credit also and was sized accordingly at 19,200 sf. The module trays are located on three terrace levels. Green roofs have numerous environmental attributes including: improving water quality runoff, reducing sewage system loads, reducing heat island effect, filtering air pollutants, mitigating smog formation, providing wildlife habitat, reducing building energy expenditures and improving urban aesthetics. From an economic standpoint, green roofs have a longer service lifespan than conventional roofs. They decrease costs associated with installation of infrastructure and related retention reservoir. Life-cycle costs between conventional and green roofs are comparable but the initial installation cost of a green roof is two times higher than a premium quality conventional roof. Other economic benefits to the building include: enhanced resale value, increased occupant comfort, increased worker productivity.

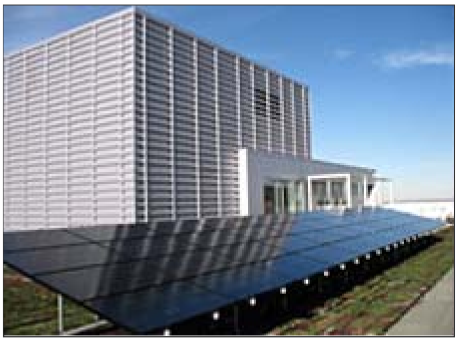
The building's mechanical system was designed for energy efficiency and increased ventilation effectiveness. The system was originally designed with waterside/floor by floor AHU but changed to a more energy efficient centralized rooftop air handling unit with air-side economizers.

Cooling is provided by a chilled water distribution system with variable-speed chillers and centralized rooftop air-side economizers.

The structural system is based on a post-tensioned flat slab with expressed beams on a 5' module. It ended up being a pan joist system.

Curtain wall design was modified for each façade with an emphasis on responding to environmental conditions while managing the cost of the system.

A 10 kW photovoltaic solar array was installed on the roof of the building.


Photovoltaic array on south corner of roof is designed to produce 10 kWh during peak sun.

Other Sustainable Strategies:

- Recycling & Waster Reduction programs
- Floors: recycled tires, natural cork
- Carpet: recycled content 8%–35%
- Acoustic Tile: recycled glass
- Wall recovering: recycled fabric, bamboo
- Countertops: local stone, recycled glass, aluminum scraps
- Ultra Low-Flow Lavatory
- Low-Flow Showers
- Low-Flow Sinks
- Water Free Urinals in men's bathrooms (Potential savings = 360,000 gallons per year)
- Dual Flush toilets in women's bathrooms

ENERGY ISSUES

Energy Use Description

The energy requirements for the building were approached from a whole building design perspective instead of from just an HVAC standpoint. This was very innovative and fairly new to the team as an approach to consider for this project. A detailed computer simulation was performed using eQuest building energy simulation program, developed to calculate hour-by-hour building consumption over the entire year using weather data for the specific location.

TestMarc was hired to perform Commissioning for the LEED energy and atmosphere requirements. The efficient mechanical systems, use of free cooling, daylighting, shading, and underfloor air system contribute to the estimated 35% energy savings. No HCFCs or halons were used in equipment. EPA agreed to purchase 100% of their power from renewable sources to achieve LEED credit 8 which addresses green power and to achieve an innovation credit.

The building is predicted to have an aggregate energy usage of 47.5 kBtu/(sf-yr), exceeding the ASHRAE 90.1 1999 baseline performance by 39%. The performance is also well below the GSA target of and average 55 kBtu/(sf-yr) for its entire portfolio. The main energy-efficiency design features of the project include:

- Building form that responds to climatic forces to enable maximum daylight penetration
- High-performance glazing and building envelope design
- Daylight redirection and control devices optimized for daylight harvesting coupled with daylight responsive lighting controls
- Optimized insulation levels
- External solar shading devices
- Energy-efficient lighting and reduced lighting power density
- Occupancy sensors
- Variable-speed drives for chiller and pumps
- Premium-efficiency motors
- Under-floor air distribution
- Air-side economizer
- Demand-controlled ventilation (CO_2 monitoring)
- Carbon-monoxide-controlled parking ventilation

Annual on-site renewable generation
PV 10 kWh array on roof

Data sources and reliability

Based on simulation? Yes
Based on utility bills? No

NOTE: Additional energy data to be supplied at a future date.

INDOOR ENVIRONMENT

Indoor Environment Approach


Elevator corridor showing use of materials with low or no VOCs such as carpet, paints, and wood products.

A variety of features were integrated into the building which improves the indoor environmental occupant quality. To achieve the IAQ prerequisites, the project met the ASHRAE 62-1999 ventilation air quality standard and is a non-smoking facility. The under-floor air system provides increased ventilation for LEED credit 2 and individual control to achieve part of credit 6.2 requirements also resulting in which results in a very high air change effectiveness. Additionally, carbon dioxide monitors were integrated to validate proper ventilation. Credit 3, which is Construction IAQ management plan during construction, was achieved through construction practices and a pre-occupancy flush-out.

Materials such as adhesives, paints, carpets, and composite wood products that have low or no volatile organic compound (VOC) emissions were specified to achieve LEED credit 4. Walk-off mats and exhaust requirements for janitor's closets and copy areas were provided for indoor chemical and pollutant source control.

Operable windows were not proposed due to concerns about air pollution and mechanical system operational control. The mechanical system was designed to achieve thermal comfort and the building facades provide sufficient daylight and view to meet the requirements of LEED credit 8 of diffuse sunlight to 75% of the space and outdoor views for over 90% of the spaces.

PROJECT RESULTS

A. Lessons Learned


Office cubicle design allows for natural daylight to penetrate into the work space.

Design-build and design excellence should not be mutually exclusive. If excellence in sustainability is a project goal from the beginning, it can be achieved. However, the project was not without its challenges. The project's structure and ambitious goals led to some challenges and missed opportunities. The project raised the issue of whether changes due to the evolution of the design and project team are reasonable and to what extent GSA and the developer can mitigate these changes.

While the team was able to work effectively with local stakeholders, there were some issues that might have benefited from early discussions. For example, an agreement could have been formed with the City of Denver on city-specific issues such as the city light fixtures and street trees up front. Since those fixtures and trees are not compatible with LEED requirements, there might have been a better possibility to explore.

The LEED process also presented a few conflicts including have to address and achieve points for things that did not necessarily apply to the Denver region or the project specifically. For example two years was spent convincing the project team that the green roof required supplemental irrigation due to the harsh arid climate, versus other green roofs installed in temperate climates of the U.S. The project team was initially more focused on not losing the LEED credit and the modeling indicated that the irrigation approach would work. So finally when the green roof was identified as a public good with respect to offering a best management practice for local and regional municipalities it was installed with temporary irrigation and will be studied for its need beyond the plant establishment period.

Additionally, the relationship of a green building to worker well-being was more thoroughly understood as the process unfolded. Members of the team learned to understand the importance of how designing a building and its systems influences employee performance, satisfaction, and health.

Overall most team members commented favorably on the process of working in an integrated team environment. It was new for many and open communication, patience in resolving complex problems, and effective listening were cited as having a positive impact on the goals of the project. Also noted was the fact that the project was very visible for EPA and the federal government and that the team approach offered great value to EPA.

B. Ratings

LEED Silver minimum submitted February/March 2007.

C. Awards

None to date

D. Publishing

- *EPA Region 8 Headquarters: Denver, Colorado, Harvard Legacy Case Study*, prepared by Julie Walleisa, Copyright 2006.
- *EPA Walks the Walk on New Denver Headquarters*, article by Headwaters News, 3-06-07.
- *USEPA Region VIII Opens Green Denver Headquarters*, article by John Laumer, in Business & Politics, 3-08-07.

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Home Depot Smart Home

GENERAL INFORMATION

Building Name: Home Depot Smart Home
Building Location:
City: Durham
State: North Carolina
Country: USA
Project Size (ft², m²): 6,000 square feet
Building Type(s): Residence Hall
Project Type: New Construction
Delivery Method: CM at Risk
Total Building Costs: $336 square feet
Owner: Duke University
Building Architect/Project Team: Managing Architect | SmithGroup
Chris Brasier, AIA, LEED AP (Vice President)
Patty Boyle, AIA, LEED AP (Associate)
SmithGroup provided Construction Administration services that included design evaluation and integration of donated materials for this project.
Design Architect and Architect of Record: Frank Harmon Architect Pa
Construction Manager: Bovis Lend Lease
Project Contact Person: Chris Brasier, AIA, LEED AP

Patty Boyle, AIA, LEED AP | Associate, SmithGroup
Phone: 919.294.0909
Email: patty.boyle@smithgroup.com

DESCRIPTION

Project Summary

A live-in research laboratory, this 6,000 gsf residence hall serves as a testing ground for smart and sustainable technologies. Initially developed by a student as a senior thesis, the Smart Home Program has evolved to include the participation of over 450 students, several of whom represented the University during the process of design and construction of the Smart Home. The program advances the students' efforts through relationships with corporate partnerships, like project sponsor The Home Depot, to evaluate product prototyping, marketability, and commercial viability.

Completed in November of 2007, the Smart Home was awarded a LEED-NC Platinum Certification by the U.S. Green Building Council for its excellence is sustainable design. Several sustainable systems are incorporated into the home including rainwater harvesting, solar hot water heating, photovoltaic power generation, a green roof, rain garden, energy recovery ventilator, and renewable and recycled materials. Alongside these systems, many innovative technologies developed by the students are integrated into the home including voice recognition systems, shower water heat recovery, and energy performance and water usage monitoring systems.

The Smart Home site is strategically located at the threshold between the University and the surrounding community of Durham. The scale and form of the building responds to the adjoining residential structures while also visibly expressing emerging technologies and design strategies aimed at minimizing environmental impact. The orientation of the building on the site provided the greatest opportunity to take advantage of solar technologies, passive ventilation, and natural daylighting.

OVERALL PROJECT GOAL/PHILOSOPHY

The goal of the project was to design a home which cultivates student-led idea-generation and innovation, ultimately working towards improving the quality of life for people of all ages and incomes.

SECURE/SAFE GOAL

To design a safe living and learning environment where occupants feel comfortable with their surroundings.

As a campus building for students, safety was a necessary goal. The building is equipped with an entry access system that is linked to and monitored by the campus security. In addition, site lighting analysis and fixture selection allowed exterior lighting levels appropriate for safety without impacting the surrounding homes and environment.

SUSTAINABLE GOAL

To design a home that serves as a model for sustainable living in the "every-day" home.

In June of 2008, the Smart Home achieved a LEED-NC Platinum rating by the U.S. Green Building Council, perhaps one of the biggest accomplishments for the Smart Home team. It is the first residence hall to receive a Platinum rating and is among the highest rated buildings in the world. The Smart Home serves a model for sustainable living for the surrounding community and beyond. Scheduled tours allow visitors to come to the home and learn more about its sustainable features and the mission of the Smart Home Program.

FUNCTIONAL GOAL

To design a home that can support and adapt to technological advancements well into the future, supporting the productivity and experimental learning of its occupants.

Many of the rooms within the Smart Home have a specific purpose, however, the floor plan still allows for interaction and flexibility. In addition, as one of the underlying goals of the project, the home is designed to adapt to future technological advancements. One example of this is the removable wall panel system and accessible ceiling areas, which allow for easy reconfiguration of the Home's internal systems.

ACCESSIBLE GOAL

To design a home with an open floor plan to promote collaboration and interaction among its occupants while still allowing space for privacy.

Upon entering the home you are immediately struck by the large, double-height common room which provides open views to the second floor and ample daylight from the south-facing windows. A clean and dirty lab anchor each end of the common room. Both labs were specifically designed without doors to promote interaction, collaboration and visibility throughout. The students' individual bedrooms provide privacy on the second floor.

AESTHETIC GOAL

To design a home that is sympathetic to the surrounding residential scale structures while also clearly articulating new ideas about the relationship between building and landscape.
In addition to usual connections to "working" landscape features such as the rain garden, the building also responds to the climate and aesthetic of the southeast region and provides "porches" and balconies that run along the southern elevation. This approach not only provides habitable outdoor spaces but also serves to shade the structure during the summer months.

