



# Continuing Education

## Renovating an Historic Structure for LEED Platinum Certification

How some key decisions made in the Portland AIA's new headquarters were geared toward sustainability

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Portland, and the state of Oregon, has always been on the cusp of environmental leadership. So when it came time for the city's American Institute of Architects (AIA) chapter to undertake a new headquarters, the organization's leadership steered it toward becoming a pioneer in renovating an historic structure into a jewel of a sustainable structure. In the end, cutting edge design and the latest in green building technology came together to create AIA Portland's new Center for Architecture, hailed nationwide as a model for urban redevelopment. The center is the first AIA building in the world to achieve a LEED Platinum rating from the U.S. Green Building Council (USGBC), but how it achieved the rating is the real story. The 10,000-square foot center, with 5,000 square feet of occupied space, has been turned into a showpiece from what was once a dilapidated livery stable thought to be the oldest surviving structure in northwest Portland's thriving Pearl District. This case study will focus on: how key decisions were made regarding the renovation that contributed to the building achieving LEED Platinum status; the products that were utilized that helped secure LEED points toward energy efficiency; renovating an historic structure that would otherwise have been torn down; innovative uses of natural and artificial lighting; and rainwater management.

### Energy Efficiency and Ventilation

Achieving measurable energy efficiency is one of the most high-profile elements of receiving LEED certification. Conserving energy is a long-term benefit of using efficient products, designs and construction techniques that can add up to great savings over the life of a structure. In fact, USGBC requires a building to achieve at least two points for energy efficiency.

To earn LEED credits for optimizing energy efficiency performance, USGBC requires one of the following path options described below be selected. Project teams documenting achievement using any of these options are assumed to be in compliance with EA Prerequisite 2.



Continuing Education

Use the following learning objectives to focus your study while reading this month's Continuing Education article.

**Learning Objectives** - After reading this article, you will be able to:

1. Describe innovative measures for managing ventilation and heating/cooling costs.
2. Explain key steps to repurpose an historic structure into a LEED-accredited facility.
3. Identify best practices for using windows to enhance natural lighting.
4. Evaluate if a rainwater runoff system is appropriate for a project.



A six-panel folding door opens the building to the surrounding neighborhood and also contributes to the space's ventilation plan.

Photo courtesy of Michael Mathers

**Option 1 - Whole Building Energy Simulation (1-10 Points)**

Demonstrate a percentage improvement in the proposed building performance rating compared to the baseline building performance rating per ASHRAE/IESNA Standard 90.1-2004 by a whole building project simulation using the Building Performance Rating Method in Appendix G of the Standard.

**Option 2 - Prescriptive Compliance Path: ASHRAE Advanced Energy Design Guide for Small Office Buildings 2004 (4 Points)**

Comply with the prescriptive measures of the ASHRAE Advanced Energy Design Guide for Small Office Buildings 2004.

**Option 3 - Prescriptive Compliance Path: Advanced Buildings™ Core Performance™ Guide (2-5 Points)** Comply with the prescriptive measures identified in the Advanced Buildings™ Core Performance™ Guide developed by the New Buildings Institute.



The windows in the Portland AIA building are actually sliding patio doors and helped earn LEED points for materials and resources and product innovation.

Photo courtesy of Michael Mathers

For Portland AIA, the chapter incorporated Option 1 and implemented several energy efficiency strategies to reduce energy consumption in its drive to achieve a Platinum rating. The first decision the chapter made was to incorporate a 100 percent electric power philosophy.

"Our goal was to make the building utilize only electric power and capitalize on the clean energy sources, such as hydro-electric and wind-power, that are available on the local electrical grid in the Northwest," said Alan Scott, AIA, a principal with Portland-based Green Building Services and a member of the Center's LEED certification team.

Other energy saving measures include natural ventilation with roof-mounted turbines and dampers with displacement ventilation, thermal destratification fans that move heated air back to the occupied zone, basement duct work that allow for diffused air heating and cooling, and energy-efficient windows and doors to conserve energy all year long and leverage natural heating and cooling opportunities. Using double-paned Low-E glass in windows and doors took advantage of today's advanced glass technology that has progressed significantly the past 30 years and is changing the way heating and cooling plans are designed in today's structures.

