Upcycled Historic Building Embodies Past, Pursues Future

BY JOHN RAHILL, AIA

THE CLASS OF 1966 ENVIRONMENTAL CENTER at Williams College in northwest Massachusetts marries a 225-year-old building with a contemporary addition. It is the first project in the nation seeking Living Building Challenge (LBC) certification to include a historic preservation component. The design team’s challenge was to fold the programmatic needs of the expanding Environmental Studies program into the existing historic Kellogg House—and to do so under the requirements of the LBC, currently the most rigorous metric of sustainability.
Early in the project goal-setting process, the college, which is located in northwest Massachusetts, made an extraordinary commitment to once again repurpose a beloved and historic campus building. Kellogg House has been the home of the college president, faculty housing and, since 1978, the Center for Environmental Studies. Demonstrating that a historic building can be retrofitted to a very high level of energy efficiency, while preserving its significant historic features, became the foundation of the project. The decision to seek LBC certification developed during intensive workshops early in the design process. The project recently received LBC Petal Certification, meeting six of seven criteria for full LBC certification. (Learn more about the Living Building Challenge Petals at living-future.org/lbc.)

It was clear to the Williams leadership that the benefit of this undertaking was in the journey, not the receipt of a plaque on the wall. Williams had an opportunity to advance its mission of providing the best liberal arts education possible and maintain its commitment to sustainability by creating a building that merges technological, operational and educational...
**CASE STUDY  CLASS OF 1966 ENVIRONMENTAL CENTER**

The historic Kellogg House and addition are linked by a central entrance.

**BUILDING AT A GLANCE**

**Name**  Class of 1966 Environmental Center  
**Location**  Williamstown, Massachusetts  
**Miles from nearest major city**  150 miles WNW of Boston  
**Owner**  Williams College  
**Principal Use**  Home for the Zilkha Center for Environmental Initiatives  
**Includes**  Classrooms, offices, teaching kitchen, outdoor classrooms, gardens  
**Employees/Occupants**  13 faculty/staff; 40 to 60 students  
**Expected (Design) Occupancy**  40 to 75 daily visitors  
**Percent Occupied**  100%  
**Gross Square Footage**  9,510  
**Distinctions/Awards**  Petal Certified by the International Living Futures Institute (Place, Water, Health and Happiness, Materials, Equity, and Beauty and Inspiration)  
**Total Cost (Renovation and Addition)**  $3.4 million  
**Cost per Square Foot**  $358 (including site and landscape)  
**Substantial Completion/Occupancy**  April 2015  
**Historic Portion Built**  1794  
**Major Renovation**  April 2015  
**Renovation Scope**  Deep energy retrofit and historic renovation

**ENERGY AT A GLANCE**

**Annual Energy Use Intensity (EUI) (Site)**  19.3 kBtu/ft²  
**Electricity (Grid Purchase)**  4.5 kBtu/ft²  
**Electricity (On-Site Solar)**  14.8 kBtu/ft²  
**Annual Net Energy Use Intensity**  4.5 kBtu/ft²  
**Annual Source (Primary) Energy**  29 kBtu/ft²  
**Savings vs. Standard 90.1-2007 Design Building**  Since a net zero building has no annual energy cost after the initial investment, it is a very different analysis compared to typical building where there are annual energy costs. Energy optimization methods are included in the article.

**Percentage of Power Represented by Renewable Energy Certificates**  0% — Not allowed under LBC

**Heating Degree Days (Base 65°F)**  5,949  
**Cooling Degree Days (Base 65°F)**  653  
**Annual Hours Occupied**  5,475 (15 hours per day M-F)

**WATER AT A GLANCE**

**Annual Water Use**  The project includes self-contained water and storm water systems as required by LBC. 100% of the water supply for the building comes from the collection and purification of water that falls on the roof and is stored in a 6,000 gallon cistern. Gray water is treated on site by a constructed wetland and sand filter.