COST-EFFECTIVE GOAL
To design a cost-effective home; taking into consideration sustainability and durability.
The Smart Home team was careful to consider cost throughout the design and construction of the building. Many of the materials and systems for the home were not only selected based on their environmental impact, but also based upon their durability and long-term benefits to the home. Life cycle cost evaluations helped inform the decision making process.

HISTORIC PRESERVATION GOAL
N/A

PRODUCTIVE GOAL
To design a productive living and learning environment.
More than 90% of the locations inside the home have direct daylight views. Large windows span the entire front of the home, providing ample daylight for its residents. Opportunities for natural ventilation are provided to introduce fresh air. In addition, the porches located on the front of the home allow residents to take advantage of the outdoors.

PROCESS

Overview of Process

Many of the high performance strategies implemented in the project were the result of extensive engagement between the design/construction team and student representatives. The students were involved throughout the entire process of design and construction, including the evaluation and selection of systems and materials for the home. This unique team composition brought multiple and diverse perspectives to the table.

PRE-DESIGN/PLANNING ACTIVITIES
Initially developed by a student as a senior thesis, the Smart Home Program gives students the opportunity to conduct research and develop innovative, sustainable designs, some of which are incorporated into the Smart Home.

DESIGN ACTIVITIES
A challenging aspect during the design phase was the incorporation of materials and systems being proposed for donation to the project. These proposals, while often attractive from a financial perspective, had to be vetted against many criteria including the primary goal of sustainability, compatibility with other building systems and materials as well as the potential collateral impact to the ongoing construction schedule. The team worked collaboratively to evaluate the trade-offs of a particular proposal and to reach a collective decision that best served to advance the overall project goals.

CONSTRUCTION ACTIVITIES

Waste generated during construction was placed in a bin and taken to a sorting facility where it was separated into disposables and recyclables. This process resulted in more than half of the total waste to be diverted from landfills.

OPERATIONS/MAINTENANCE ACTIVITIES

All of the owner training sessions were digitally recorded and stored on a network, allowing occupants access at any time to fully understand how the systems worked in the home.

The Smart Home participates in Duke's campus-wide initiative of a sustainable campus. This includes the University's recycling program, which services over 800 locations containing 1900 bins per week and collects 17 different items for recycling.

POST-OCCUPANCY EVALUATION ACTIVITIES

As a "living laboratory" occupants of the Smart Home are continuously conducting experiments and evaluating their results, which often lead to other studies and experiments. While students move in and out of the home each semester, their projects remain, influencing and informing the work of the next generation of occupants. This continuous cycle of testing and experimenting is conducted with the single mission of working towards a more sustainable future.

INFORMATION AND TOOLS

Energy Modeling Software

(used to calculate performance and determine the energy contribution from the photovoltaic rays)

- eQuest
- pvWatts

Project Management Software

(allowed potential material and system donors to upload technical data for evaluation by the design team, vetting proposals against the projects sustainability goals)

- Expedition

PRODUCTS AND SYSTEMS

WATER SYSTEM

Two 1,000 gallon storage tanks located on either side of the home collect rainwater from roof runoff and is later used for irrigation and landscaping the property. Any excess water that cannot be stored is diverted to the site where it flows through a series of "rain gardens" before entering the municipal storm water system. In addition, six 350 gallon rainwater storage tanks are located in the basement of the home. This water is used for toilet flushing and clothes washing.

HEATING, VENTILATION, AND AIR CONDITIONING (HVAC) SYSTEM

The electric heat pumps installed in the home have a SEER (Seasonal Energy Efficiency Ratio) of up to 16 (Cooling Efficiency) and a HSPF (Heating Seasonal Performance Factor) of up to 9.85 (Heating Efficiency). For a comparison, the current national efficiency standard for new heat pumps requires a minimum SEER of 13 and a minimum HSPF of 7.7. In addition, the refrigerant used in the HVAC system is R-410a, which is an environmentally friendly alternative to normal refrigerants used in air-conditioning systems.

The air in the Smart Home is purified by the Trane CleanEffects air purification system that filters air and creates up to 99.98% cleaner air via electrically charged fields making it easy to clean. The system is 8 times more effective than the best HEPA filters and 100 times more effective than the standard filter or ionic-type room appliance. The system removes 12% of .3 micron sized particles from the air in the Smart Home every minute.

ENERGY STAR APPLIANCES
Most of the kitchen appliances in the home are ENERGY STAR certified.

REMOVABLE WALL PANEL SYSTEM
Requested by students, removable wall panels were strategically distributed throughout the house at critical vertical and horizontal nodes. The design allows students to easily modify and monitor the home's infrastructure systems in support of their research and on-going exploration of innovative technologies.

MATERIAL SELECTION
Low-emitting materials including paint, sealants and adhesives, carpet and composite wood were used throughout the home, providing a healthier environment for its occupants. Durability and long-term benefits were also significant factors in material selection.

ENERGY ISSUES

Energy Use Description

As a model for sustainable living, several systems within the Smart Home are energy-efficient. Exceeding the current national efficiency standards, the HVAC system is very resourceful, with an SEER of up to 16 and a HSPF factor of up to 9.85. In addition, the photovoltaic panels reduce energy by up to 30% in the home.

Currently, energy performance data is being collected and tracked through the Siemans Apogee system in the Home. Once a substantial amount of data has been collected, the results will be posted onto the Smart Home website for public viewing.

INDOOR ENVIRONMENT

Indoor Environment Approach

DAYLIGHTING
More than 90% of the locations inside the home have direct daylight views. Large windows span the entire front of the home, providing ample daylight for its residents.

HVAC SYSTEM
The Home's air purification system provides 99.98% cleaner air within the home and is 8 times more effective than the best HEPA filters.

MATERIALS
Low-emitting materials, including paint, sealants and adhesives, carpet and composite wood were used throughout the home.

PROJECT RESULTS

A. Lessons Learned

The single greatest lesson learned on the project could be summarized by the often quoted, rarely achieved axiom of "the whole being greater than the sum of the individual parts". This synergy was evident not only in the attitude approach and results of the project team's efforts but also in the building itself. The building is far more successful as a research facility as a result of the embedded residential program and also a more inspiring student residence as a result of the integrated research environment. This lesson in the power of collaboration continues to be evident in the imaginative and innovative work of the student teams that now inhabit the building.

B. Ratings

The Smart Home earned a LEED-NC Platinum rating from the United States Green Building Council. With 69 points being the maximum number of credits achievable in LEED for new construction, the Smart Home received 59 total points, making it one of the highest ranked LEED buildings in existence and the first residence hall to receive a Platinum rating.

C. Awards

Sustainable Buildings Industry Council (SBIC), 2008 High-Performance Building Awards

- Category A – High-Performance Building Award

Associated Builders and Contractors, Inc., 2008 Excellence in Construction Awards

- Carolinas Green Award (1st year a Green Award was given)
- Eagle Award

Triangle Business Journal, 2008 Green Awards

- Nonprofit Education Program Award

D. Publishing

- *Building Design + Construction*; September, 2008; "Living in a Green Laboratory"
- *Business North Carolina*; Special Advertising Section: NC Goes Green; "Seeing Green"
- *Duke Engineer*; 2006-2007; "The Home Depot Smart Home at Duke"
- *Duke Engineer*; 2008; "Life Inside Duke's Smart Home"
- *Duke Magazine*; January-February 2008; "Green Living"
- *Duke Magazine*; May-June, 2008; "Campus Observer: Smart Living"
- *Duke Today*; Volume 2: No. 10; "Building Green"
- *Durham Herald-Sun*; October 29, 2008; "Duke buildings get LEED certification"
- *Durham Herald-Sun*; "Universities' projects put environment first"
- *Sustainable Duke*; "Tour Duke's new energy efficient Smart Home"
- *Footprint Eco Magazine*; April/May 2008 Issue 1.1; "Duke Smart Home Program Gets Smarter"
- *The Chronicle*; "High-tech home opens doors"
- *The Chronicle*; March 18, 2008; "Smart Home selects top leaders, residents for Fall"
- *The News & Observer*; "Campuses join green bandwagon"

Official Website: www.smarthome.duke.edu(http://www.smarthome.duke.edu)

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NAVFAC Building 33

GENERAL INFORMATION

Building Name: Naval Facilities Engineering Command, Headquarters Building, Buildings 33 and Quadrangle Buildings
Building Location: Washington Navy Yard, Washington, DC, USA
Project Size (ft², m²): 156,000 gross square feet
Building Type(s): Office building
Project Type: Renovation/Modernization
Delivery Method: Design/Build (Bridging)
Total Building Costs: $21,000,000 renovation
Owner: Naval District Washington, Washington DC
 Contact: Public Works Officer, (202) 685-8000
Building Architect/Project Team/Contacts:
 Client: Naval Facilities Engineering Command Engineering Field Activity, Chesapeake (NAVFAC EFA CHES), (202) 685-3075
 Tenants: Naval Facilities Engineering Command Headquarters, Washington, DC
 Contact: Office of Engineering, NAVFACENGCOMHQ, (202) 685-9170. Also Navy Office of the Judge Advocate General (OJAG)
 Design Architect: Ewing Cole Cherry Brott, Philadelphia/Washington, DC
 Contact: (215) 923-2020 (Philadelphia), (202) 833-3433 (DC)
 Design-Build Contractor: The Sherman R. Smoot Company, Washington, DC
 Contact: Bruce Spengler, (703) 998-1100 x547
 Architect of Record (in association with the design-build contractor): Shalom Baranes Associates, Washington, DC
 Contact: Barry Habib, (202) 342-2200M
 Sustainable Development Program Coordination: Michael G. Chapman, AIA, Senior Architect for Design Policy and Architecture, Naval Facilities Engineering Command, Headquarters Office, Washington Navy Yard, 1322 Patterson Ave. SE, Washington, DC 20374, (202) 685-9175, MChapman@navfac.navy.mil(mailto:MChapman@navfac.navy.mil)

DESCRIPTION

A. Project Description

The project, completed in July, 1998, is located in the Washington Navy Yard, an historic district in Washington, DC, and included complete renovation of four existing historic industrial structures and construction of one new linking structure for office, conference, and support spaces. The project consists of an "L" shaped main building linked to a cluster of three smaller courtyard buildings, providing approximately 156,000 gross square feet of office and conference space, as follows:

- Building 33—Built in 1850, this was originally a 45-foot high open bay factory building. Now, it is essentially a building within a building: a four-story structure providing general office space on three floors, with the fourth floor constructed within the roof trusses providing library, storage, and mechanical space.
- Building 109—A three-story structure providing conference rooms and general office space.
- Building 39—A two-story structure providing general office space.
- Building 37—A two-story structure providing restrooms, locker rooms, and storage.
- Link Building—A new three-story open atrium structure providing a first-floor multi-use area, stairs to three levels, and connecting walkways on three levels between buildings.

The existing buildings had been large, open manufacturing facilities, so extensive remodeling was required. A small "lean-to" building attached to Building 33 was demolished, which enhanced the daylighting opportunities. The demolition waste was recycled to the fullest extent possible.

B. Project Goals

OVERALL PROJECT GOAL/PHILOSOPHY

Building 33 was selected for modernization in order to reduce government expenditures by eliminating rental space requirements and fully utilizing government owned properties in accordance with Base Realignment and Closure (BRAC) legislation. In addition, this project was selected as a pilot project to examine the impacts of "green" building design and implementation strategies on facility delivery and performance, and the financial impacts it would have over the life cycle of the facility.


Interior courtyard view

ACCESSIBLE GOAL

Design and construct the existing facilities to meet requirements for accessibility in accordance with the latest Uniform Facilities Accessibility Standards (UFAS) and Americans with Disabilities Act Accessibility Guidelines (ADAAG).

AESTHETIC GOAL

Maintain consistent architectural appearance respecting the historic nature of the building shell, and the overall congruency of the Washington Navy Yard. Interior was designed to reflect a modern, high quality level of office appearance and function.

COST-EFFECTIVE GOAL

Reduce the annual energy costs as much as possible utilizing innovative and integrated building systems design, while creating a high performance work environment that enhances overall productivity.

FUNCTIONAL GOAL

Create a fully functional and flexible work environment that will accommodate spatial and organizational change with reduced churn cost.

