Old Is New Again

When restored and reopened in 1899 following a fire, the press heralded the building as an example of innovation in ventilation, circulation and daylighting. Today, Cambridge City Hall Annex is again a showcase and sends the message that sustainable design is achievable and makes economic sense in historic preservation and municipal projects. The renovated annex became the oldest building certified under the USGBC LEED® for New Construction (NC) program in 2005, earning the Gold rating.
Building History
Originally built as the Harvard School in 1871 at a cost of $30,000, the building accommodated 900 grammar school students in 12 classrooms. The two-story building had a third floor Mansard roof, which was destroyed by fire in 1899. During the reconstruction, the former attic space under the mansard was enlarged into a full fourth floor with decorative pediments on each side.

The school was converted to a municipal office building in 1942. The deteriorating parapet and chimneys were removed for safety reasons in the 1950s. After many partial renovations, the building, which was contaminated by mold, was evacuated in February 1999. Because the building required extensive remediation (lead and asbestos were also found in the building), the city had an opportunity to demonstrate that it could be a leader in redesigning buildings with historic preservation, energy efficiency, renewable energy and environmental sustainability as primary goals.

Redesign
Prior to its redesign, visitors entered into the stairwell landing of a drab, poorly lit building that had a confusing layout, unclear signage, poor handicapped accessibility, and only one restroom for the entire building (located in the cellar). The new design provides a welcoming entry and lobby, large public meeting rooms, clear layout

Above-grade windows in the previously uninhabitable cellar regain lost space.

Building at a Glance

<table>
<thead>
<tr>
<th>Building Name</th>
<th>Cambridge City Hall Annex</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>344 Broadway, Cambridge, Mass.</td>
</tr>
<tr>
<td>Size</td>
<td>33,216 ft²</td>
</tr>
<tr>
<td>Started</td>
<td>October 2002</td>
</tr>
<tr>
<td>Completed</td>
<td>February 2004</td>
</tr>
<tr>
<td>Use</td>
<td>City hall with public meeting rooms, offices and art gallery</td>
</tr>
<tr>
<td>Cost</td>
<td>$11.76 million</td>
</tr>
<tr>
<td>Distinctions</td>
<td>LEED-NC Gold; Sustainable Buildings Industry Council, First Place Exemplary Sustainable Building Award 2006; Massachusetts Historical Commission Preservation Award 2005; Environmental Design and Construction Excellence in Design Award Finalist in Government Category 2005; Building Design and Construction Innovation Award 2004</td>
</tr>
</tbody>
</table>

Building Team

Owner City of Cambridge, Mass.
Architect and Interior Designer HKT Architects, Inc.
Architect of Record David Perry Architects, Inc.
MEP Engineers Arup
Structural Engineers Weidlinger Associates, Inc.
Civil Engineers Beals and Thomas, Inc.
Landscape Architect Hammer Design
General Contractor Consigli Construction Co., Inc.
Commissioning Agent Sebesta Blomberg
Public Artist Mike Glier, commissioned by the Cambridge Arts Council

Old photographs and original architectural drawings from 1899 guided the restoration of the building.
The renovation of this 134-year-old building used LEED certification as a design goal: sustainable site, water efficiency, energy and atmosphere, materials and resources, indoor environmental quality, and innovation and design process.

### Sustainable Site

Reuse of an existing building contributes positively to urban redevelopment.

Water efficient landscaping reduces water use by 50%.

Alternative transportation is supported: public transit, cycling, carpooling, hybrid car available for employees who use alternative transportation.

### Indoor Environmental Quality

CO₂ sensors have been installed.

Low VOC-emitting materials were used for paints, adhesives, carpets and wood products.

Sources of indoor pollutants, such as copiers and printers, are segregated.

Operable windows enhance ventilation effectiveness and distribution of air in naturally ventilated spaces in at least 90% of the rooms.

Ninety percent of the building interior receives daylight, and 90% of the interior space has outside views.

Original skylights were restored. A lightwell was created between the third and fourth floors.

### Energy Efficiency and Renewable Technologies

A 26.5 kW solar photovoltaic system is installed on the roof.

No furnace or boiler: Eight ground-source heat pumps meet all the building’s heating and cooling needs. They also operate together with a traditional office variable air volume (VAV) air-distribution system (the central air handler).