**KEY SUSTAINABLE FEATURES**

**Water Conservation**  In addition to signage and occupant education, the following measures reduce water use: low flow faucets in bath (0.375 gpm); low flow faucets in teaching kitchen (1.5 gpm); Energy Star commercial dishwasher (<1 gallon per cycle); foam flush composting toilet (3 oz. per flush).

**Recycled Materials**  During construction 80% to 100% of waste materials were diverted from landfills.

**Daylighting**  Orientation, building depth, shaded exterior windows, and interior clerestory windows allow every occupied room to have access to balanced daylighting.

**Individual Controls**  12-ton air-to-air heat pump systems services 24 ductless units with individual controls.

**BUILDING TEAM**

**Architect**  Black River Design, Architects  
**General Contractor**  Consigli Construction  
**Mechanical Engineer**  Kohler & Lewis  
**Electrical Engineer**  DuBois & King, Inc.  
**Energy Modeler**  Efficiency Vermont  
**Structural Engineer**  Novelli Engineering  
**Civil Engineer**  Gunflow & Associates  
**Environmental Consultant**  Integrated Eco Strategy  
**Landscape Architect**  Wagner Hodgson  

**BUILDING ENVELOPE**

**Roof**  
**Type**  5 in. polyiso under slate (Kellogg House) and white TPO (addition)  
**Overall R-value**  R-30

**Walls**  
**Type**  5 in. polyiso (continuous exterior insulation)  
**Overall R-value**  R-30  
**Glazing Percentage**  40%

**Basement/Foundation**  
**Slab Edge Insulation R-value**  R-15  
**Basement Wall Insulation R-value**  R-25  
**Basement Floor R-value**  R-15  
**Under-Slab Insulation R-value**  R-15

**Windows**  
**Effective U-factor for Assembly**  U 0.2  
**Solar Heat Gain Coefficient (SHGC)**  0.25 to 0.32  
**Visual Transmittance**  0.43-0.56

**Location**  
**Latitude**  42°42’51.84”N  
**Orientation**  ESE

**Carbon Reduction Strategies**  There is no combustion on site. Source locations for building materials and services adhered to strict restrictions. Significant and creative strategies were sought to reduce the building’s and site’s embodied carbon footprint.

**Transportation Mitigation Strategies**  An asphalt parking lot on the project site was removed and converted to edible landscape; bike racks are included at both front and back entrances.
 iniciatives. In doing so, the school created a unique center for sustainable living and learning.

The design and construction of this project is only the first chapter in a story that explores and experiments with the connection to the immediate (and global) environment. This building is designed to be a place that will encourage the best young minds and future leaders to think, in first-hand ways, about their connections to their surroundings through energy use, water supply and waste.

**Renovating a Historic Structure**

Deep energy retrofits and historic preservation don’t typically go hand in hand. The priorities reflected in each are often at odds. The project is an example of a functional compromise that aligns the two priorities and shows the benefits of upgrading a building to modern standards, while increasing the longevity and usefulness of our historic existing building stock.

The Federal-style architecture of the Kellogg House is elegantly simple in its symmetry and construction. Its solid plank wall construction meant there was no stud cavity to fill with insulation. Therefore, to improve the thermal resistance of the walls, insulation needed to be added to either the interior or the exterior. The team opted to add the thickness to the exterior, wrapping the exposed plank walls in 5 in. of rigid board insulation and clapboard siding applied over wood strapping. This keeps the vulnerable original wood structure free from the destructive effects of condensing moisture, since all components remain at room temperature.

Architectural trim such as the frieze board with its dentils, and the eaves with their crown molding...
Fireplaces were decommissioned, and an insulating layer added to the envelope to ensure continuity.

Envelope
Both the historic Kellogg House and the addition use continuous exterior insulation, a technique of wrapping the entire structure with high R-value rigid insulation. This strategy avoids thermal bridging, critical to achieving the targeted R-value, but was either repaired or replaced. Materials used were “in kind” and locally sourced. The interior of the attic remained completely intact. The exposed rafters, corbeled chimneys and original wood shingles would all remained exposed, allowing one to see the changes in building technology over time.