HISTORIC PRESERVATION GOAL

In order to adapt this 1850's manufacturing facility to a modern office facility a radical change to the internal systems was necessary, so the outward character was the sole focus of the preservation efforts. The goals focused on historic masonry, window and roof integrity, allowing roof skylight penetrations to occur on the courtside only.

PRODUCTIVE GOAL

Maximize visual access to the natural light afforded by the historic, large windows that served the building for 150 years, then design for flexibility in office arrangement infrastructure and connectivity.

SECURE/SAFE GOAL

Located on the Washington Navy Yard, security levels are accommodated on a yard-wide basis, but added building access security is provided by card-key readers at all doors. The latest fire protection standards and systems were employed with a focus on the safety of the occupants.

SUSTAINABLE GOAL

Building 33 was a pilot project for "green" building design and construction for the U.S. Navy. A goal was to incorporate as many of the strategies of sustainable design that had been identified at the time of design and were affordable by the established budget. The ultimate goal was to reduce life cycle costs, waste and pollution generation while enhancing the work environment for greater employee health and productivity.

OTHER SIGNIFICANT ASPECTS OF THE PROJECT

This historic building had 100 years of industrial use with processes that contributed to local environmental degradation. The "brownfield" qualities of soil and acquifer pollution were remediated to the greatest extent practicable beneath the area of the building. The "green" strategies incorporated in this project set a course for the design and construction of a

Navy project with one million square feet of office complex on the Navy Yard that included adaptive reuse of two more industrial buildings. The Office of the Environmental Executive (OFEE) recognized the valuable contributions of these projects and awarded the Naval District Washington the 2003 Closing the Circle Award for "Sustainable Design/Green Buildings in Adaptive Reuse".

The project was completed using a "design/build bridging" methodology, which entailed selecting an initial A/E firm (A/E #1) to develop the preliminary design documents, and then soliciting competitive bids from design/build teams (Contractor and A/E #2) to perform the construction. The initial design work did not incorporate sustainable design; the request for sustainability was issued as part of the solicitation for the design/build package, based on a "greening study" performed by A/E #1. The greening study resulted from a sustainable design charrette involving the Navy and a "green" design team representing architects, engineers, and sustainability experts, selected and coordinated by Dr. Amory Lovins and the Rocky Mountain Institute. From this collaborative, integrated charrette, a list of "greening opportunities" was generated.

The fact that this project primarily involved the adaptive reuse of existing historic structures established some constraints. First, the character of the exterior had to remain as is, which meant that the existing single-pane windows had to remain in place, and whatever space was to be placed in the building had to fit within the existing shell. Second, the design had to meet requirements of the Historic Preservation Office, National Capitol Planning Commission, and Commission of Fine Arts as well as the Navy Design Criteria. Third, the project budget, which was not based on sustainable design techniques (which sometimes result in a higher first cost in order to save money in the long run), was fixed. This led to decisions to use only cost-effective ideas, use only technology that was available "off the shelf", and to save energy only if it improved the comfort and health of the building occupants. Because of the implementation of integrated design techniques, some materials or systems that had higher first costs were able to be incorporated, due to trade-offs, that is, areas where money was saved.


Interior view

The initial goals were to adaptively reuse the historic buildings and to create a flexible, comfortable professional working environment for 550 people. Following the design charrette and greening study by A/E #1, additional goals to incorporate sustainable features were adopted. The proposing design/build teams were given the list of "greening opportunities" and asked to include in their bid not only their price, but also which sustainable strategies they would incorporate in the project, either from the list or strategies that they may have come up with. In addition, a DOE BLAST energy model of the building performed by A/E #1 established the target energy budget for the project. A/E#2 was required to submit a BLAST run with their proposal, which was in turn reviewed by A/E#1 for verification purposes.

The decision was made to "green" the building because NAVFAC had been promoting sustainable design, and wanted to teach by example on their own headquarters. Additionally, since this project was the first of its kind for the Navy, papers have been authored and lectures given by those involved. Sustainable design is now mandated in all NAVFAC building projects.

The project was funded under the Base Realignment and Closure initiative. The directive to implement sustainable strategies came from the Undersecretary of the Navy, with the expectation was that the sustainable strategies would be cost-effective. The initial analysis indicates that the additional project cost was .005% increase, and will be recouped in the first year. The payback period, based on an $85,000 increase first cost, with an anticipated energy savings of $130,000 was less than 8 months. The building cost $21,000,000 total to construct, including all costs, fees, etc. Sustainability measures were estimated at $85,000 more expensive in terms of first cost than "standard" measures, but the project was completed within the Navy's budget.

PROCESS

Overview Of Process

PRE-DESIGN/PLANNING ACTIVITIES

As part of the Base Realignment and Closure requirement, special planning that brought this project into the program was performed. No particular variation for establishing other requirements was performed, and no consideration for sustainable design or "greening" strategies and technologies was budgeted.

DESIGN ACTIVITIES

The adaptive reuse of Building 33 was designed under the typical Design-Bid-Build processes, approaching 100% design. The decision to incorporate sustainable design technologies came from the Under Secretary of the Navy through NAVFAC after the CD documents were already developed. This was consistent with the already ongoing sustainable design initiative. The need for a pilot project program had already been identified, as good model programs after which the Navy could pattern its program could not be located. The interest of the Under Secretary of the Navy added a significant boost to the program. Also, the funds to complete the project had been allocated without consideration of sustainable design. So the goal was to award the contract to the design/build team that could meet the budget while incorporating the maximum number of sustainable design strategies. A significant consideration was the desire to accomplish this without increasing the first cost of the project—a philosophy that had been presented to the Navy by the Rocky Mountain Institute, but which had not been adequately tested on ordinary projects. Radical changes in the strategies that had been incorporated in the original design had to be re-evaluated. To accomplish this, the project was taken back to the 35% design package and a "greening" charrette was performed, including experts in the field, to identify opportunities for improvements toward that goal.

The "Greening" Charrette. In the greening study design charrette, the participants worked together to come up with concepts collectively in an integrated way, as opposed to on their own. The "Greening Plan—Opportunities and Parameters", developed from the charrette, had identified the following as "opportunities" to be considered by the proposing design/build teams:

1. Use of super glazing at new windows and skylights
2. Use of reflective blinds at windows
3. Installation of light diffusers at skylights
4. Installation of a reflective barrier on roof under shingles
5. Construction of light shelves at windows
6. Decrease in the "U" values at walls and roofs (increasing the "R" value)
7. Installation of revolving doors at primary entrances on Patterson Ave. and the courtyard
8. Use of indirect lighting (from fixtures as well as daylighting)
9. Provide additional daylighting on the 4th floor library with skylights
10. Use high efficiency HVAC and related equipment
11. Use high efficiency chiller
12. Use high efficiency cooling tower
13. Use variable speed cooling tower fan motors
14. Reduce fan power requirements by reducing both pressure drops on fans and the coil face velocities and by increasing duct sizes
15. Reduce pump power requirements
16. Reduce pressure drops on pumps by increasing pipe sizes and reducing the number of bends
17. Use the area under the raised floor as a supply air plenum for HVAC distribution in lieu of an overhead VAV system
18. Use high efficiency elevator system motors
19. Reduce ambient lighting levels from 50fc to 30fc
20. Revise open office perimeter accent lighting to be consistent with the 30fc ambient light level
21. Revise lighting design to accommodate the skylights on the 4th floor, if additional skylights are provided
22. Use more energy efficient lighting fixtures (i.e. compact fluorescent) in toilet rooms
23. Use more energy efficient lighting at entrance and elevator lobbies
24. Use automatic sensor systems that both dim and turn off lights in response to daylighting at open office area, private offices, and the library
25. Use automatic occupancy sensors of the active ultrasonic (motion detector) or passive infrared type at private offices and the library
26. Use automatic occupancy sensors of the hybrid type (active ultrasonic and passive infrared technology) for light fixtures in toilet rooms
27. Reduce VOC (volatile organic compound) emissions by:
    1. Using materials that do not contain formaldehyde
    2. Minimizing the use of adhesives that contain styrene butadiene latex and other VOCs
    3. Using low solvent or water-based adhesives in lieu of solvent adhesives
    4. Requiring paints without aromatic hydrocarbons, halogenated solvents, mercury or mercury compounds, lead, or other heavy metals
28. Encapsulate all glass fiber insulation

29. Minimize construction waste
30. Recycle construction and demolition materials
31. Use construction products that include recycled materials in their content
32. Perform purging of indoor air after installation of "wet" materials and prior to the installation of gas absorbing materials without using the HVAC system

The project was contracted under a Design/Build methodology, with the constructor involved with the final selection of systems and materials to be incorporated. From the list of opportunities, the proposing design/build teams worked together to incorporate as many goals as possible in their technical proposal. Each proposer was required to submit a DOE BLAST energy analysis run with their proposal, which was in turn reviewed by the design A-E for verification purposes. The winning design/build team was selected as part of a "best value" process that provides for consideration of both technical proposal and associated cost.


Interior entrance view

CONSTRUCTION ACTIVITIES
Waste from demolition and construction was recycled. The specific materials recycled were not monitored by the owner nor reported by the contractor. Removal of all interior structure and harmful materials that made up the building and site beneath it was a major undertaking. For the most part, construction was fairly typical, although the actual occupancy date was delayed by approximately 2 months from that originally anticipated, due to unforeseen conditions encountered during construction. The new internal office floors were formed up and poured independent of the historic masonry perimeter walls. The Navy's construction office representatives and contractor's quality control representatives were responsible for construction administration.

OPERATIONS/MAINTENANCE ACTIVITIES
Operations and Maintenance manuals were produced by equipment manufacturers and subcontractors. Preventative maintenance inspections are performed on a regular basis by the Navy to address functional maintenance, and a cyclic maintenance program is performed each year to address aesthetic upkeep.

MWR (Morale, Welfare and Recreation) coordinates recyclables collections in the Washington Navy Yard. Collection containers are placed in the coffee mess areas. There is a program in place on the campus for recycling of aluminum cans, white paper, newspapers, cardboard, wood, and metal.

POST-OCCUPANCY EVALUATION ACTIVITIES
An energy analysis project took place between December 1999 and December 2000. The Pacific Northwest National Laboratory (PNNL) gathered energy data and analyzed the effects of "greening" strategies against an office building of standard construction. The results in brief are shown later in this study. The past three years the meters have remained in place. A project will begin in the winter 2003 to download the recorded data since 2000 and analyze the performance of Building 33 over that period.

INFORMATION AND TOOLS

Software

DOE BLAST (Building Loads Analysis and System Thermodynamics) energy modeling software

PRODUCTS AND SYSTEMS

Some cost estimating with life cycle considerations was performed in the greening study. The materials used did comply with the criterion for CFC/HCFC/Halon/VOC elimination.

The following materials incorporating recycled content were included in this project:

- Site furnishings include recycled plastic
- Geo-textile and waterproofing materials include recycled plastic

- Bricks were refurbished and reused from the demolition project on the site
- CMU incorporated fly ash in the cement mix
- Concrete incorporated fly ash in the cement mix
- Carpet contains recycled plastic
- Gypsum wallboard contains recycled gypsum
- Joint filler
- Ceiling tiles include recycled newsprint

ENERGY ISSUES

Energy Use Description

The energy targets were established by A/E #1 using a BLAST modeling run. The base case building was designed to surpass ASHRAE 90.1, and it was anticipated that the sustainable building design would use 30% less energy annually than the base case design.

The strategies implemented in order to save energy included increasing insulation levels in the roof and walls, super windows, high-efficiency indirect lighting, and task lighting that reduced ambient lighting levels from 50 fc to 35 fc, perforated blinds to assist in daylighting the space, lighting controls such as occupancy sensors and photoelectric dimming at the building perimeter, and borrowed light to help light adjacent spaces. This resulted in a substantially reduced electric load and reduced anticipated plug loads. As a result, the chiller and associated HVAC equipment, piping, ductwork, and HVAC feeder sizes could be reduced.

The shallow cross section of the building allows for good daylight penetration, and the courtyard configuration allows for natural light from both sides. Also, skylights were installed in the courtyard side of the roof of Building 33. (No skylights were allowed on the street side due to historic constraints). The south wall of the link incorporated heat mirror glazing that minimizes heat gain. Additional sun control is accomplished with horizontal louver blinds. The blinds are perforated to allow for view and some daylight penetration.