Makeup air in public meeting rooms comes from the outside operated by the displacement ventilation system. The heat recovery system minimizes heat loss by preheating the incoming air with heat from the outgoing air.

The white roof minimizes heat absorption.

Low-e double glazed panes in operable windows prevent heat loss and gain and reduce passage of infrared and ultraviolet radiation into the space.

Using intelligent lighting, light output is adjusted to daylight levels and occupancy.

A heat recovery system targets energy use.

### Materials, Waste and Resource Management

Eighty-five percent of the construction waste was recycled.

Recycled materials, including steel framing, carpet and ceiling tiles, were used.

Over 50% of the framing lumber used in the building came from certified forests.

### Green Historic Preservation

The annex presents sustainable restoration and adaptive reuse of a historic city building. The overall design process required approval from the Mid-Cambridge Neighborhood Historic District Commission. The 19th century building façade was preserved and restored. However, the commission opposed any adverse impact on the historic nature of the building, such as rooftop mechanical equipment or photovoltaic panels that were visible from the street.

The small footprint created a conflict between locating the rooftop mechanical equipment and providing a large enough array of solar photovoltaic panels. The design team solved the problem by adding a steel superstructure above the rooftop units that allowed us to mount the photovoltaic panels on a flat surface with little or no visibility from the ground.

and signage, efficient offices, several staff lounges and restrooms, and code upgrades including handicapped accessibility. Eighty-five percent of the construction waste was recycled in this complete interior renovation.

Natural daylight floods into every room and most employees have an operable window in their office. The small percentage without windows benefits from borrowed light via transoms, transparent sidelights and skylights. Murals, commissioned through the city’s Public Art Program, enrich a busy public space.

Tens of thousands of visitors pass through the building annually. The building stands at a prominent corner and houses many of Cambridge’s public offices, including the Arts Council’s art gallery and service windows for paying traffic and parking tickets. It is also the meeting place of the Planning Board and Conservation Commission as well as several advisory committees.

Photovoltaic panels, mounted on a flat surface, are not visible from the ground.
Cambridge City Hall Annex became the oldest building certified under the USGBC LEED-NC program.
In addition, the Historic District Commission was concerned about the appearance of new windows. The existing windows were large double hung units. Our task was to provide high performance thermal-glazed windows with intermediate mullions that matched the original profile. The local historic commission accepted these windows, albeit with applied mullions that matched the historic profile.

The redesign is an innovative marriage of old and new and sets an example of municipal responsibility around environmental and historic preservation issues. Historic detailing on the interior and exterior respects the original building design. Old photographs and original architectural drawings guided the restoration of the brick parapets. This work required skilled masons to recreate the ornate patterns.

Inside, wood paneling and lighting fixtures reflect the civic nature of the building while incorporating the latest technology, including motion-sensitive lighting controls. In the main public hearing room, a wide range of modern audiovisual equipment is available. The new main entry, reoriented from a side

![1871 Before fire and destruction of mansard roof.](image)

![1899 Rebuilt with parapets after fire.](image)

![2000 In disrepair.](image)

![2004 After renovation.](image)
Advertisement formerly in this space.
issues requiring a complete interior renovation, acknowledges and values the role it has played in shaping the surrounding culture, society and history. Historic preservation merged with sustainable design offers a number of additional advantages.

The renovation benefited from sustainable features inherent in the original design, in this case passive ventilation and daylighting through large windows and skylights. There was embodied energy in the building materials, the energy required to duplicate a structure (Btu/ft²) multiplied by the building’s area. We saved on the cost of demolition, disposal of debris, and waste costs (85% of the debris from the interior demolition was recycled on this project).

The building’s energy use was predicted to decrease by 56%, but actual energy use only decreased by 28%. This prompted the city to contract for a commissioning study. The commissioning agent helped reset the controls for lighting, mechanical equipment and systems. After commissioning, the electricity consumption of the building was drastically reduced by around 40% of the consumption when the building was initially occupied.

The commissioning study identified and the city subsequently corrected a number of issues. Many of these issues could have been identified early on had the commissioning agent been on board in the design phases.

Well pumps were run near full speed much of the time.

In cold weather, AHU-1 was being run at low speed, in full recirculation mode, rather than being shut down completely, to safeguard against the building temperature dropping too low and freezing the coil.

The heat pump had a COP of 2.88 at specified design conditions per the submittal, but the design drawings showed a heating COP of 3.5.