#### Low-E and Other Glass Technology

Advances in glass coating technology and stronger regional energy code requirements have helped create a new generation and more sophisticated array of Low-E glass options. The windows and doors in the Portland AIA chapter's new headquarters feature Low-E coatings that contributed to LEED certification points.

To know which Low-E is best suited for a project, it's important to understand just what Low-E is, and how it works. Low-E, meaning "Low-Emissivity," is an extremely thin layer, or more commonly several layers, of metallic particles applied to the glass which, in simple terms, allows the glass to act like a sieve. Long wavelengths, or heat, are filtered out, while short wavelengths (the visible light spectrum) are allowed to pass through.

However, today Low-E means much more. By changing the types of materials used in the "stack" or layers of Low-E, or by increasing or decreasing the number of layers, it is possible to get more specific in designing glass that will meet exact project needs. Need high visible light but low U values? There's a Low-E for that. Need greater protection from fading? There's a Low-E for that. And it can get even more precise. Adding argon gas to the captive air space between glass panes will improve insulating value. Adding various tinting agents to the glass itself will allow for even further refinement of the glass' performance.

Low-E is not the same as tinted glass. Tinting is the adding of alloying materials to the glass itself. The depth of color of tinted glass will change with glass thickness, so that a sheet of 3mm glass will have a lighter tint than that of a sheet of 6mm glass. Small windows next to large fixed units or doors can have different tints, since the standard glass thickness of smaller panes is typically thinner than that of larger ones. Low-E, on the other hand, is applied to the glass, and therefore will have a similar appearance regardless of glass thickness. Also, tinted glass tends to absorb sunlight and will get very hot when installed as a single pane, hence tinting does not improve insulating value.

Solar Heat Gain Coefficient (SHGC) is a rating for measuring how much heat gain is admitted through a window. The lower the SHGC rating, the better the ability of the window to block the heat from the sun. SHGC can also be controlled by the use of Low-E coatings combined with the use of tints, and can even be influenced by the glass surface the Low-E coating is placed upon. Additionally, since less than half of the total solar energy spectrum is visible to the human eye, solar performance of glass can be visually deceptive.

Darker tints don't necessarily mean significantly better SHGC values. For instance, green tinted glass will allow 77 percent visible light transmission, while gray glass only allows 45 percent, yet the gray glass only improves SHGC by 2 percent. A better way to improve SHGC, without compromising visible light transmittance, is through SHGC-specific Low-E coatings.

Perhaps one of the least-often discussed elements regarding glass performance is the comfort level of occupants. If the inside glass temperature of an insulated unit is significantly lower than the room temperature, it can give the occupants a feeling that the room is colder than it actually is. For example, at 0 degrees Fahrenheit outside, the inside surface of double pane glass can be as much as 30 degrees warmer than single pane glass, but still 25 degrees cooler than the same assembly with Low-E coated glass. The converse can be true during hot summer months. Since the Portland AIA building does experience some days of extreme heat and cold throughout the year, this factor was important for keeping occupants comfortable all year long and during those extreme temperature swings. Low-E has the ability to keep the temperature of the surface of the glass facing the interior very near that of the room itself, regardless of outside temperatures.

#### Window Sensors

To further take advantage of the operable windows and maximize energy usage at the same time, Portland AIA utilized window-mounted switches that turn off the Center's HVAC systems if the windows are left open. This technology ensures that no energy is wasted if the structure envelope is not engaged to conserve the resources used.

"The window sensors have worked better than expected," said Scott. "The way the system works is if one window is open, the HVAC system shuts off the heating or cooling in that zone but not the overall mechanical ventilation system. Only when more than one window is open does the system shut-off and defer to the roof vents."

Scott says one of the biggest benefits of the redesign is that the AIA staff understands and has adopted the overall system. Because of the staff's buy-in, the building is running 21 percent more efficiently when it comes to energy usage than first predicted in the initial model.

"They truly prefer the natural ventilation system and are aware of the energy efficient measures," he said. "The connection between the design and the users is the success story with this building."

The windows and doors contributed to other LEED credits through materials and resources selections and process innovation.