Natural ventilation is a typical strategy for achieving energy efficiency, however, since this building is a historical facility the existing fixed windows were retained. Ventilation is accomplished through mechanical means.

The fixed windows did help, however, to create a "super window" effect. Double glazed insulating glass was installed inside of the existing glazing creating a high thermal performance with over 12" of overall thickness. A suspended coated film (SCF) glazing product (heat mirror) was used in the link building windows and skylights. In both cases; the new glazing and the retrofit, high performance was achieved.

Increased wall and roof insulation was accomplished by building a "building within a building", constructing new insulated wall and roof assemblies inside of the existing historic shell.

A direct/indirect lighting system was used throughout. Ambient lighting levels were reduced from 50 fc to 30 fc with task lighting being included at workstations. Energy efficient fluorescent lamps were used throughout. Dimmers and occupancy sensors were installed at the building perimeter, toilet rooms, storage spaces, and private spaces respectively to save lighting energy consumption. High-efficiency outdoor site lighting was also installed.

Chillers were able to be downsized from 500 to 330 tons, due to a reduction in building cooling loads resulting from the lower energy use by lights and equipment, and increased insulation levels. Also, high-efficiency, variable speed motors were installed, and piping, ductwork, and HVAC equipment feeder sizes were reduced. The significant cost savings here provided for many of the other sustainable features which, in some cases, had a higher first cost.

Heating is provided by the campus' existing steam system, and is used in winter months for water heating. In the summer, water heating is accomplished by electric water heaters.

All plumbing fixtures (toilets, urinals, showers, faucets, and drinking fountains) are "low-flow". No lead solder or pipes were used in the building.

The only systems commissioned were the HVAC, elevator, and UPS (uninterruptable power supply). The contractor was required to submit a plan for commissioning, based on the ASHRAE standard, far in advance of project completion. This was not done, and the actual commissioning fell short of what the client expected. Fortunately, the Navy does feel that the systems do operate fairly well, although there are some areas in the building that are either too hot or too cold due to less than optimal HVAC.

Metering and monitoring energy data collection occurred in the twelve month period between December 1999 and December 2000. For analysis, the Building 33 complex as constructed was compared with a baseline "standard" facility that would not have the greening strategies employed. Overall, the sustainable design features in Building 33 as described here resulted in an estimated 15% annual energy savings and an annual energy cost savings estimate of $58,000 compared to a hypothetical Building 33 designed without the sustainable design strategies. Table S.1 below details the savings by major energy end use category. The greatest savings came from the mechanical system and downsized chiller. With the reduced overhead lighting levels in Building 33, task lighting energy consumption in Building 33 increased significantly over the baseline building because of the increased use of task lighting to meet the lighting needs in the individual work areas.

Table S.1 Annual Energy Savings Estimate for Building 33 from Sustainable Design Concepts

End Use	Bldg. 33	Baseline Building	Savings
Electric (kWh)	3,999,648	4,723,584	15%
Plugs (kWh)	397,788	397,788	0%
Overhead Lighting (kWh)	565,380	580,284	4%
Task Lighting (kWh)	112,692	93,324	-21%
Chiller (kWh)	2,593,200	3,234,000	20%
Mechanical System (kWh)	330,588	418,188	21%
Steam (MMbtu)	422,777	422,777	0%

General office equipment, personal computers, and printers are a significant load in an office/administrative building. However, none of the sustainable design concepts implemented in Building 33 specifically targeted this type of equipment, so no change in the plug load is expected between the baseline building and Building 33.

Differences between Building 33 and the baseline building envelope that impact the heating requirement were minimal and steam usage in the two buildings was assumed to be the same.

The sustainable design strategies incorporated in the building design and the opportunities to improve the overall building performance were constrained. Because of the historical significance of the original structure, the character of the exterior shell had to be unchanged and the design had to meet the requirements of the Historic Preservation Office, National Capitol Planning Commission, and Commission of Fine Arts, as well as Navy Design Criteria. Additionally, the project budget that had already been fixed (without any sustainable design concepts) could not be impacted by any additional cost design changes. This led to the decision to use only cost-effective, readily available technologies that could save energy and improve the comfort and health of the building occupants. Because sustainable design methodology is an integrated decision making process, some enhanced performance technologies that had higher first-costs were incorporated in the final mix due to their effect of reducing the requirements and first cost of other building system technologies.

All of the measurement and verification methods for determining energy savings from the sustainable design strategies are based on the same principle-energy savings are derived by comparing the energy usage of Building 33 with sustainable design technologies to the energy use of an identical baseline building with current industry standard construction and operated under the same conditions.

Therefore, energy savings could only be inferred based on assumptions about a hypothetical baseline building energy consumption[1]. Where appropriate, Building 36 (a similar, opposite hand structure in the Sanger Quadrangle) was used as the proxy for the baseline building energy use. Engineering analysis and adjustments as warranted were used to adjust the Building 36 energy usage for differences in design, occupancy, and schedules between the two buildings.

[1]Measurement and Verification (M&V) Guidelines for Federal Energy Projects, U.S. Department of Energy, February 1996.

INDOOR ENVIRONMENT

Indoor Environment Approach

Preferred indoor environmental quality conditions were developed by the owner and design/build team with regard to air, lighting, noise, and health. ASHRAE standards were used to establish IAQ and thermal comfort levels.

To assure air quality, asbestos was eliminated from the existing buildings during demolition, and smoking is banned inside the renovated building. Also, VOCs, CFCs, HCFCs, and Halon were minimized in construction. Finally, a pre-occupancy purging was called for, that required a complete flushing of the building's air after all wet materials were installed, but prior to installation of any absorbent material, without using the building's HVAC system.

Currently, there is no official IAQ Management Plan in place to assure continued compliance with standards. There are, however, carbon monoxide sensors throughout the building, and chemicals are stored in appropriate containers. Additionally, the main entrance lobbies have a walk-off mat to minimize particulate materials in the building that would contribute to diminished air quality, as well as wear and tear on flooring materials.

High quality lighting was achieved with direct/indirect fluorescent fixtures at an ambient light level of 30fc. Levels of 50fc or more on work surfaces are achieved with task lighting and daylit areas.

Noise control and privacy are areas receiving mixed reviews. Some occupants (especially those who came from private offices) complain of not enough acoustic privacy. This is partly due to the partial height partitions, but also to the fact that the HVAC system is very quiet. On the other hand, some appreciate the acoustic silence, and feel that people speak softer because of the open office. Also, some appreciated the visual connection with each other.

In addition to the direct design of IEQ measures, strategies such as using a raised floor system and modular offices help to minimize debris as a result of frequent moves of personnel from one office to another.

PROJECT RESULTS

A. Lessons Learned

The primary benefits of the effort include:

- Anticipated energy savings of $130,000 per year
- Additional savings in maintenance and remodeling costs due to the raised floor system, systems furniture and carpet tiles
- High-quality lighting, reducing eye strain and fatigue
- Good indoor air quality promoting health and productivity
- Improved connection to nature
- High thermal comfort
- Enhanced communication and flexibility because of the open plan.

Constraints that were encountered include:

- Existing historic building character had to be maintained. Therefore, a building within a building was constructed, with insulated walls, roof, and windows.
- Existing windows had to be retained. New, insulating, double-pane windows were installed inside of the existing windows, resulting in highly efficient, effective triple glazing. However, the head heights of the windows were fixed, forcing a low head height on the second floor.
- Reduced HVAC loads resulted in an unacceptably low volume of airflow within the internal zones. It was therefore perceived that HVAC sizing could not be minimized as much as desired.
- The HVAC reheating system was designed to utilize steam heat. However, the steam system is turned off for the summer months. In the fall, if there is a cold day prior to the steam system's start-up, the HVAC system blows out cold air. This problem is being resolved using an electric boiler for a reheat system when the steam system is shut down.
- The interior walls were spray painted originally with a thin, high gloss paint. When a spot needs to be repainted, a brush and/or roller are used, and the touch-up does not match the existing finish. So, often, entire walls are repainted when only a touch-up was needed.
- The interior paint colors selected do not match the typical colors used on previous projects. Therefore, separate cans of paint must be kept for touch-up.
- The carpet tiles used are a different size than the access hatch in the raised floor system. Therefore, when access is desired, several carpet tiles around the hatch must be taken up.

Lessons learned include:

- Actual operating conditions can vary from the modeled conditions, and the effective energy savings are affected. The calculated energy cost savings was $130,000 per year. Metered, actual energy savings achieved less than half of

that, primarily due to variations in operating hours, temperature range set points and commitment to assuring the design strategies were well understood by staff and occupants.
- Need to clearly define the sustainable goals. Many terms were too vague, creating confusion on specific requirements.
- Should be less prescriptive regarding sustainable design in the RFP. This would allow more creative solutions on the part of the design/build team.
- Need to monitor the contractor's performance to verify compliance with sustainable initiatives.
- Open office areas need to have acoustic privacy addressed.
- In some areas, the corridor in open office areas had reduced light levels. This bothered some occupants sitting next to the corridors and they felt that a consistent light level should be maintained throughout the open office area.
- Some feel that the partitions are too tall, so as to be a hindrance to communication.

This project was a quantum leap forward for the Navy in implementing sustainable design. The improvements in building energy performance, indoor environmental quality, resource efficiency, and waste minimization have established a new standard for government facility design. The fact that this building houses NAVFAC's headquarters will allow Naval designers the opportunity to study first hand which strategies work and which need improvement—not only the specific sustainability strategies, but construction contracting procedures as well. It is in both of these areas that opportunities lay for achieving even greater degrees of sustainability on future projects.

First, in the area of sustainable design principles, increased design integration among architects and engineers should yield even lower energy usage levels. This would include optimally designed building envelopes (considering thermal and daylighting strategies) combined with the most efficient electrical and lighting systems (including efficient equipment and realistic demand assumptions) followed by HVAC system design incorporating not only the most advanced technology, but accurate sizing assumptions as well.

Another strategy to consider is to review specifications to assure that they are in agreement with the stated sustainable design goals. There are often contradictory directions resulting from lack of coordination between general goals and specific, outdated requirements.

One of the most significant opportunities offered by this project is the ability to learn by direct measurement and comparison how successful the energy efficient strategies are that have been incorporated. Building 33 is being monitored for its energy performance, as is Building 36, the building forming the other half of the quadrangle. This will provide extremely valuable data in determining the effectiveness of the energy efficient strategies and in planning and designing future projects. This kind of measurement and verification is a crucial step in learning from experience in order to refine the design process.

In the area of procedural modifications, the first obvious step is to incorporate sustainable design from the project's inception. The opportunity to achieve the greatest level of sustainability is in the beginning. The gains realized in this project could have been even greater had the mandate for sustainability come sooner. Related to that issue, the general requirements for sustainable design should be clearly stated; i.e. energy performance targets, material and resource efficiency, lighting levels, etc. To achieve this goal, consideration should be given to using an objective sustainability rating system, such as the U.S. Green Building Council's LEED Building Rating System.

Another recommended procedural modification is to determine more accurately on what assumptions decisions are being made. A clear understanding of the base's operating procedures could have prevented this problem.

Next, a verification procedure of the contractor's compliance with sustainable requirements should be established. Since commissioning is vital to a building performing as designed, adherence to this procedure is strongly recommended. Given that these sustainable requirements are relatively new contractual obligations, the Navy needs to establish some means of site supervision and enforcement measures to verify compliance.

B. Ratings

No ratings applied for or received to date.

