WHAT'S GREEN ABOUT HISTORIC BUILDINGS?

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Performance-based energy-efficiency benchmarks are usually expressed in terms of improvement over relevant standards. New buildings typically accomplish these benchmarks using technologies, products, and materials that weren't available when historic properties were built. Also unavailable, however, were air conditioning and other crutches that discourage architects from using passive, energy-saving design strategies. The Secretary’s Standards can bar changes that a green project team might be inclined to make, but teams should think twice anyway before scrapping the old strategies.

Old buildings and sustainability
Rather than rushing into a building project with preconceived notions of what needs to happen, many professionals working on historic buildings advocate for a gradual approach. Jean Carroon, AIA, principal for preservation at Goody Clancy in Boston, said that when her firm rehabilitated Trinity Church, an 1877 masterpiece by Henry Hobson Richardson (the only American architect, says Carroon, to have a major architectural style, Richardsonian Romanesque, named for him), she approached the building as an artifact. “Our first mandate was to do no harm,” she said. The firm monitored temperature and humidity conditions in the building, which were a concern relative to the interior artwork, for a year before beginning construction.

Mark Webster, senior staff engineer at Simpson Gumpertz & Heger, Inc., in Boston, said that besides respecting the historic features of a building, there are good reasons for treading lightly. “I think of these older buildings as laboratories for how to do things sustainably. They tend to be simpler, more long-lasting and durable,” he said. “One hundred years ago we didn’t automatically reinforce all our slabs-on-grade with mesh or rebar. Having those examples is helpful from a design standpoint.”

Matthew Bronski, a senior staff engineer who works with Webster, agreed: “There are technical benefits of traditional building design and materials that aren’t always well recognized or appreciated today.” As an example, Bronski points to windows. “On old windows you tend to get dense, old-growth lumber that holds up well,” he said. While acknowledging the environmental benefits of lower-quality, finger-jointed wood often used in today’s windows, “their durability in exterior environments can be poor,” Bronski said. “I’ve seen low-quality finger-jointed wood windows deteriorate and rot in less than five years. You’ve more than lost any initial environmental benefit there.” Although new windows may boast double- or triple-pane sealed insulated glass units (IGUs), and glass with high energy efficiency, Bronski said the quality of the factory hermetic seal in the IGU can vary greatly, and this ultimately tends to limit the useful life of the IGU, as the hermetic seal fails and the IGU “fogs,” or allows condensation inside the panes. “I worked on a job where we rejected about 25% of the IGUs that showed up on the site because of voids or defects in the hermetic seal,” he noted.
Webster acknowledged many problems with older buildings, too. "Many older buildings don't perform well in earthquakes," he said. "You can generally retrofit them, but there are going to be some extra costs there." Depending on the era of a building and construction type, it may not be very well built. For example, Bronski noted that "early 20th-century buildings with steel frames embedded in masonry often have corroding structural steel and can be really costly to rehabilitate." With more recent buildings up for consideration as historic with every passing year, building professionals will find greater diversity and greater challenges as buildings based on newer technologies need historic rehabilitation.

**Embodied energy in old buildings**

Despite the environmental qualities of many older buildings, concerns about energy efficiency are common. "There's an incredible bias throughout the green building agenda that if you want to achieve energy efficiency in a building, you have to start over," said Michael Jackson, FAIA, chief architect for preservation services at the Illinois Historic Preservation Agency.

Jackson, like many in the historic preservation community, touts the embodied energy of historic buildings as a way of balancing the desire within the green building community for operating energy efficiency improvements that may be difficult to achieve. According to Jackson, in order to realize life-cycle savings in a new building, compared with renovating an old building, "the timeframes you need are longer than the predictable life of some of the buildings being built today."

Jackson supports his view with studies claiming that the embodied energy associated with upgrading or replacing old buildings would take three decades or more to recoup from reduced operating energy in more efficient new or renovated buildings. The study that EBN examined, however, appeared to significantly overstate its case because it failed to differentiate between site energy and source energy for building operations. The study also used outdated embodied-energy numbers rather than current information from environmental life-cycle assessment (LCA) databases.

Many historic buildings contain materials and features that are valuable from several perspectives: the energy and materials expenditure that reuse of existing materials displaces; the architectural features and workmanship that may be impossible to replace; and the societal value of maintaining artifacts. LEED for New Construction awards up to three points for building reuse, and, although numerous historic projects have been awarded the first of those points, for partial reuse of existing walls, floor, and roof elements, buildings are rarely awarded all three points, which require nearly full reuse of the shell and at least 50% maintenance of interior nonstructural elements.