For example, the windows and doors were manufactured within 500 miles of the Portland area, as was the glass used in the units and the Low-E coating that was applied. In addition, the wood windows and doors were treated to the core with a proprietary, water-based, vacuum-pressure process that is free of volatile organic compounds (VOCs) and ensures a long-lasting lifecycle, making it more environmentally preferred than the industry standard "dip treatment" method.

#### Rainwater Management

Portland is known for its rainfall and the Center for Architecture wanted to capitalize on the amount of precipitation the area experiences annually. An innovative management system that captures and reuses rain helped the building earn six LEED points for water efficiency.

The rainwater system came about because the design team needed to perform a seismic upgrade on the building for better earthquake preparation, said Alan Scott, AIA, a principal with Portland-based Green Building Services and a member of the Center's LEED certification team. The solution for more stability was

to build a concrete box in the basement and build on top of that a rigid steel frame in the entryway. The design team saw an opportunity to use the concrete box as a 6,000 gallon cistern for storing captured rain water that could then be used in place of potable water in toilets and urinals. All that was needed was a flexible water bag that acts as the central part of the system to line the cistern.

In addition, the gutters and downspouts on the north end of the building were combined with the gutters of the adjacent building, meaning two structure's worth of water was being funneled to the cistern.

"We wanted to capture all that water so the Center is really doing more than its fair share to manage stormwater in the setup," noted Scott. "The system collects water off the north half of our building and the south half of the building next to us. It goes through a prefilter and then into the cistern. Then the water is pumped out and goes through filters and a UV sanitizer. From there, the water goes to toilets and urinals.

The results speak to the success of the custom rainwater management system. Through water efficient fixtures and reused rainwater, the AIA reduced its annual potable water demand for toilets and urinals by 97 percent, plus provided for the Center's minimal irrigation needs. In addition, storm water planters on the south side of the building and permeable pavers in a portion of the sidewalk manage the remaining runoff.



Through water-efficient fixtures and reused rainwater, the AIA reduced its annual potable water demand for toilets and urinals by 97 percent, plus provides for the Center's minimal irrigation needs.

Photo courtesy of Michael Mathers

"Overall, we reduced potable water use by about 88 percent," said Scott. "That's a tremendous cost savings and environmental benefit."

To determine if a rainwater management system is right for a building, Scott suggests calculating the number of people in the building and the operating schedule (demand), measure the roof area for capturing rainwater, and determine the area's rainfall data on a monthly basis. That calculation will determine if there's sufficient rainwater capture to meet monthly demand and what the optimal cistern size should be.

### Operable Window and Door Units

Moving from a building that had no operable windows, the new Center for Architecture team determined that workable windows and doors were important. The idea of increasing natural ventilation, as well as connecting with the local community and welcoming them into the space, was accomplished by installing multiple windows at street level and folding doors that completely opened up large openings, similar to what is used in restaurants for outdoor seating areas.

Due to the uniqueness of the space, the windows needed to be oversized yet still be operable. The window provider came up with the solution to actually use sliding patio doors as the windows, and install handles not in the middle but at the bottom so they would be easy to reach for occupants. The result is a series of patio doors on the south wall designed to look like windows.

One of the original features of the structure was an arched entryway that was used for transporting horses into the stable. Years later, the arch was covered over. However, when the chapter saw this unique feature it planned to restore the archway for visual appeal and to keep with the traditional design of the building. To make this a focal point, the architect team brainstormed ideas with its window and door provider to install a folding door that would completely open up the entryway and allow easy access as well as ventilation.

The folding door contains five panels and opens accordion-style to the east side of the building, which is also the side that faces the Portland Streetcar that runs just a few feet away. The Center for Architecture staff can easily open the folding door system and welcome guests and bring natural ventilation into the space.

To provide further energy efficiency and increase ventilation, the architect designed a series of small ventilation holes above the main front entry door that allows cool night air to flow through the building without the security concern of open

windows and doors. This night flush system supports the passive cooling plan to save energy costs while still maintaining a comfortable interior environment.

"The beauty of the Portland climate is that it does cool down at night, even on the hottest days of the year," said Scott. "We wanted to take advantage of that with an automated system that starts itself when the outside temperature drops below a certain point. It works like a whole-house fan in a residence and pulls cooler air into the space."