The building’s historic double-hung windows, complete with floated glass, are a defining element and were retained. Airtightness targets and required R-values were achieved by adding an operable inswing interior double-glazed window. Conveniently, the size and placement of the historic windows, in conjunction with the orientation of the narrow building, provided almost ideal daylighting ratios for the classrooms and offices. The choice of ductless indoor heat pump units also required few modifications to the historic interior for heating and cooling distribution.

Fireplaces were the primary heat source in the Kellogg House, but masonry fireplaces and chimneys constitute a large hole in the envelope. LBC guidelines prohibit any kind of combustion, no matter how efficiently, including wood, as a heat source. The original brick fireplaces were therefore decommissioned, and the flues sealed to prevent the significant heat loss that accompanies fireplaces. The masonry chimneys were reconstructed above the roof insulation plane incorporating an insulation layer to complete the continuity of the insulation and to avoid thermal bridging.

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ensuring durability by keeping all the vulnerable parts of the exterior wall warm and avoiding any moisture damage that can occur as you tighten a building envelope. High-quality weather-stripped exterior doors; highly insulated, strategically, and sparingly placed windows; and solar shading were also used. By scheduling blower-door testing at three critical stages during construction, rather than waiting until completion, the team was able to easily identify and fix leaks before they became inaccessible. The building, including the historic half (Kellogg House), has achieved air tightness that nearly meets Passive House standards.

**Mechanical and Electrical Systems**

A highly energy-efficient air-to-air heat pump heating and air-conditioning system in the Class of 1966 Environmental Center makes the highest and best use of the on-site solar energy sources while providing excellent thermal comfort. The energy-efficient envelope keeps the heating and cooling loads to a minimum, with the target of running the entire building on solar-generated electricity.

A strategic approach to lighting design, using balanced natural lighting, maximizes the energy savings during the day while giving occupants sufficient light to perform their tasks. The narrow building works to our advantage here, as most rooms are easily daylit. Even interior spaces are daylit using interior glazing. To further reduce unnecessary use of lighting in all areas (except common spaces), wall switches were programmed to “manual-on/automatic off,” which requires the occupant to turn on the light fixtures via local wall switch, but the switch automatically shuts the light fixtures off when no one is in the room.

The projected heating load is small (less than the other projected electrical loads), which puts great pressure on the occupants to understand the impact of, and perhaps change, their behavior. Promoting conscious and sparing energy use is a goal of the project, but, ironically, creating a popular building risks drawing more people and users than anticipated, resulting in higher energy consumption. Energy monitoring equipment and feedback systems have been
Net Zero
From the perspective of building design, one of the primary challenges of Living Building Challenge (LBC) is the requirement to be net zero for energy and water use.

Net Zero Energy. To meet the LBC requirements of net zero energy, the Class of 1966 Environmental Center site must generate as much energy as the building and its occupants consume. Using the Massachusetts Stretch Energy Code as a base, the design team analyzed the cost of incremental increases in every component of energy saving until it was more effective to buy a unit of energy from a photovoltaic (PV) energy source than it was to save a unit of energy.

Strategies included exemplary space utilization, lower heating/cooling loads through an energy-efficient envelope, and lower water, lighting, process, and plug loads. Extensive energy modeling was performed to find the balance point or “sweet spot” between spending in energy savings vs. energy generation. The Class of 1966 Environmental Center has not yet achieved net zero energy, the last requirement needed to achieve Living Building Challenge certification, but additional PVs are in the works to make up the gap.

Net Zero Water. LBC-certified buildings must meet all of their water sourcing and disposal needs on site. This goal presents many challenges for an urban or semi-urban site such as a college campus. Zoning ordinances require the use of municipal systems if available, and setbacks made an on-site well and leach field impossible. The Class of 1966 Environmental Center is a “closed loop” system, with all of the water harvested from the rooftop and graywater treated on site. Solid waste is handled by a foam-flush composting toilet. The project was the first in Massachusetts to be permitted as a new non-chlorinated public water system with surface supply source. Municipal water is only connected for emergency and sprinkler use.