Some historic preservation advocates suggest that LEED should be amended to award more credits for building reuse, and especially for reuse of historic buildings. At the same time, some in the green building community argue that the historic value of existing buildings and materials should not be confused with their environmental value. In the end, practical, case-by-case considerations will take precedence. Does the owner have a use for the existing building? Does the building have one foot in the grave, or is it structurally sound? Does the economic benefit of reusing the existing building—which may include grants or other incentives—balance the cost of rehabilitation? Do the client’s goals support preserving historic attributes of the building?
Operating energy
Whatever the reason for reusing a historic building, reducing energy use is usually at the top of the rehabilitation agenda. Fortunately, neither preservationists nor sustainability advocates believe that older buildings necessarily are, or need to be, energy hogs. "In doing energy modeling on an older building, you might find it's better than you thought it would be," said Bronski.

Marc Rosenbaum, P.E., of Energysmiths in Meriden, New Hampshire, has worked on several historic buildings for educational institutions in New England, and he said he has a strong message for his clients: "Here you've got a building that has served this institution and community for a century. Given how we are entering a vastly different resource climate, how do you make this building serve the community for another century?" Rosenbaum added, "If you preserve a historic building as an untouched object, then you can't use it anymore."

In Cambridge, Massachusetts, Rosenbaum consulted on the Harvard University Operations Services headquarters building on Blackstone Street. In this building, Rosenbaum focused on improvements to the building envelope, taking on the contentious issue of whether and how to insulate the building's load-bearing brick walls. With monolithic masonry load-bearing walls, many building-science professionals believe that adding insulation is problematic. Adding insulation to a wall tends to reduce its drying potential by reducing movement of air and heat through and around the wall. These walls do not have the protection of the drainage plane common on today's brick veneer walls, and, with increased exposure to freeze-thaw cycles with insulation added to the interior of the walls, they can degrade. "You'd love to insulate them on the outside," said Rosenbaum, which would allow the introduction of a drainage plane and insulation from freeze-thaw cycles, "but if it's a historic building, this is in direct conflict with the preservation intent."

At Harvard, Rosenbaum and building scientist John Straube, Ph.D., of the University of Waterloo, Ontario, convinced the project team to insulate from the inside with sprayed, open-cell urethane foam. Recognizing the reduced drying potential of this arrangement, Straube advocated for a preventive approach, which involves keeping the brick dry from the outside with careful detailing of flashing, windows, and parapets so that there is no concentrated wetting of the wall. The team also installed rigid foam insulation across the building's low-slope roof and energy-efficient replacement windows (the windows had been replaced previously in the early 1990s, reducing historic preservation concerns). The project is aiming for LEED Gold certification with targeted 30%-35% energy savings over ASHRAE standards. The building is on the National Register, so the Secretary's Standards were used, but as a tax-exempt nonprofit, Harvard did not seek the federal tax credit.

An educational building in central Vermont is another exemplar in energy performance in historic structures. Debois Hall at Vermont Law School in South Royalton, Vermont, was built in 1893 as the town's first central "graded school." The wood-framed building with a distinctive belfry is a town landmark, part of a National Register historic district, and a striking example of Queen Anne-style architecture.

Among the more challenging aspects of Debois Hall from a green and a historic standpoint were the original double-hung wooden windows, which, according to
Rosenbaum, who served as a consultant to the $6.5 million renovation and expansion project, were “in terrible condition.” The windows were restored, however, complete with sash weights. The building team installed fiberglass interior storm windows with low-emissivity, argon-filled glazing and dealt with the air gap containing the sash weights by adding insulation to both sides of the weights. Due to structural problems and general deterioration, most areas inside the building required a total gut, making insulation relatively easy. The work paid off, said Rosenbaum, with air leakage being reduced by four-fifths, even with a 26% increase in the building’s area. Total energy use could not be compared before and after construction, but energy use for heating dropped by two-thirds.

Although, like Harvard, Vermont Law School did not seek federal tax credits for its work, Lyssa Papazian, a historic preservationist based in Putney, Vermont, was retained for the job. “My job was to ensure that it met the Secretary’s Standards, and I feel that it did,” she said. The building’s most important historic feature, its exterior, was maintained. Historic preservation proceeded on the interior with a “zone system,” Papazian said. Two first-floor classrooms retained their many historic features. That proved more difficult elsewhere due to the need for structural work as well as an unexpectedly broken historic fabric, with renovations having been made over the years that weren’t sensitive to the building’s history, but key features were maintained wherever possible. Cautioning that “the devil’s always in the details with preservation projects,” Papazian noted that, despite carefully thinking through the installation of the storm windows, their visual impact on the original windows from the inside looking out was higher than expected.