#### 2030 Challenge

In addition to LEED certification, Portland AIA was also designed to meet the goals of the 2030 Challenge, which aims to reduce the amount of global greenhouse gas (GHG) emissions to positively influence climate change. Architecture 2030, the organization that started the challenge, says that buildings are the major source of demand for energy and materials that produce by-product greenhouse gases (GHG).

"Meeting the 2030 Challenge was the bigger picture we had our eye on in improving the overall energy efficiency plan for the building," said Scott. "The decision to use alternative energy sources, and to incorporate operable windows, was a direct result of our goal to meet 2030. We knew we wanted to do as much as possible to reduce our carbon emissions."

Architecture 2030 has issued The 2030 Challenge asking the global architecture and building community to adopt the following targets:

- All new buildings, developments and major renovations shall be designed to meet a fossil fuel, GHG-emitting, energy consumption performance standard of 50 percent of the regional (or national) average for that building type.
- At a minimum, an equal amount of existing building area shall be renovated annually to meet a fossil fuel, GHG-emitting, energy consumption performance standard of 50 percent of the regional (or national) average for that building type.
- The fossil fuel reduction standard for all new buildings and major renovations shall be increased to:
  - 60 percent in 2010
  - 70 percent in 2015
  - 80 percent in 2020
  - 90 percent in 2025
  - Carbon-neutral in 2030 (using no fossil fuel GHG emitting energy to operate).

These targets may be accomplished by implementing innovative sustainable design strategies, generating on-site renewable power and/or purchasing (20 percent maximum) renewable energy and/or certified renewable energy credits.

Because of its innovative measures and decisions to reduce its carbon footprint, already the Center for Architecture is achieving 91 percent reduction in carbon emissions and plans to bridge the remaining distance to meet the 2030 Challenge through photovoltaic panels and the purchase of carbon offset credits.

#### Cost Savings Results

The sustainable strategies put into place for energy efficiency have so far paid off for Portland's Center for Architecture. For example, the baseline design called for 77,000 kWh of energy for the building over the course of a year for a total of \$11,103 in energy costs based on current prices. The design that was implemented uses just 47,612 kWh of energy for a 38.2 percent reduction of energy consumption, and resulted in a 57.1 percent savings in energy costs.

#### Renovation of an Historic Structure

Because reuse is a staple of achieving LEED certification, the question of whether to remodel or move was brought up several times by the chapter's leadership during the early discussions of a new headquarters. However, the Portland AIA chapter had grown from 400 members in 1992 to 1,000 members in 2006, making it one of the top five AIA chapters in the country. The city was becoming a leading destination for architects on the West Coast and it was apparent that changes in the chapter's headquarters were becoming necessary. The old space was proving to be physically inadequate for hosting chapter events, their frequent education meetings and staff functions, and environmentally unhealthy for staff and visitors given that the few windows in the office were all fixed, and very little natural light was available. Above all, Portland AIA wanted to demonstrate its commitment to sustainability and become a more visible part of the growing community it was serving.



From the outset, continuing education was a main driver of how any new design at the Center for Architecture would be implemented. Since the new location had to be centrally-located, the thought was that any space that was flexible enough for classes and dinner meetings could be offered to the community for rent for everything from business meetings to press events.

Photo courtesy of Michael Mathers

After the decision was made to look for a new location, the Portland AIA Board of Directors established a set of goals for its future headquarters:

#### LEED Platinum Rated Space

Because of Portland's sustainable reputation and the growing interest in green building among chapter members, the bar for this project was set notably high and the sustainable goals had a tangible influence on every decision being made.

#### A Healthy and Supportive Workspace for Staff

Achieving LEED Platinum certification would mean integrating healthy choices in building materials, designs and the overall workspace environment. Unlike its former offices, the Center for Architecture would take advantage of advanced ventilation and natural lighting technologies as well as certified and recycled materials.

#### Located within One Mile of the Greatest Concentration of Portland's Architects

Portland's vibrant new Pearl District, once home to auto shops and taverns, was transforming into a cultural center of the city. Located just north of downtown and within walking distance, the area in the early part of this decade was sprouting with new mixed use buildings, restaurants, shops and condominiums. The chapter leadership saw this growth as an opportunity to focus its search for a new location within the Pearl District and secure its future in one of the growing areas of town.