C. Awards

1. "Commanders Award for Design Excellence" in the 1999 NAVFAC Design Awards Program (the "grand prize" award for NAVFAC)
2. Recognized by the Washington Chapter of The American Institute of Architects with an Honor Award for Design in

2000
3. 2003 Closing the Circle Award for "Sustainable Design/Green Buildings in Adaptive Reuse" from the Office of the Environmental Executive (OFEE)

D. Publishing

WEBSITES

- Appendix B: Federal Agency Profiles, U.S. Navy(http://www.ofee.gov/sb/appendixB-03.pdf)
- Foundation Knowledge: The Knowledge Management Portal for facilities, infrastructure and the environment(http://www.foundationknowledge.com/KM%20Center/sustainable_development/sustdevCaseStudies.htm)
- Green Building Design and Sustainable Systems Management(http://www.usgbc.org/expo2002/schedule/documents/DS109_Chapman_P725.pdf)
- GreenClips.106 10.21.98(http://www.greenclips.com/98issues/106.htm)
- U.S. General Services Administration, Office of Governmentwide Policy, Office of Real Property(http://www.gsa.gov/Portal/gsa/ep/channelView.do?pageTypeId=8203&channelPage=/ep/channel/gsaOverview.jsp&channelId=-13180)

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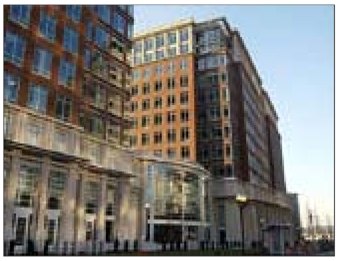
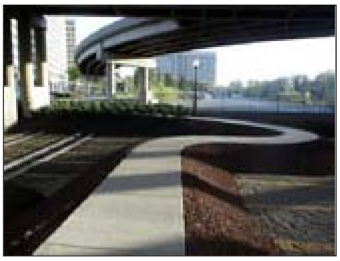
One and Two Potomac Yard

GENERAL INFORMATION

One and Two Potomac Yard represent one of the first "green," new speculative office building projects in the Washington, DC area. The project is located on a formerly abandoned railroad yard in Arlington, Virginia. Within this urban setting, the two twelve-story buildings total 654,000 SF and consist of office and retail spaces as well as a fitness center for use by building occupants. One and Two Potomac Yard has earned LEED (Leadership in Energy and Environmental Design) Green Building Rating System® Gold for New Commercial Construction (NC) certification.

Construction of the buildings began in 2004 and was completed in May 2006. Recognizing the complexity of the project, Crescent Resources, LLC, the developers, set out to form a team of experienced professionals to develop designs for their first class buildings. Early on, they involved an Environmental Building Consultant and a Commissioning Authority to educate the design team about sustainable design and provide assistance on potential LEED items. Throughout the delivery process, they were also forthcoming with information, which helped foster a cooperative relationship with the lessee, the U.S. General Services Administration (GSA), and the lead tenant, the U.S. Environmental Protection Agency (EPA) in the review of the project. As a result, One and Two Potomac Yard exemplify a balance of function, cost, security, and sustainability.

Left to right: South façade of the south tower of Potomac One; connection between One and Two Potomac Yard where the green roof resides; sustainable landscaping on the north side under the overpass for Reagan National airport

Overall Project Goal/Philosophy

As the first project at the Potomac Yard site, which is a significant gateway to Ronald Reagan National Airport and nearby Washington, DC, the developers of One and Two Potomac Yard wanted to set the right tone for future developments at Potomac Yard. They aimed to create architecturally distinctive, first class, high quality, sustainable design that would provide an inviting, dignified, and professional image, reflecting the values of the federal government tenants they were appealing to. In order to accomplish this goal, the project team and stakeholders, including GSA and EPA had to work together to resolve a multitude of issues, including balancing Arlington County's requirements for accessibility/openness and active street fronts within their urban design guidelines and GSA's requirements for security and the developers desire to keep control of costs.

SECURE/SAFE GOAL

While this project was approved for development in August 2001, the terrorist attacks on September 11, 2001 brought security requirements to the forefront. The project team responded by revising the design to meet new Federal Protective Services requirements for Level 4 security.

SUSTAINABLE GOAL

With the lease award by GSA in 2004, new sustainability criteria—such as LEED Silver certification and Energy Star® certification—were required of the project, else the developers faced penalty equal to 10% of the annual rental payments due for the GSA/EPA-leased spaces. The developers went beyond these minimum requirements and achieved LEED Gold-NC certification for One and Two Potomac Yard.

FUNCTIONAL GOAL
As speculative office buildings, creating functional and adaptable work environments with reliable technology infrastructure that would easily accommodate spatial and organizational changes were very important. To address energy and security issues, an emergency generator was installed to provide power to only critical systems in cases of blackouts, brown outs, or other disruptions in the electrical service.

ACCESSIBLE GOAL
The accessibility goal was to comply with all local, state, and federal requirements (i.e., Americans with Disability Act [ADA] and Architectural Barriers Act [ABA]).

AESTHETIC GOAL
The developers wanted to create architecturally distinctive, high quality, sustainable buildings that would provide an inviting, dignified, and professional image, reflecting the values of the federal government tenants they were appealing to.

COST-EFFECTIVE GOAL
While the developers made additional investments to comply with—and in some cases exceed—GSA and EPA requirements, they saw the potential marketing value and operational savings of creating sustainable, high-quality, durable buildings.

HISTORIC PRESERVATION GOAL
N/A

PRODUCTIVE GOAL
To create effective work environments, GSA/EPA and the developers placed importance on designing healthy and thermally, visually, and acoustically comfortable spaces. Required metrics included compliance with all aspects of ASHRAE 62-1999, Ventilation for Acceptable Indoor Air Quality, Addenda 2001; development and use of IAQ Management Plan; limits on VOC content of products; compliance with ASHRAE 55-1992, Addenda 1995 for thermal comfort; and installation of a permanent temperature and humidity monitoring system configured to provide operators control over thermal comfort, including humidification. Daylighting was maximized by stepping offices back from exterior windows and creating open plan spaces. The spaces were also designed for flexibility in office arrangement infrastructure and connectivity.

OTHER SIGNIFICANT ASPECTS OF THE PROJECT
N/A

PROCESS

Overview Of Process

One and Two Potomac Yard are complex mixed-use projects that required extensive coordination and cooperation among the stakeholders—developers (Crescent Resources LLC), their design and consulting team, their contractors, the lessee (GSA), the primary tenant (EPA), and the local government entity (Arlington County)—throughout the development process. Using this integrated team approach, it was possible to establish common goals and reconcile various—and sometime conflicting—requirements by GSA, EPA, USGBC (for LEED certification), Federal Protective Service (for security), and Arlington County. To ensure that the buildings operate optimally throughout their lives after construction, the buildings were commissioned, permanent monitoring systems were installed, operations and maintenance requirements were defined, and post-occupancy activities were identified prior to occupancy.

PRE-DESIGN/PLANNING ACTIVITIES
Crescent Resources LLC, the developers, selected the Potomac Yard site on an abandoned railroad yard because of its central location within Arlington County and proximity to services and existing infrastructure, including public transportation and utilities. This decision fits well with one of Crescent Resources' corporate goals of caring for the

environment and the communities it serves. Furthermore, Crescent Resources agreed to agree to comply with Arlington County's Phase Development Site Plan Conditions to have the projects be certifiable through the USGBC LEED rating system. Thus, from the beginning, One and Two Potomac Yard were planned to be sustainable buildings. Also, as the first development on the site, Crescent Resources wanted to set a positive tone for Potomac Yard by creating first class, high quality, distinctive buildings, which could reinforce Potomac Yard's Crystal City's position as the gateway to the nation's capital. However, as an abandoned railroad yard, there were a lot of concerns about the environmental risk associated with soil contamination. In fact, when Jack Kent Cook retracted his plans for a new Redskins stadium at the Potomac Yard site in 1992, he stigmatized development there by announcing that the overwhelming environmental problems would keep him from building the stadium. These concerns were mitigated prior to site acquisition when Crescent Resources confirmed that EPA oversaw remediation of the site and verified the "no further action" letters issued by EPA and the Virginia Department of Environmental Quality.

GSA awarded the lease to Crescent because the Potomac Yard site met the Solicitation for Offers requirements which stated that the leased space "shall be located in a prime commercial office district with attractive, prestigious, professional surroundings with a prevalence of modern design and/or tasteful rehabilitation in modern use."

During the pre-design stage, Crescent Resources agreed to comply with Arlington County's Phased Development Site Plan Conditions and Design Guidelines. Initially One and Two Potomac Yard met the requirements for 17 credits. During this early stage of the delivery process, the Arlington County Board Chairperson recognized the complexity of the site plan and building permit process and assigned an Assistant County Manager to oversee the Potomac Yard development process. The Assistant County Manager held monthly meetings to bring together the various County departments and the developer team to review the issues and challenges facing the projects.

DESIGN ACTIVITIES

Responding to the complexity of the project, Crescent Resources set out to form a team of experienced professionals to develop designs for their first class buildings. Early on, in response to the Solicitations for Offer (SFO) put out by the EPA, they involved an Environmental Building Consultant to educate the design team about sustainable design and provide assistance on potential LEED items. A Building Commissioning Authority was hired to guide the team through both the design and construction stage commissioning process, beginning with defining the developers' performance requirements for the buildings' systems and equipment. Also, Crescent Resources procured pre-construction services from construction contractors to provide input on the system designs, pricing, constructability, and timing.

Engaging the integrated design process, the design team completed the design for One and Two Potomac Yard in August 2001 based on new urbanism principles and gained Arlington County approval for the projects soon thereafter. The terrorist attacks on September 11, 2001, led to new security requirements for all GSA leases that conflicted with Arlington County's new urbanism. For example, new urbanism promotes multiple pedestrian and vehicular access points to buildings and destinations, but post-September 11th security requires limited and controlled access points. The street level retail activity conflicted with limited street access to the buildings. Moreover, Arlington's Urban Design Guidelines required an active streetscape and no setbacks; new security guidelines require setbacks of 50 to 100 feet. To meet the security requirements of the Potomac Yard lease with GSA, major changes had to be made to the design.

In addition to the security revisions the lease awarded by the U.S. General Services Administration (GSA) in May 2004, major changes had to be made to the design to accommodate GSA's new requirements for sustainability which were more stringent than the developer's original plan. These included: minimum LEED Silver certification instead of LEED certifiable projects, indoor air quality testing, limiting levels of volatile organic compounds in building materials, building energy-cost savings of 20% and an Energy Star® building label, recycled-content products according to EPA's Comprehensive Procurement Guidelines (CPG), construction waste management, standards of performance for heating, ventilating, and air-conditioning systems, bicycle storage and changing and shower facilities, and recycling rooms.

Retrofitting the projects to incorporate LEED requirements after obtaining zoning approval from Arlington County complicated the project's design process. However, by readily disclosing information and involving the U.S. Environmental Protection Agency (EPA)—the lead tenant for the buildings—and the GSA in discussions with the designers and contractors throughout the re-initiated design stage, all parties were able to cooperate and work together to achieve their respective goals. The project team learned that the project goals (including LEED certification) should be set at project inception; that the team should have frequent coordination meetings starting early in the process (including meetings focused on specific topics like LEED and security); and that the team should begin documenting LEED strategies early on. Examples of collaborative design solutions include: installation of plasma televisions behind the windows, facing out from the first floor conference room in One Potomac Yard to liven the streetscape while providing the interior meeting space needed by EPA; and reinforcement of site furniture which serves as both furniture and bollards to provide access control and perimeter protection.

Related to functionality and workplace productivity as well as energy and security, an emergency generator was installed in One and Two Potomac Yard as an emergency back-up in cases of blackouts, brown outs, or other disruptions in the electrical service. The generators have the capacity to provide power to all critical systems (i.e., alarm systems, CCTV monitoring devices, fire detection systems, entry control devices, emergency and security lighting systems, and computer data centers).

Commissioning:
A Commissioning Authority (CxA) was engaged early in the project process. As required by the Solicitation for Offers, the CxA provided a Design Stage Commissioning Plan as part of the developers' submission package. Once the project was awarded to Crescent Resources, the Design Stage Commissioning Plan was fleshed out throughout the Design Stage and re-released in final form as a Construction Stage Commissioning Plan. The Design Stage Commissioning Plan focused on assuring the owner's performance requirements are incorporated and properly integrated in the prepared and accepted construction documents. Details of systems tests and procedures, assembly-specific checklists, and testing and documentation responsibilities were incorporated in Construction Stage Commissioning Plan as well as the projects' construction specifications.

As part of the requirements for LEED credit EA3, Additional Commissioning, the CxA was responsible for reviewing design prior to construction documents and reviewing the construction documents prior to contract documents.