Debevoise, the Harvard Operations Services headquarters, and numerous other green historic rehabilitation projects demonstrate that older buildings can compete with new buildings, even high-performing new buildings, in terms of energy performance.

Opportunities and Challenges
Old and historic buildings are often environmentally friendly, and they contain opportunities for becoming greener.

Rehabilitation standards generally encourage the preservation of existing materials or replacement of them with similar materials that don’t disrupt a building’s character-defining appearance. Recycled-content and otherwise green products that are increasingly available for roofing, cladding, and decking are unlikely to be approved under current rehabilitation standards.

But even in areas where green and preservationist agendas come into direct conflict, compromise is possible. According to Walter Sedovic, AIA, who has worked on projects combining preservation and green building, many of the earliest incandescent light fixtures showed off dozens, if not hundreds, of bare bulbs, which at the turn of the twentieth century were a “fabulous new sight.” Those fixtures can use an enormous amount of energy, yet in many cases it would be historically inappropriate to remove those fixtures or to retrofit them with compact fluorescent bulbs.

Faced with massive chandeliers in the Eldridge Street Synagogue restoration project in New York City, Sedovic engineered a compromise. “We’ve outfitted it with
incandescents that are period appropriate, and we've incorporated a dimmer on that and many other light fixtures like it," he said. "We have the ability to present the original light fixtures using far less energy than the first time around." Modern energy-efficient fixtures were installed to supplement that light, and the incandescent lights were wired to come automatically to full brightness in an emergency, fulfilling the need for emergency lighting. "Elements should reflect the time in which they were conceived and manufactured," said Sedovic, explaining the choice, consistent with the Secretary's Standards, to install unobtrusive contemporary fixtures alongside historic ones.

Similar challenges—and opportunities to compromise—await architects in the bathroom. "If you look at most early sanitary plumbing fixtures," said Sedovic, "you'll see the piping is oversized, the faucets need to be shut off by hand, the urinals can be so large you can step into them and the toilet tanks are massive 8–12 gallon (30–45 l) affairs." Rehabilitation approaches differ even among preservationists. Said Park, "In most cases, bathrooms and kitchens are considered areas where modernization goes on," unless "you have something that is really extraordinary." Sedovic agreed, but recommended trying to maintain historic fixtures, reducing waste by keeping them in good working condition, considering retrofits that can reduce their water use, and replacing potable water with rainwater or graywater.

The integrated design process has been established as an important component of green building, and examples like these demonstrate that the innovative approaches reached through that kind of process are needed just as much, if not more, in green historic rehabilitation. In fact, as in the case studies already discussed, teams need to involve historic preservationists as well as building-science professionals. The shortage of professionals who can navigate both green building and preservation has been an obstacle in the advancement of this field. There's nothing like learning on the job, however—discussing the success of the Debevoise renovation, Papazian gave credit to the architect on the project, Stephen Rooney, AIA, of Truex, Cullins & Partners, who, she said, "transformed himself into a historic preservationist" during the project.

A shared outlook
Despite inherent conflicts in the environmental and preservationist movements, shared opportunities dwarf those concerns. The greatest enemy of both movements—in the public and in building owners—is short-term thinking, in which buildings are designed and built for the moment, without thought of the long-term consequences of design choices. Both the environment and cultural heritage suffer when buildings are treated as disposable. While green builders who value energy efficiency may not always see eye to eye with preservationists who treasure old windows and other existing features, both groups share a great deal of common ground and have a lot to teach each other.
CONSIDERATIONS FOR GREEN BUILDINGS
AND HISTORIC PRESERVATION
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Energy and Atmosphere
Energy Modeling
Model existing buildings using software programs such as Energy-10 or, for larger buildings, DOE-2. Modeling can provide valuable information about how well or poorly an existing assembly is performing and can help the project team overcome biases.

Heating and Cooling
If the building envelope is relatively inefficient, increasing the efficiency of the HVAC system will tend to have a favorable cost-benefit ratio. Efficient systems requiring higher-than-average capital investment, such as ground-source heat pumps, could be more cost-effective in these cases.

Low-Impact Retrofits
Consider using systems, such as radiant heating and cooling and displacement ventilation, that reduce the size of the HVAC system and eliminate the need for ductwork or dropped ceilings that can conceal, destroy, or detract from historic features.

Daylighting
Often built when artificial lighting was less prevalent, many older buildings feature large windows that promote daylighting. Capitalize and expand on those assets when possible, while mitigating against glare, solar gain, and heat loss. In some cases, older daylighting systems were covered up or altered during renovations; restoring original features can sometimes bring daylighting back.