#### Location Near Public Transportation

Nationally known for its mass transit light rail system, Portland has been expanding its Metro Area Express (MAX) light rail system from just one line to five lines today. The Portland Streetcar is part of the MAX system and runs from Portland State University in the southwest part of the city, through the Pearl District, and up to the northwest part of town. The streetcar served as a roadmap for searching for a new headquarters, as a location near public transportation was important to earning LEED credits. The area is also a popular hub for bike commuters who ride to work or combine their commute with public transit.



#### Street Level Visibility

Rather than be situated on the upper floors of a new office building, Portland AIA wanted to be part of the fabric of the district and showcase its building and engage its members and the neighborhood. Street-level access and visibility served as the bridge to immersing the Center and its visitors and staff into everyday life in the Pearl District.

#### Flexible Classroom Space Suitable for Continuing Education and Rental to Outside Groups

Flexibility was key in acquiring a new space. From the outset, continuing education was a main driver of how any new design would be utilized. Since the new location had to be centrally-located, the thought was that any space that was flexible enough for classes and dinner meetings could be offered to the community for rent for everything from business meetings to press events.

#### Commitment to A Collaborative Integrated Design Process

Who better to design an architect association's headquarters than local architects, the chapter's leadership thought. The location was designed by Holst Architects of Portland and the Center's sustainable goals were set through a community-led process, including a series of meetings open to the neighborhood as well as AIA members.

According to the LEED requirements, alternative commuting transportation credits are available for buildings that have the intent to reduce pollution and land development impacts from conventional automobile use for commuting trips. The requirements to earn credits are based on providing people with transportation choices which result in a reduction in the number of commuting round trips made by regular building occupants using single-occupant, conventionally-powered, and conventionally-fueled vehicles. For the purposes of this credit, alternative transportation includes mass transit. Since Portland has an efficient system of bus lines and light rail, Portland AIA wanted its new headquarters to be near these mass transit options.



Flyash concrete, which is a byproduct of coal combustion, was used for the floor of the Portland AIA's Center for Architecture and helped earn a carbon reduction benefit.

Photo courtesy of Michael Mathers

After narrowing its search in the Pearl District, the Portland AIA chapter came upon a vacant 10,000-square foot building built in the 1880s that was originally used as a livery stable for horses, and was most recently an art gallery. It is thought to be the oldest surviving structure in the Pearl District.



Located in the heart of the district, the building also had the benefit of being located directly on the Portland Streetcar line, one of the city's light rail options that connect the outer suburbs to the inner city. The fortunate location meant staff and visitors could take public transportation to the Center and literally be within a few yards of the building at the nearest stop. Bike racks encourage bikers to commute to work and provide a secure location to park.

In addition, the building met many of the association's other goals mentioned previously: it featured street level access, an open layout, and had the potential to be configured into a flexible space.

#### Reusing Materials

The Portland AIA was determined to use as much of the original building configuration and its materials in the redesign and remodel as possible. Starting with the shell, which is iconic in the area and conveys an old-Portland feel with its single story that sits amongst new hi-rises, the architectural team used the original envelope as a guide to work within and kept as many interior components as possible. In addition, materials with recycled content were regionally sourced when possible to keep the project local and sustainable. As Scott adds, "the most sustainable material is the one you don't use."

After years of use and a slope that pointed toward the city's sewer system, the structure's floor needed to be redone and leveled for use as a functional office environment. Rather than using traditional Portland cement, the architects specified high-volume flyash concrete, which is a reusable byproduct of coal-fired electric generating plants.

"The floor was sloped and had a step with one-third of the area at a lower level," said Scott. "We demolished much of the floor and leveled it off with flyash concrete. The idea was to have the floor function with a dual purpose of structural strength and an attractive finish. It turned out beautifully and has functioned well."

Scott said that by putting flyash in place of some of the typical cement content, the Center achieved a carbon reduction benefit. According to [www.sustainablesources.com](http://www.sustainablesources.com), flyash concrete is defined in cement and concrete terminology as "the finely divided residue resulting from the combustion of ground or powdered coal, which is transported from the firebox through the boiler by flue gases."