Well pumps had 5 hp motors, where the design drawings showed 2 hp. Although 5 hp may be correct sizing, the energy model could have been based on 2 hp well pumps. AHU-1 had a 50 hp supply fan motor, although the design drawings showed 40 hp. Although 50 hp may be the correct sizing, the energy model could have been based on a 40 hp fan.

The building was found to have high humidity during summer 2004. Factors that may have contributed to this include:

- Chilled water setpoint changed from 44°F to 47°F.
- AHU-1 discharge air temperature setpoint on a reset schedule was based on return air temperature rather than outside air temperature.
- Coils were balanced to heating flow rather than cooling flow.

Benefits of Renovation

The City of Cambridge understood that reusing an existing building, even one with serious remediation

street, no longer leads to a handicapped-inaccessible stairwell. The inviting two-story entry lobby sets a more appropriate civic tone and makes it easier for visitors to locate the services they need. In the redesign, we were able to capture space lost by the two-story atrium by using above-grade window openings in the previously uninhabitable cellar.

Site-specific wall paintings by artist Michael Glier animate the main entry lobby and third floor public meeting areas with imagery conceptually tied to the function and mission of the building. The themes of transparency, flow, growth and pleasure are directly drawn from the mission statements of the city departments that occupy the building. The artwork depicts urban moments within a garden environment and reveals the complex relationships among civic goals, green design, historic preservation and public transparency.

The renovation benefited from skylights in the original design.

© Dan Gair/Blind Dog Photo, Inc.
Advertisement formerly in this space.
Energy Use Intensity
A building that meets code without any additional efficiency measures has an Energy Use Intensity (EUI) of 79. The design EUI for the renovated Cambridge City Hall Annex was 29. The building was expected to perform at or below the design EUI. However, the actual EUI as measured in kBtu/ft² per year, including renewable energy, was 59 in 2005 and 63 in 2006.

Post-Occupancy Survey Findings

Around 20% of the survey respondents perceived that their productivity increased after the building’s renovation. Seventy-three percent of the respondents were aware of at least seven out of 12 green features of the building. Occupants perceived the building’s important green features as occupancy light sensors, skylights, photovoltaic-based electricity generation and wood from sustainable forests.

The survey also identified that the building’s indoor temperature was too high or too low on some days, and there were issues with the relative humidity levels in the building.

Photovoltaic System
The 26.5 kW photovoltaic system has been partially offsetting the electricity consumption of the building through on-site electricity generation. A simple financial payback analysis indicates that the system payback due to the avoided energy costs (taking into account a $236,250 photovoltaic system design and construction grant from the Massachusetts Technology Collaborative) is around 46 years. However, the payback period is reduced to 33 years when considering the demand charge avoided because
peak demand time for energy use coincided with peak production of the photovoltaics.\(^1\)

Despite the long payback period, the city chose to install this renewable technology as a demonstration and educational project where residents and students can access information about energy savings in real time on the Internet. It was a learning experience for everyone on this project, including the city.

The building was the City of Cambridge’s first green municipal project and has set the standard for all of its future municipal projects. The 2004 renovation successfully merged best practices in historic preservation with sustainable design. It speaks to the city’s environmental values and can make for a healthier and more productive workplace, resulting in better service for residents and taxpayers. ●

References


William R. Hammer, AIA, is one of the founding principals of HKT Architects, Inc. in Somerville, Mass.

Lessons Learned

Collective Commitment to Sustainable Design This was a bold step for the City of Cambridge and has paid off in the sense that the city is committed to doing all major projects this way. The city is in the process of revising the zoning bylaws to require major developments to meet LEED standards. The city’s commitment to sustainable design at the outset and the collaboration exhibited by the design and engineering team made a very tricky and difficult project a pleasure to work on.

Commissioning A commissioning agent was brought on at the conclusion of construction and start-up of the systems as required by LEED. We discovered conflicts existed in the geothermal system design and interface with the building management system. Had the commissioning agent joined the project during the design phase, most of these conflicts would have been avoided. Now, the City of Cambridge includes a commissioning agent on every major project.

Historic Preservation Can Be Green Reasonable compromise is a viable avenue when dealing with a living, albeit historic, building. Because it was a complete interior renovation, we had the opportunity to focus much effort on a high performance envelope, i.e., windows, walls and roof, as part of our overall sustainable design toolkit.