Natural Ventilation
Many historic buildings use (or used) operable windows and other natural ventilation features. Often, these features were altered or sealed during renovations, and restoring these capabilities may reduce energy consumption and improve comfort.

Renewable Energy
Install photovoltaic panels on flat roofs or away from the building where they will not detract from historic character.

Embodied Energy
In determining whether to rehabilitate or replace a building or building component, factor in its embodied energy compared with that of the replacement building or component. Life-cycle assessment tools such as Athena Environmental Impact Estimator may be helpful.

Refrigerants
Replace CFC-based equipment, or retrofit existing equipment to HFC refrigerant.

Building Envelope
Windows
Restoring historic windows and adding either interior or exterior storm windows can improve energy performance while maintaining historic features. Don’t focus on windows while ignoring the whole building envelope; however, window performance can be a relatively small driver of energy performance, depending on glazing percentage and other factors.

Insulation
Add insulation where possible without damaging historic aspects of the building. Consult a building-sciences expert to investigate the vapor profile and drying potential of the existing envelope assembly and the proposed rehabilitation to prevent moisture and durability problems.

Roofs
Green roofs and reflective roofs provide various environmental benefits. Neither may be possible for historic sloped roofs, but they should be considered with less-visible low-slope or flat roofs.

Interior
Plumbing Fixtures
Consider replacing underperforming plumbing fixtures with modern, efficient fixtures, or upgrade existing fixtures with components that reduce water use.

Lighting Fixtures
Incorporate appropriate, modern, efficient lighting technology, including lamps, and daylighting with occupancy sensors.
**Materials**

**Materials Reuse and Recycling**
In addition to reusing structural elements, save building materials from areas that need to be gutted or demolished, and reuse them in a way that is consistent with their historic character. Sell or donate to salvage markets any historic materials that can’t be reused in the building.

**Materials**
Find ways to maintain the good indoor environmental quality common in older buildings by specifying nontoxic, low-VOC (volatile organic compound) materials in all areas.

**Finishes**
Oil-based finishes, which tend to have high VOC content, are often preferred on historic properties for aesthetics and authenticity, even though low-VOC acrylic finishes are often just as good. Whenever possible, choose low-VOC paints and finishes.

**Paint Strippers**
Though often used in rehabilitation projects, conventional paint strippers, including those containing methylene chloride, are notoriously hazardous and should be avoided. Low-hazardous alternatives are available—look for low-VOC, nontoxic, biodegradable products such as those listed in GreenSpec® Directory.

**Hazardous Materials**
Remediate or encapsulate hazardous materials, such as asbestos and lead paint, according to relevant local statutes. (These materials typically fall outside LEED requirements for landfill waste diversion.)

**Site and Other General Considerations**

**Monitoring**
Conduct as much environmental monitoring as possible prior to doing any work to aid in understanding how the building functions and what environmental impacts are affecting it. Continue monitoring after work is complete.

**Expansion**
If a building is not large enough for the desired programming, consider expanding it rather than demolishing and rebuilding. Increasing the density of existing buildings creates environmental benefits, and numerous buildings have successfully been expanded—up-, out-, or downward—while maintaining their historic character.

**Durability**
Many historic buildings have survived because they are aesthetically pleasing, functional, and well built, using durable materials, and because they employ relatively simple, effective, and enduring designs. Identify those factors, and honor, preserve, and learn from them.

**Reparability**
Older buildings tend to have materials and components that are designed and suited for repair by local tradespeople. Many of those components are relatively efficient, environmentally friendly, and locally available, and the expertise to repair them may still exist. Supporting these local sources supports regional economies and contributes to long-term building maintainability.

**Reversibility**
When altering features and floorplans of historic buildings, design to allow choices to be revisited and changes to be made in future renovations.

**Passive Survivability**
Many historic buildings were designed with sensitivity to their sites and built to be relatively capable of withstanding loss of electricity while maintaining livability. While maintaining some of these features of passive survivability, such as natural ventilation, may be difficult to reconcile with modern energy and comfort standards, inventory these features and maintain or enhance them when possible.

**Integrated Design**
Use an integrated design process to capitalize on existing green and historic features, and maintain or increase those in rehabilitation. Understand the Secretary’s Standards, and, in turn, discuss and consult with historic preservation experts and NPS authorities on environmental design goals.

**Landscaping**
The existing site and landscaping plan, if intact, usually contributes to the historic fabric of a building, and the flexibility needed to reduce its maintenance and irrigation needs may be limited. On the other hand, historical research may reveal that original plantings offering environmental benefits were removed over time. Consider adding rainwater catchment and graywater systems to meet irrigation needs.