Flyash is one of three general types of coal combustion byproducts (CCBP's). The use of these byproducts offers environmental advantages by diverting the material from the wastestream, reducing the energy investment in processing virgin materials, conserving virgin materials, and reducing pollution.

Although flyash offers environmental advantages, it also improves the performance and quality of concrete. Flyash affects the plastic properties of concrete by improving workability, reducing water demand, reducing segregation and bleeding, and lowering heat of hydration. Flyash increases strength, reduces permeability, reduces corrosion of reinforcing steel, increases sulphate resistance, and reduces alkali-aggregate reaction. Flyash reaches its maximum strength more slowly than concrete made with only Portland cement. The techniques for working with this type of concrete are standard for the industry and did not impact the budget of a job.

By using the maximum amount of flyash in the floor concrete, the Center's architects turned what was once a major polluter into one of the most eco-friendly buildings in Portland.

#### Natural and Artificial Lighting

Daylighting is an important step to leveraging natural light through the use of open-air design. During the design process, it was recommended to consider incorporating atriums, skylights, and windows to draw sunlight into workplaces and take advantage of this abundant natural resource. It's also important to balance artificial light with natural light to create a healthy and desired light balance in the building.

With an abundance of windows, doors and skylights in its new space, the Center for Architecture was able to earn two LEED points for Daylight and Views (EQ Credits 8.1 and 8.2).

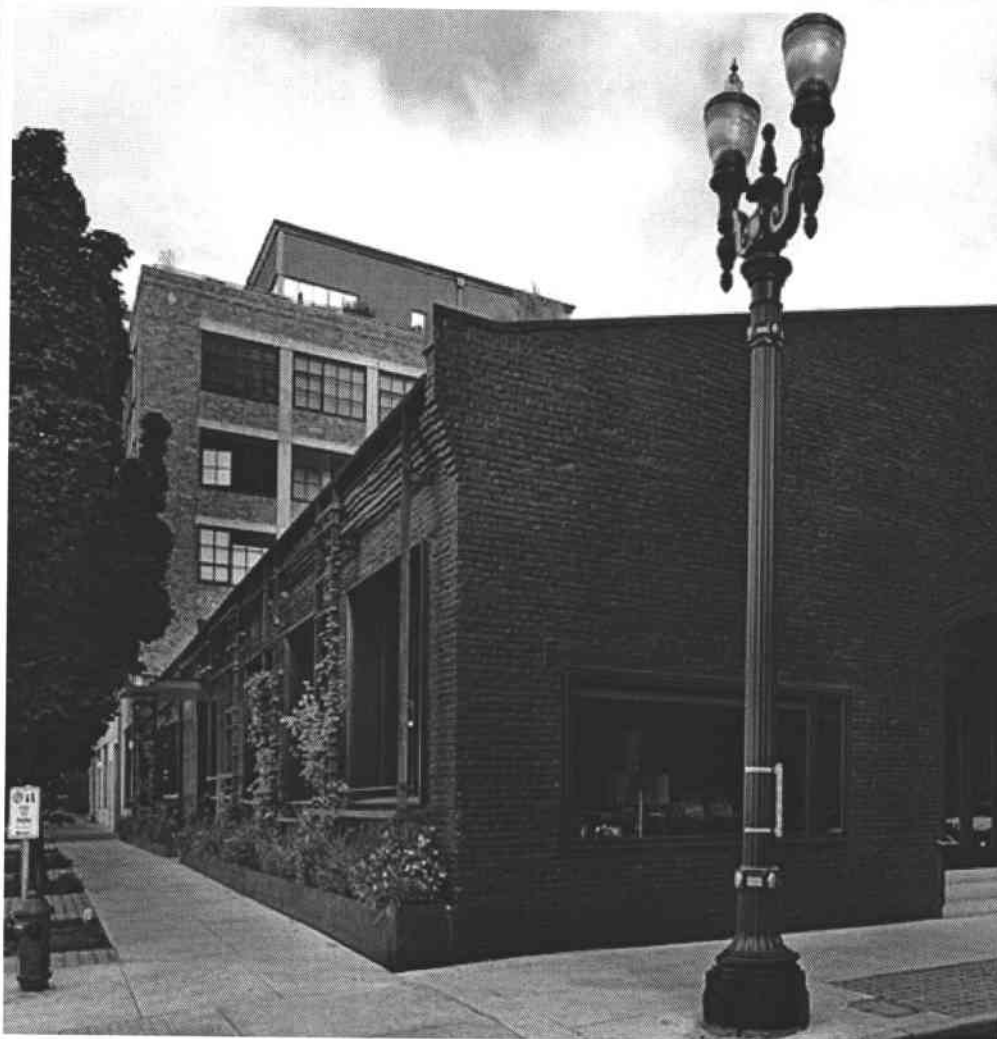
The goals of these points are to provide a connection between indoor spaces and outdoor environments through the use of daylight and views in the occupied areas of the building.