CONSTRUCTION ACTIVITIES

Because the construction contractors were involved in the projects during the Design Stage, the transition from design to construction was mostly seamless. At the beginning of construction, a partnering session was conducted with the major stakeholders, construction contractors, and their primary subcontractors to define communication protocols, and to ensure that everyone understood the goals of the projects. This helped to build cooperative, constructive working relationships among the team members. Nevertheless, the project team did encounter a number of challenges during the Construction Stage.


Locker and shower facilities for bicyclists

One of the lessons learned during the Construction Stage was that pursuing LEED certification adds time to the construction process. For example, certain LEED credits made material specification more complicated than for a typical project because it necessitated more research. It also required taking the time to educate the subcontractors about the importance of LEED materials and installation requirements. For example, IAQ requirements for carpet air out might seem arbitrary to a carpet installer; however, carpet air out affects IAQ and passing IAQ testing drives GSA's acceptance of the building. Crescent Resources learned that selecting design team members and subcontractors with LEED experience is essential to minimize the extra time required to achieve LEED certification.

Another challenge during this stage was enforcement of the implementation of LEED requirements. Some subcontractors were lax with requirements because they did not understand the complexities and interrelationships of LEED requirements. As a result, a quality control program, with frequent field inspections, was established to ensure achievement of LEED requirements.

Finally, one of the interesting challenges was to balance efficient construction practices and construction waste recycling requirements. Efficient construction operations depends on keeping a site free of debris and waste, but recycling requires maintaining and sorting piles of waste materials. The project team learned to use dumpster management techniques to meet recycling goals and to minimize the disruption of the construction process caused by waste hauling.

Commissioning:
The major commissioning activities occurred during construction. The CxA worked with the contractors to test/witness /accept systems and equipment, ensuring that the installed systems and equipment meet the developers' performance requirements. The CxA reviewed submittals relative to systems being commissioned. The CxA also oversaw training of

O&M staff, which is critical to the proper operations and maintenance of the buildings. Crescent Resources also executed a contract with the CxA to review building operation procedures and performance with the O&M staff one year after construction completion.

OPERATIONS/MAINTENANCE ACTIVITIES

The Operations and Maintenance Stage just began for One and Two Potomac Yard. In anticipation of the O&M Stage of the projects, a Green Housekeeping Plan was developed to ensure that housekeeping practices would not adversely affect the level of sustainability initially achieved by the buildings. The Green Housekeeping Plan details such items as the types of cleaning products to be used and the isolation requirements for construction near occupied spaces.

Wheat board counter with laminated top.

Also, a User Education Program, which includes signage, was developed to inform building occupants and visitors about the sustainable features of the buildings and how to use them properly.

Integrated into the environmental control system are permanent temperature and humidity monitoring system and permanent carbon dioxide monitoring system. These systems provide feedback to the O&M staff so that operational adjustments can be made to ensure indoor environmental quality and comfort for building occupants.

POST-OCCUPANCY EVALUATION ACTIVITIES

Per EPA's requirements, metering equipment was installed for the following end-uses, including lighting systems and controls, motor loads and operations, building-related process energy systems and equipment, and water service systems, for One Potomac Yard. This will allow EPA to continually monitor the building's performance so they can work with the O&M staff to optimize the energy and water consumption performance of the building.

Sustainable landscaping

INFORMATION AND TOOLS

Energy Simulation software used: eQUEST 2.55

PRODUCTS AND SYSTEMS

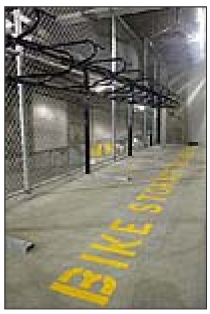
Function, security, sustainability, and costs were drivers for making material and system decisions at One and Two Potomac Yard. In addition, LEED requirements and EPA-specific requirements had to be adhered to.

Metro bus stop

Examples of specific EPA requirements include:

- Purchase of recycled content products as designated by the Comprehensive Procurement Guidelines (CPG);
- Use of environmentally preferable products and materials where economically feasible;
- Reduce application of pesticide, fungicide, and rodenticide;
- Use alternatives to vinyl products where possible; and
- Comply with Volatile Organic Compound standards, as listed in the Solicitation for Offers (SFO), for materials such as adhesives, sealants, caulks, paints, coatings, carpet systems, and wood products.

To ensure procurement of products with the required green characteristics, the environmental building consultant developed "green" specification language that was included in the construction specifications and drawings as appropriate. The environmental building consultant also worked with the tenant's team to ensure that the interior specifications also complied with EPA and LEED requirements. Another level of oversight was provided through the review of product submittals by both the developer team and/or the lessee/lead tenant.



In addition, each building has a dedicated recycling area (approximately 500 SF) in the loading dock for collection and separation of paper, corrugated cardboard, glass, plastics, and metals to reduce the waste generated by building occupants that is disposed of in landfills.

Secure bike storage area in garage

Careful selection, specification, procurement, and quality control of environmentally preferable products resulted in the following:

- 27% of the materials contained recycled content (value of post-consumer content plus half of post-industrial content as a percentage of total cost of all materials)
- 63% of the materials were manufactured regionally within a 500-mile radius
- 61% of the regionally manufactured materials were also extracted regionally
- 83% of wood-based materials and products were FSC-certified

Related to function, durability, and workplace productivity, the modular furniture system used in the office spaces was chosen for its ease of assembly and disassembly, which facilitates reusability and reduces churn costs. In addition, the carpet tile by Interface can be recycled and manufactured into new carpet tiles.


Left to right: Conference area with abundant daylight and views of the Potomac River and airport with energy efficient, double-glazed windows; daylit corridor

ENERGY ISSUES

Energy Use Description

In order to reduce the energy-related impacts of One and Two Potomac Yard, Crescent Resources engaged an experienced design team to design these energy-efficient buildings. The developers also engaged an independent commissioning agent to ensure that the energy-using systems were designed, installed, functionally tested, and capable of operation and maintenance according to the owner's needs. To achieve energy cost savings of 20% over ASHRAE 90.1 1999 as required by EPA, the designs of One and Two Potomac Yard had to incorporate the following: lighting-power densities that fall between 0.74 and 0.9 watts per square feet; high-performance window and entry systems that maximize thermal performance, reduce solar gain, and minimize air leaks and uncontrolled water infiltration; light-colored materials that maximize the effect of daylight and reduce energy use and heat gain from artificial light sources; building management control systems that monitor carbon dioxide, humidity, and temperature and that control air movement and temperature; and high-efficiency HVAC systems. Moreover, the HVAC and refrigeration equipment and fire suppression systems at One and Two Potomac Yard are free of ozone depleting substances like HCFCs and Halon. Due to EPA requirements, continuous metering equipment was installed for various end-uses, including lighting systems and controls, motor loads, HVAC system loads and operations, building-related process energy systems and equipment, and water service systems in One Potomac Yard only. EPA has also agreed to purchase grid-source green power for both buildings for one full year or 50% of the green power costs for two years.


Curved Energy Star® white roof covering the mechanical systems and Energy Star® compliant reflective flat roof

Energy modeling results using eQUEST 2.55 indicate the following savings over ASHRAE 90.1-1999: 23.5% for One Potomac Yard and 20.7% for Two Potomac Yard. Also, the Energy Star® scores (using Energy Star® Target Finder tool) for One and Two Potomac Yard are 85 and 82 respectively.

Annual Energy Use by Fuel

Electricity	4,551,000 kWh
Gas	n/a
Fuel Oil	n/a
Biomass	n/a
Other fuel	n/a
Total	4,551,000 kWh

Annual Energy by End Use

Heating	888,000 kWh
Cooling	1,168,000 kWh
Fans & pumps	813,000 kWh
Lighting	1,530,000 kWh
Domestic Hot Water	153,000 kWh
Plus loads & equipment	n/a

Annual On-Site Renewable Generation

PV	n/a
Solar thermal	n/a
Wind	n/a
Midro-hydro	n/a
Biomass electricity	n/a
Biomass thermal	n/a
Other renewable	n/a
Total	0

Peak Use

Peak electricity demand	1,427 kW (summer); 3,667 kW (winter)
Peak natural gas demand	n/a
Cooling load	900 ton
Heating load	10,455 Btu/hr
Connected lighting load	471 kW

Data Sources and Reliability

Based on simulation?	Yes XX
If yes, list software and versions.	
eQUEST 2.55	
Based on utility bills?	No XX
If yes, please list company(s) dates of bills.	

Comments on data source and reliability.

As a pre-construction simulation, the energy model is a prediction subject to changes in actual operation.

INDOOR ENVIRONMENT

Indoor Environment Approach

One and Two Potomac Yard was constructed with an emphasis on providing high-quality, interior environments for all users. This starts during the design stage with proper specification of low-emitting materials and design of ventilation and monitoring equipment; then during the construction stage with the development and implementation of an IAQ Management Plan; then during the pre-occupancy stage with an IAQ testing plan; then finally with the occupancy stage with the implementation of a green housekeeping plan.

PROJECT RESULTS

Lessons Learned

The success of One and Two Potomac Yard was a result of cooperation and teamwork between the developers (Crescent Resources) and their contractors/consultants, the lessee (GSA), the tenant agency (EPA), and the local government (Arlington County). Once the lead tenant was identified, it was critical come together and work towards common goals, including sustainability (minimum of LEED Silver rating) and security. The results are two distinctive, quality, high-performance, LEED Gold NC for One and Two Potomac Yard, secure, and accessible office buildings that will serve as models for present and future developments at the Potomac Yard site.

Following are some of the lessons learned by the project team in overcoming the challenges of creating One and Two Potomac Yard, particularly in regards to the LEED certification process.

- Various stakeholders (i.e., USGBC, EPA, Federal Protective Services, and Arlington County, etc.) have conflicting requirements. To overcome this, the project team learned to realistically assess requirements and address requirements accordingly.
- Executing a success project requires teamwork. At One and Two Potomac Yard, readily disclosing information created a positive, cooperative, productive relationship between the developers, GSA, and EPA. This allowed them to resolve issues and conflicts effectively.
- Pursuing sustainability, LEED certification, and security requires careful planning. The goals of the project, including LEED certification, should be set at project inception, the team should have frequent coordination meetings starting early in the process, and the team should begin documenting LEED strategies early on. Otherwise, as was experienced on this project, retrofitting the project to incorporate LEED and security requirements after obtaining zoning approval from Arlington County unduly complicated the process.
- Pursuing LEED certification adds time to the construction process and increases design/engineering fees. At One and Two Potomac Yard, LEED-related design costs were about 33% of the corresponding LEED-related construction costs (design costs are typically around 3-4% of construction costs).
- Enforcing implementation of requirements, including LEED, during construction is difficult. Crescent Resources learned that a quality control program, including frequent field inspections, is critical to successfully implementing the project's requirements.
- Embracing the complexity of urban mixed-use projects will mitigate obstacles. There are more variables than equations, and some of the variables are random. The complexity cannot be controlled or reduced. Embracing complexity allowed the project team to attempt rational decision-making without getting frustrated by the lack of resolutions.

Ratings

- EPA's Energy Star® Building label(http://www.energystar.gov/index.cfm?fuseaction=labeled_buildings.showBuildingSearch) (expected 2007). The lease states the developer has 14 months after 95% occupancy to attain Energy Star® certification.
- U.S. Green Building Council LEED-NC®, v2.1(http://www.usgbc.org/DisplayPage.aspx?CategoryID=19) LEED Gold certification (received June 2006)

Awards

- Northern Virginia Chapter of the National Association of Industrial and Office Properties (NAIOP)—Best Building, Environmentally Responsible - Green Construction: Award of Merit, "Best of NAIOP Awards" (2007)

- Arlington Economic Development Commission and Arlington Chamber of Commerce—Green ABBIES Award (2005)
- GSA—Lease Project of the Year Award (2004)

Publishing

- DOE High-Performance Buildings Database(http://www.eere.energy.gov/femp/highperformance/)

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Strategic Computing Complex

GENERAL INFORMATION

Building Name: Strategic Computing Complex
Building Location: Los Alamos, New Mexico USA
Project Size (ft², m²): 300,000 ft²
Building Type(s): Super computing facility with office space
Project Type: New Construction
Delivery Method: Design/build
Total Building Costs: $91,000,000
Cost/ft² or Cost/m²: $303/ft²
Owner: U.S. Department of Energy, Federal Govt., Los Alamos National Laboratory
Building Architect/Project Team: Hensel Phelps/HDR/ Carter Burgess
Project Contact Person: John Bretzke (505) 667-9182

DESCRIPTION

A. Project Description

The Strategic Computing Complex (SCC) is a 300,000 square foot facility built specifically to house world class super computers and a nuclear weapons design staff. The facility design staff had to carefully consider and balance safety, security, efficiency, life cycle costs, working conditions, and the need for flexibility to address changing computing technology. The project went through the planning phases from late 1997 through 1999. The design/build contract was signed in October 1999 and the building was completed in December 2001. The facility was constructed near the core of the Los Alamos National Laboratory on an existing parking lot.