The rainwater harvesting system for Kellogg House consists of rooftop collectors, a 6,000-gallon underground cistern, a first-flush diversion system, a pump to create system pressure, cartridge filters and UV disinfection system (for treating the water to potable standards). This water serves the whole building, both for internal consumption demands and for the irrigation needs of the gardens. Rooftop rainwater becomes runoff only when the underground cistern is full.

Ensuring enough water is available for the building use will require careful metering and real-time data feedback. Building users will know how much or how little water is available.
asparagus, strawberries, horseradish, walking onions, and Jerusalem artichoke are all grown just beyond the outdoor classroom/patio and teaching kitchen.

**Biophilic Design**
The Living Building Challenge encourages design elements that connect people to nature. Rather than creating symbolic references to nature, The Class of 1966 Environmental Center creates direct connections through outdoor classrooms, an amphitheater, patio and gardens and edible agriculture. Where possible, natural materials have been incorporated to provide an immediate connection to nature. In the addition, site-harvested pine provided ceiling paneling, and locally sourced slate is used for window sills and wall base. Furniture also provides a link to nature. Site-harvested stumps and lumber retained a natural form as they were used to make tables.

**Red List**
The Living Building Challenge (LBC) Material Petal requires that project design teams find products that not only perform well, but also do not contain chemicals that have been designated as harmful to living creatures. The “Red List” imperative posed a unique and significant challenge to every member on the design team; unique in that every design discipline has its own set of materials with specific guidelines that apply; and challenging because very few product manufacturers are equipped to disclose all their product’s ingredients.

Wide pine boards harvested and sawn on site were milled locally and used as ceiling and wall paneling.
All these elements combine to create an environment that is unique and demands a different interaction with the building and an increased awareness of our impact on our environment. Indeed, building occupants may need to alter their own behavior and habits by using electrical appliances more judiciously. The experience of being part of the process to achieve energy efficiency, instead of passively observing it, may be the most profound consequence and impact of an LBC building.

Conclusion
The renovation of the Kellogg House and contemporary addition that created The Class of 1966 Environmental Center achieves the programmatic goals, but greatly reduces overall operating costs, contributes to the college’s greenhouse gas emissions goals and creates a sustainable building that attracts international attention, while being alive with student activity.

Exposed Systems
It’s hard to not notice the Class of 1966 on the Williams campus. The building is designed so activities inside the building are noticed by passersby. Typically, the design team works hard to hide the many mechanical systems that support the human activities of a building. By contrast, this project’s design uses many elements that set the building as a teaching tool. Exposed gutters for rainwater gathering, visible sand filters and foam-flush toilets all let occupants know how the building works. Visitors, upon entry, can see the LBC building performance monitor, which displays current statistics on building performance. Because LBC requires deep engagement from building users, the opportunities for education (curricular and cocurricular) are profound. These are important life lessons that can spread to other realms of students’ lives.

Performance-Based Certification
Energy use had at first exceeded the predicted levels and generating capacity of its systems, but after meetings and strategic interventions by faculty, students and staff, the use has dropped to projected levels. It is tempting to view the building as a victim of its own success since the performance shows a small but persisting gap between solar production and energy use, principally a result of less than projected PV panel performance. This struggle to balance energy use with power generation continues to be an ongoing opportunity for increased awareness and the need for ongoing vigilance. It is this performance proving, rather than just projecting, requirement that makes the Living Building Challenge such a powerful ongoing educational tool.

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Local Sourcing
For a Living Building project, the source of product ingredients needs to be considered. Within LBC, products are organized into distance zones, with the heaviest and most simple products needing to be sourced closer to the project than the lightest and most complex products. In doing this sourcing research, project team members become advocates for a stronger local building materials economy.

Some building materials were quite easy to come by, as they were made from trees harvested on site, milled locally, and used for siding and exterior and interior furnishings. Reuse of historic elements from Kellogg was also seamlessly in line with the red list and sourcing requirements.

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ABOUT THE AUTHOR
John Rahill, AIA, is a founding partner of Black River Design, Architects in Montpelier, Vt.