"The existing structure did have quite a few windows and one existing skylight" said Scott. "Our lighting partner did a daylight analysis in terms of what was needed and made recommendations. We also held all of our design meetings in the space prior to the renovation with the lights turned off, so even on cloudy days our team knew there was good daylight."

For daylight points, LEED stipulates a building must achieve a minimum glazing factor of 2 percent in space occupied for critical visual tasks, not including copy rooms, storage areas, mechanical, laundry, and other low-occupancy support areas. Exceptions include those spaces where tasks would be hindered by daylight.

Glare control must be provided for all windows where direct sunlight would interfere with normal activities.

The Portland AIA building achieved a 2 percent glazing factor in over 75 percent of all spaces occupied for critical visual tasks.



The Portland (Ore.) AIA chapter's Center for Architecture was the first AIA building in the world to earn a LEED platinum rating.

Photo courtesy of Michael Mathers

For views, spaces must achieve direct line of sight to the outdoor environment via vision glazing between 2'6" and 7'6" above the finished floor for building occupants in 90 percent (Credit 8.2) of all regularly occupied areas.

Given its bank of sliding doors that serve as windows, two skylights overhead and a six-panel folding door that provides near total outside views, the Center for Architecture earned a LEED point for sight lines that reached 90 percent of all regularly occupied areas.

"The space is small enough that with its open plan you can pretty much see outside from any spot in the building," noted Scott. "The design capitalized on the excellent resource that was provided to us."

The fenestration products were specifically designed and built to achieve both daylight and view points, and also accomplish the goal of opening up the one-story building to the sights and sounds of the neighborhood.

For the Portland AIA, day lighting has already proven to be an excellent strategy for increasing energy performance by eliminating the redundancy of artificial light when natural light is available. The Center utilizes low-energy light fixtures with daylight sensors to control energy usage and provide additional light as warranted by occupants. For the most part, the entire space relies on natural light throughout the day, a key contributor to reduced energy bills.

"One of the keys to success of our day lighting are the controls we selected," said Scott. "It is a low-voltage control system that allows for a lot of flexibility. We have daylight sensors that dim general lighting automatically when there is sufficient natural light. Occupancy sensors turn off lights if the space is vacated, and manual dimmers control shades and lighting levels when a darker room is needed."

Studies by the U.S. Green Building Council (USGBC) have shown that employee satisfaction improves when people are given control of their lighting environment. Shades or blinds can help them control natural light, and lighting controls can help control artificial light at workstations.

When it came to artificial lighting, the Portland AIA chapter has general illumination with a low Lighting Power Density (LPD) that supplements natural lighting during daylight hours. In work spaces this illumination is augmented with efficient task lighting providing point of use control to suit individual preferences.

Since its opening in 2008, the Portland AIA's Center for Architecture has been a welcome addition to the neighborhood, and identified as a model of sustainability by experts around the world. A look at its LEED scorecard shows the facility earned its Platinum rating by gathering 11 points for the sustainable site, five points for water efficiency, 13 points for energy and atmosphere, 12 points for materials and resources and five points for innovation and design.

The most recent addition to the structure, the USGBC's LEED Platinum plaque, hangs proudly in the front entry for all to see and serves as a constant reminder that this revitalized structure is a bright example for the future of sustainable architecture.

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