B. Project Goals

OVERALL PROJECT GOAL/PHILOSOPHY

The mission assigned to the SCC required careful consideration of the significant aspects identified. The stated goal was for this facility to facilitate and support the design and testing of nuclear weapons through the use of super computers. This involves melding high technology with a range of scientists and computer specialists. Supporting a team approach to work through building design was a focal point for the design team.

ACCESSIBLE GOAL

The accessibility goal was to comply with all Federal requirements, taking no exceptions due to the stringent security requirements that often conflict or make compliance difficult.

AESTHETIC GOAL

The aesthetic goal was tied to future staff recruitment. We wanted a facility that would generate excitement and anticipation in our new staff recruits.

COST-EFFECTIVE GOAL

Overall cost effectiveness was a major point of focus for this project. Given a budget ceiling from the DOE, the cost objective was to maximize the number of office spaces that could be provided once the computer floor was "paid for."

FUNCTIONAL GOAL:

The office space were grouped to support a team environment with central break areas to encourage walking the hallways and interfacing with peers.

HISTORIC PRESERVATION GOAL
N/A

PRODUCTIVE GOAL
The productive goal was to create an environment that actively supported teaming and communication by a broad spectrum of specialty scientists.

SECURE/SAFE GOAL
The security requirements were extensive and were constantly presenting new challenges relative to the other goals and needs of the facility. In the end, the facility was successful in preparing a world class facility to construct, test, and operate super computers under an extremely secure environment.

SUSTAINABLE GOAL
Environmental concerns regarding the power and water use necessitated by the super computers were thoroughly evaluated and considered. Use of recycled water to cool the computers (and the whole building) resulted in this building having no net increase impact to water use at the Los Alamos National Laboratory. Environmental aspects were also included to limit power consumption, use of daylight, and use of recycled material. All of this had to be accomplished while maintaining separate power distribution systems for classified and unclassified electronic gear and communications equipment.

OTHER SIGNIFICANT ASPECTS OF THE PROJECT
Security requirements were significant given the primary mission of the Los Alamos National Laboratory and this specific building.

PROCESS

Overview Of Process

PRE-DESIGN/PLANNING ACTIVITIES
The most intensive effort was during the pre-design/planning phase of the project to ensure proper integration and balance between all aspects of the facility. During this phase a cross-functional team was assembled to develop a conceptual design of the facility. Weekly meetings between this team and the architects/engineers allowed for all aspects of the design to be discussed in front of all interested parties. Safety, security, and the ultimate users were participants in all meetings. At the completion of this effort, the team assembled the key points that they learned through the conceptual design process into functional and operational requirements (F&ORs) by room type. The F&ORs were then used as the core portion of the request for proposal (procurement) process to result in a design/build contract. Once the contract was signed, the design, construction, turn-over, and operations began with the F&ORs providing the roadmap and inspection requirements to assure ultimate compliance.


Strategic Computing Complex, Los Alamos, NM

DESIGN ACTIVITIES
During the design phase, the integrated team continued to review the design as it progressed for conflicting requirements and opportunities for improvement.

CONSTRUCTION ACTIVITIES
Construction activities also were overseen by the integrated team. Daily site tours were utilized to ensure that the answers developed during the design phase were actual solutions to the problem statements.

OPERATIONS/MAINTENANCE ACTIVITIES
Formal turnover of the facility from construction to operations and maintenance included the entire team to fully convey

the design intent to the occupants.

POST-OCCUPANCY EVALUATION ACTIVITIES
N/A

INFORMATION AND TOOLS

Resources

U.S. Green Building Council's LEED® rating system(http://www.usgbc.org/LEED/LEED_main.asp)

PRODUCTS AND SYSTEMS

Materials were deliberately selected based on many of the characteristics identified in this topic. Recycled and recyclable material was frequently chosen over other products and life-cycle cost evaluations were utilized to assist in the selection of other materials.

ENERGY ISSUES

Energy Use Description

Energy efficiency was a large concern for the design team since the computers already had such a large demand identified (7MW). Therefore, energy efficient lighting and heating were used throughout the building. Motion sensors were also used in the offices to control lighting.

Annual energy use by fuel
Electricity: 7,000 kWh
Total: 7,000 kWh

INDOOR ENVIRONMENT

Indoor Environment Approach

Indoor issues required the balancing of safety, security, teaming, and operating efficiency. Security was ultimately resolved by building the entire facility to comply with vault-type room standards to support efficient teaming among the staff while still protecting the classified data. The electrical and data distribution system also had a number of unique features to support the security requirements. These issues were dealt with one-by-one within the integrated project team until solutions that properly balanced the needs and met the requirements were identified.

PROJECT RESULTS

A. Lessons Learned

The building exceeded everyone's expectations in all the categories identified in this topic. The project was completed ahead of schedule and 15% under budget. The users have found the building very friendly and supportive of their working requirements. The environmental aspects are all operating as intended. All-in-all, the method used to develop the F&OR's and the design/build contracting methodology combined wonderfully to complete this project.

B. Ratings

None

C. Awards

1. Distinguished Performance Award, granted by LANL, October 1998
2. Engineering Excellence Award, granted by the American Consulting Engineers Council of New Mexico, October 1999
3. National Finalist for the Engineering Excellence Awards, granted by the American Consulting Engineers Council,

March 2000
4. Program and Project Management Award, granted by the Deputy Administrator for Defense Programs, DOE, October 2000
5. Performance Excellence Award 2000, granted by the DOE Albuquerque Operations Office, October 2000
6. Knowledge Sharing Award, granted by the National Nuclear Security Administration, DOE, June 2001
7. Los Alamos Awards Program, granted by LANL, September 2001
8. Performance Excellence Award 2001, granted by the DOE Albuquerque Operations Office, October 2001
9. Mechanical Project of Year, granted by Southwest Contractor Magazine, November 2001
10. AGC 2002 Build America Award in the Design-Build Category, March 2002
11. DOE Deputy Secretary Award of Achievement, March 2002
12. Construction Management Association of America, 2002 Construction Management Project Achievement Award, October 2002
13. Design/Build Institute of America, 2002 Best Industrial Project over $25 million, October 2002
14. 2001 DOE Defense Programs Awards of Excellence, awarded in December 2002

D. Publishing

- Carter & Burgess, Inc.(http://www.c-b.com/projects/projects.cfm?id=389&servid=24)

The Mutual Building – Christman Company Headquarters

GENERAL INFORMATION

Building Name: The Mutual Building – Christman Company Headquarters
Building Location:
City: Lansing
State: Michigan
Country: USA
Project Size (ft², m²): 57,875 square feet
Building Type(s): Office
Project Type: Office/Historic Rehabilitation
Delivery Method: Construction Manager
Total Building Costs: $8,500,000 Construction Cost
Cost/ft2 or Cost/m2: $147 square feet
Owner: The Christman Company
Building Architect/Project Team: SmithGroup
Project Contact Person: Brooke Smith, AIA (Project Manager, SmithGroup)

DESCRIPTION

Motivated by its need for additional space, The Christman Company, a 114-year old construction and development firm, was faced with a unique opportunity and elected to take a fully integrated approach to the development of its new national headquarters. Having been located in the same downtown Lansing building for 80 years. Christman was firmly committed to maintaining its downtown presence and, spurning the trend of urban sprawl, elected to become an integral partner in the City's ongoing downtown revitalization. Christman soon settled on a vacant six-story building in downtown Lansing: the landmark Mutual Building, a circa 1928 Elizabethan structure that was on the National Register of Historic Places.

This landmark downtown building and brownfield site designed and built to house the Michigan Millers Mutual Fire Insurance Company Headquarters in 1928, was an irresistible candidate for a milestone green and historic preservation project. Aside from its rich past, the historic features of the building included limestone detailing on the exterior and wood trim and Pewabic tile throughout the corridors and stairways. Protecting and preserving the historical integrity soon became a fundamental element of the sustainable design strategy.

Completed in February of 2008, the renovated building contains approximately 60,000 gsf, including the addition of a conference center at the roof-top level. Given that the owner's corporate offices and support functions only required 50% of the buildingâ€™s available area at the time of completion, two floors are currently being leased to other tenants, with a third floor reserved for future tenants and/or company growth. When completed, the project was awarded the first LEED Dual Platinum designation in the world by the USGBC.

OVERALL PROJECT GOAL/PHILOSOPHY

The Christman Company's key challenge lay in developing an outstanding building design that fulfilled the rigorous requirements of the USGBC LEED Rating System and the Secretary of Interior's Standards for Historic Preservation.

Shortly after acquiring the building, Christman and members of the design team embarked upon a visioning and organizational development study that led to the establishment of five guiding principles that drove the design process. The objectives were to represent the company's core values, people, energy, expertise, accomplishments, and history; encourage team collaboration; create an environment that shares successes and energy, as well as provides for mental and physical breaks; maximize comfort with individual thermal and lighting controls, ergonomic workstations and daylighting; and plan adaptively for growth, change and space needs of short-term on-site project personnel. Beyond creating a healthy and productive work environment for its employees, Christman realized that this was a major opportunity to demonstrate its commitment to integrated and sustainable design and construction, to historic preservation, and to the downtown revitalization of their home city.

SECURE/SAFE GOAL

The Mutual Building historic rehabilitation was performed without any worker being injured, and there were no accidents resulting in lost time or classified as recordable. This was a major accomplishment given the short duration schedule. Different trade workers were required to perform overlapping activities at the same time in the same spaces for a majority of the project. The raised access floor also created a significant number of trip and fall hazards for a majority of the project's interior construction. By diligently managing safety communications and supervision, the project team effectively eliminated the potential for anyone to be injured.

SUSTAINABLE GOAL

The owner's initial sustainability goals included pursuing LEED Certification Core and Shell (CS) for the entire building with the caveat that there be no appreciable increase to the cost of construction. As the project progressed, it became clear that Platinum certification was well within reach for both the Core and Shell (CS) and Commercial Interiors (CI) LEED rating systems. According to the owner's records, the cost for all sustainability initiatives added approximately 2.0% to the cost of the project, of which 70% of the added costs are attributed to the LEED certification process. In addition to the financial benefits of increased occupant comfort, health, and productivity, the owner expects to see a four-year return on their investment in green construction through the buildingâ€™s increased energy efficiency.

FUNCTIONAL GOAL

The reuse of a historic building on a previously developed site is intrinsically resource efficient and provided the basis for the functional goal of the project. Through respect and reuse of the existing, the team was able to create an office space that was functional and sustainable. The design enabled 92% of existing walls, roof and floors to be reused. By weight, 77% of all Commercial Interior project construction and demolition waste was diverted from landfills through reclamation and a recycling program.

Recycled materials were also used extensively. By cost, recycled materials account for 20% of the Core and Shell (CS) project, and 25% for the Commercial Interior (CI) project. Additionally, regional manufactured materials make up 42% of total materials costs for the CS project and 37% of total materials costs for the CI project.

ACCESSIBLE GOAL

Accessibility and convenience to the downtown Lansing community was a key design goal. The selection of the historic landmark building, and rehabilitation of a Brownfield site, is considered to be a significant factor in Lansing's ongoing downtown revitalization. Moreover, the Christman Building is serving as a testament that the principles of sustainability can be forged with the rigorous standards for historic preservation to yield a significant piece of historic architecture capable of meeting the needs of a 21st century office building. Its location avoids further urban sprawl and provides convenient pedestrian access to community services thereby helping to reduce the use of fossil fuels. The project provides employees access to bike racks, showers and locker facilities to encourage building occupants to walk, run or bike to work. And, due to the availability of nearby public parking facilities, no new on-site parking was added.

AESTHETIC GOAL

At its most general level the overall design aesthetic explores the notion of how new construction will inhabit and engage a historic Core and Shell. The developed design looks to lightly touch the existing building where necessary and to avoid touching it at all where possible. It also complements the existing building by being true to the architecture of today rather than trying to mimic the past; all the while creating a holistic project. This directly relates to the Department of the Interiorâ€™s criteria for new construction within historic structures.

COST-EFFECTIVE GOAL

This project clearly demonstrates that sustainable design and construction does not have to cost more than conventional construction. For the CS project, the costs associated with achieving green goals represent 1.3% of the total budget. Two-thirds of those green costs are related to the LEED certification process. For the CI project, the costs associated with achieving green goals represent 0.70% of the total budget. Of those green costs, 95% are related to LEED certification.

HISTORIC PRESERVATION GOAL

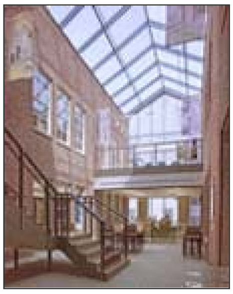
All of the preservation work on the building has been approved by the State Historic Preservation Office and the National Park Service to ensure that standards protecting the National Registered building have been upheld. Restoration of historically significant building features includes the main entrance doors and plaques, the mica shade light fixtures and Pewabic wall tiles in the main hall, and the light fixtures and verdigris bronze handrail finish in the stairwell and lower level.

Bricks salvaged from the removal of the penthouse have been used to patch exterior walls. Benign products, such as citrus strippers, wet grinding, and low VOC coatings, were used to restore historic finishes, such as the walnut paneling in the executive offices on the first floor. All plaster walls has been restored using several restoration techniques.

This is the first building in the world to receive dual LEED Platinum Certification. It was accomplished while adhering to the Federal and State requirements for Historic Preservation Tax Credits.

PRODUCTIVE GOAL

In planning the corporate offices, the designers took advantage of large perimeter windows and were able to provide day lighting to 92% of occupied spaces and outside views to 90% of the occupants. This was key to increasing worker comfort and productivity. Through the use of high efficiency indirect lighting optimally located by calculating luminance and illuminance levels, occupancy sensors in private offices, conference rooms, toilets and stairways, combined with programmed timers in common spaces, day lighting dimming controls and individually controlled task lighting, the design for the lighting system is projected to result in approximately 27% energy savings over ASHRAE/IESNA Standard 90.1-2004.



A new sky lit atrium, open to the 4th and 5th office floors as well as a new 6th floor conference center, was created by enclosing what had been an open-ended light well located at the center of the U-shaped building. In addition to its use as an informal gathering and collaboration area, the new inner courtyard serves as a focal point and supports the organizations goals toward unification and collaboration. It is also a key factor to insuring that nearly all employees have access to natural daylight. The space has quickly become the favorite place to work due to the quality of day lighting and architectural character of the space.

PROCESS

Overview of Process

The process was one of integration of sustainable and historic preservation construction capabilities, and commitment to the environment and the community.

PRE-DESIGN/PLANNING ACTIVITIES

The company conducted a pre-design organizational development study, which included an open-ended questionnaire to elicit opinions and input for follow-up small group discussions, which were attended by the project architect. The study produced five design criteria: to represent the companyâ€™s core values, people, energy, expertise, accomplishments, and history; to encourage team collaboration internally, with branch offices and with customers in both informal and formal settings; to create an environment that shares successes and energy, and also provides for mental and physical breaks; to maximize comfort with individual thermal and lighting controls, ergonomic workstations, and daylighting; and to plan adaptively for growth, change and the space needs of short-term on-site project personnel.

DESIGN ACTIVITIES

Evaluation of the design within sustainability metrics led to an integrated and cost efficient implementation of the design criteria.

- The building's exterior, main stairway, main corridor and first floor offices were meticulously restored to reflect the

original Elizabethan architecture.
- A sky lighted atrium housing an inner courtyard was created to provide daylight and encourage employee interaction.
- Workspaces are arranged in "quads," which provide non-disruptive visual accessibility to employee energy and creativity, and foster collaboration.
- Under floor air distribution systems (UFAD) were installed and thermal control was provided in each workspace.

CONSTRUCTION ACTIVITIES
Sustainable construction practices were used extensively for the building's core and shell and commercial interior. The firm also used these practices to fit out space under contract to two tenants.

- Indoor air quality was carefully managed during construction by using low-emission VOC products. Air filtration systems created a healthier construction site.
- LEED construction guidelines were tied to subcontractors' contracts.
- By weight, 77% of all CI project construction and demolition waste was diverted from the landfill through a reclamation and recycling program and many building components were reused.
- All preservation work was approved by the State Historic Preservation Office and the National Park Service

OPERATIONS/MAINTENANCE ACTIVITIES
Detailed specifications were developed for a green housekeeping program that stipulates the use of environmentally responsible and low-emission cleaning products and practices. The computerized building management system (BMS), which has several thousand control points, is used extensively for fine tuning the operation of HVAC and lighting systems to occupancy and climatic conditions. The BMS is also used to prompt maintenance activities.

POST-OCCUPANCY EVALUATION ACTIVITIES
Energy usage is subject to continuous monitoring and evaluation. The data is used to fine-tune the systems, to prepare the annual energy budget, and to charge the tenants for their electrical usage. A post occupancy survey was conducted after the first six months of occupancy and the systems are being further fine tuned to ensure maximum comfort conditions for the staff.

INFORMATION AND TOOLS

- Web-based building management system (BMS) tracks and measures electricity and gas usage, as well as atmospheric conditions inside and outside the building.
- Trane Trace 700 software was used to conduct energy modeling.

PRODUCTS AND SYSTEMS

Energy use is reduced by task lighting, occupancy sensors, programmed timers in common areas, daylighting for 92% of occupants, high efficiency windows and Energy Star office equipment and appliances. High efficiency HVAC systems provide individually controlled comfort conditions. The under floor air distribution system maximizes efficient, healthy ventilation. Low flow fixtures reduce water consumption by 40%.

The design reused 92% of existing walls, roof and floors, and most of the company's former office furnishings. Recycled and regionally manufactured materials, and low emission sealants, paints, carpets, and furniture were used extensively.

The interior provides outdoor views to 90% of occupants. Workspaces were designed for flexibility, adaptability, collaboration and teamwork.

Extensive recycling diverted 77% of construction debris from the landfill.

A 40% reduction in potable water and sewage use was achieved by careful selection of water efficient plumbing, such as low-flow fixtures, 0.5 gallon-per-minute automatic lavatory faucets with aerators, and dual flush valves throughout the building.

The reuse of a historic building on a previously developed site is intrinsically resource efficient. The design reused 92% of existing walls, roof and floors.

Approximately 3% of the building components were refurbished and reused, including historic door hardware, light fixtures and wood trim molding. The majority of file cabinets, office furniture and work stations were moved and reused from the former headquarters offices.

Recycled materials were used extensively. By cost, recycled materials made up 20% of the materials costs for the core and shell project, and 25% for the Christman Company commercial interior project. Regionally manufactured materials made up 37% of total materials costs for the commercial interior project. Regionally manufactured materials (10% extracted) made up 42% of total materials costs for the core and shell project, and 24% for the commercial interior project.

Recycling containers for paper at each desk and for other materials on each floor are emptied regularly and contents sent to a dedicated, central recycling room in the basement. Paper, plastic, cardboard, glass, batteries, lamps, printer cartridges and metals are all recycled.

ENERGY ISSUES

Energy modeling projected that the building will exceed minimum energy efficiency requirements by 34%. Measures incorporated include:

- White roof and 6" of added insulation
- Restored faÃ§ade windows fitted with double-glazed glass.
- Side/rear exterior windows replaced with high efficiency aluminum windows.
- HVAC systems designed and equipment selected to minimize energy use while providing individually controlled comfort conditions.
- Daylighting to 92% of occupied spaces, with additional background lighting provided by high efficiency fixtures and T-5 fluorescent lamps. All workstations have individually controlled multi-level task lighting.
- Appliances/office equipment are Energy Star rated.
- Purchase of Renewable Energy Certificates for clean wind energy to offset 70% of the building's core and shell electricity use for two years and 100% of The headquarters' electricity use for two years

Energy Issues

Annual energy use by fuel
Electricity 576,331 MMBtu
Gas (Natural) 1,056 MMBtu

Annual Energy by end use
Heating 1, 103.1 MMBtu
Cooling 465.1 MMBtu
Fans & pumps 159.8 MMBtu
Lighting 403 MMBtu
Plug loads & equipment 708.6 MMBtu
Stand alone Base Utilities 180 MMBtu
Unspecified End Use 0.400 MMBtu

Data sources and reliability
Based on simulation? Yes
Trace 700 v6.0

Comments on data source and reliability.

Commissioning

The project included a commissioning agent beginning in the earliest planning stages. The building was extensively commissioned with functional checks on all HVAC and electrical systems, lighting controls and domestic water systems. The intention is to continuously commission the building for the first year and then to re-commission all systems every five years.

Measurement and Verification/Post-Occupancy Evaluation

Energy usage is subject to continuous monitoring and evaluation. The data is used to fine-tune the systems, to prepare the annual energy budget, and to charge the tenants for their electrical usage. A post occupancy survey will be conducted after the first six months of occupancy and the systems will be further fine tuned, if necessary, to ensure maximum comfort conditions for the staff and maximum energy conservation.

INDOOR ENVIRONMENT

Indoor Environment Approach

The approach included the selection of environmentally sensitive materials and construction practices to reduce adverse effects after occupancy.

- UFAD system provides 200-300% more ventilation to the breathing zone, substantially exceeds minimum IAQ requirements.
- Indoor air quality is maintained by high efficiency air filtration system.
- All finishes met rigorous low-emission VOC standards.
- Daylighting to 92% of occupied spaces.
- Thermal, ventilation, and lighting systems controls at every work station.

PROJECT RESULTS

A. Lessons Learned

This project proved that sustainable design and construction need not cost more than conventional practices. Commitment to the LEED approach and collaboration among the owner, project team and subcontractors was essential to success.

The historic preservation and sustainable construction goals of the project were mostly complementary.

Installation and keeping under floor air system space clean proved to be a real challenge due to the debris generated by some of the historic preservation activities, such as plaster restoration.

Public interest in this green historic preservation project continues to be high. Visitors to the facility learn about sustainable design and construction through permanent signage and guided tours by Christman staff.

Ongoing evaluation of energy use efficiency measures and tracking consumption information are used to make changes needed to achieve our goals.

B. Ratings

This project is the first building in the world to receive dual LEED Platinum certification. It was accomplished while adhering to the rigorous requirements of the Secretary of Interior's Standards for Historic Preservation thereby enabling the owner to secure approximately $2.5 million in Federal and State historic tax credits.

C. Awards

2nd Place, Evergreen Awards
Eco-Structure, 2008

Green Building of the Year
CAM Magazine, 2008

Beyond Green High-Performance Building Award
Sustainable Buildings Industry Council (SBIC), 2008

Build Michigan Award
Associated General Contractors of Michigan, 2008

AGC Aon Build America Award
Associated General Contractors of America, 2009

Green Contractor Award
XL Insurance, 2008

D. Publishing

The Christman Building has been featured in over 26 articles and over 23 local and national publications. Some of the most notable include:

- *Eco-Structure*, HANLEY WOOD, LLC, October, 2008
- *Environmental Design + Construction*, McGraw Hill Companies, September 26, 2008
- *Crain's Detroit Business*, Crain's Communications, May 27, 2008
- *Architect Magazine*, HANLEY WOOD, LLC, June 5, 2008
- *ArchitectureWeek.com*, Artiface, Inc., June 18, 2008
- *Building Design + Construction*, Reed Business, September 8, 2008

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