JOURNAL OF

greenbuilding

VOLUME 6 NUMBER 1 **WINTER 2011**

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The Journal of Green Building
Volume 6, Number 1

The *Journal of Green Building* is published quarterly in the winter, spring, summer, and fall by College Publishing, 12309 Lynwood Drive, Glen Allen, VA 23059 (USA). Contact by phone is toll free within the U.S. at (800) 827-0723; outside the U.S. at (804) 364-8410; by fax at (804) 364-8408; and by email at collegepub@mindspring.com. The print subscription rate for individuals is U.S. $149 and U.S. $489 for corporations, libraries, and institutions. The print and online subscription rate for libraries and corporations is U.S. $589. For Canadian orders please add $15 for shipping and handling. For all other international orders please add $30 for shipping and handling. Order forms are available at the *Journal of Green Building*'s Web site: www.collegepublishing.us/journal.htm.

Submission of articles: Please visit our Web site at www.collegepublishing.us/journal.htm for directions on how to submit articles and their electronic requirements.

Printed in the United States of America
Date of issue: Winter 2011

International Standard Serial Number: 1943-4618 (Online)

College Publishing
12309 Lynwood Drive
Glen Allen, VA 23059
Phone (804) 364-8410 outside the U.S. or (800) 827-0723 within the U.S.
Fax (804) 364-8408
Email collegepub@mindspring.com
Internet www.collegepublishing.us/journal.htm

THE GREENEST BUILDING (IS THE ONE THAT YOU DON'T BUILD!) Effective Techniques for Sustainable Adaptive Reuse/Renovation

Barbara J. Thornton, AIA, LEED AP[1]

INTRODUCTION

As an advocate for the older building, I offer the following article as a compendium of useful arguments for the caring institution manager, trustee, or architect. They can be used to support your efforts to convince others to fund the reuse of your wonderful existing buildings from a "green" point of view!

Not everyone appreciates the quirks and qualities of older buildings, and, to be fair, they do require more time and attention than brand new facilities. However, there are many advantages to adaptive reuse or renovation:

KEYWORDS

adaptive reuse, renovation, sustainable techniques, historic

ADAPTIVE REUSE IS COST EFFECTIVE

The forward-looking institutional client is often open to, and in fact desperate for, the creative reuse of his or her older building spaces. A clear savings over new construction of approximately 30% for site, shell, and structure, even with roof, window, and door replacement and skin repoint or paint, can be demonstrated.[1] This is even prior to accounting for land capitalization. The resulting spaces often retain, or can justify, a level of quality construction detailing that cannot be economically achieved with most new work. The spaces themselves can be designed in innovative ways that interest and intrigue. True, renovations are harder to design and the construction more difficult to manage than new construction. Your architect's fees will be 3% higher while you save that 30% over new construction cost, but that's very short-term pain for long-term gain.

A few examples from our Rhode Island neighborhood:

- At Johnson & Wales University in Providence, an historic bank building adapted to offices and student services returns to its historic façade (Fig. 1).
- Next door, a prior factory building is converted to contain an entrepreneurship center with graduate and faculty offices, classrooms (Fig. 2 and 3).
- Down the street, an 1840s convent reused as student dorms and an intercultural center is restored to maintain its historic exterior (Fig. 4).
- At the University of Rhode Island, a granite 1910 building, originally the college library/lecture hall, is now a major performing venue and large lecture site with faculty offices (Fig. 5 and 6).
- An empty Church basement at St. Augustine's in Providence transformed to provide a parish hall space without new exterior construction costs or land purchase (Fig. 7 and 8).
- At Brown University, an 1890s dormitory college has been recast floor-by-floor for departmental headquarters and research offices (Fig. 9 and 10).
- A textile mill in Pawtucket with tenant renovations to provide research offices and work space for 12 psychologists associated with local universities (Fig. 11 and 12).

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FIGURE 1. Historic façade salvaged.

FIGURE 2. Downtown factory before.

FIGURE 3. Factory reused as Center for Entrepreneurship.

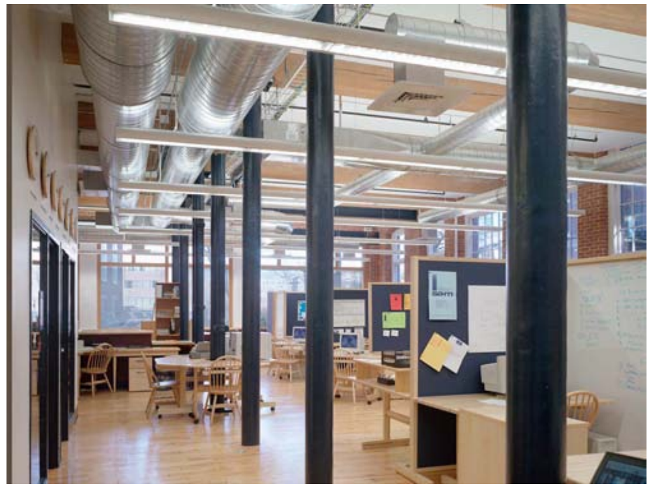

FIGURE 4. Historic chapel exterior preserved.

FIGURE 5. 1910 lobby with 1960 remodel.

FIGURE 6. 1910 lobby restored.

EVEN INCREMENTAL CHANGES CAN REAP BIG ENERGY SAVINGS

A common argument for replacement and against renovation is that older building shells cannot be insulated effectively. While we do not often recommend insulating an historic stud, mass masonry, or timber wall,[2] other energy savings are very easily achieved. Adding sealants, stopping drafts, weather-stripping doors and windows, correcting roof leaks, and upgrading mechanical systems are all actions that can be taken prior to adding wall insulation to improve energy efficiency. Insulation in attics with properly located vapor retarders and ventilation, or added exterior roof rigid insulation in ways that do not detract from historic eave lines (hidden behind parapets, for example), can also result in dramatic energy improvements. During recent re-roofing at two masonry/concrete 20th century schools, we added rigid insulation beneath a SOPREMA modified bituminous membrane roof system designed to receive solar PV film in the future. Daylighting of the hallways was introduced with Solatubes not visible from the exterior. Similarly, although new windows would have helped another older historic masonry parochial school project of ours, funding for a new boiler was all that was available. Replacement with dual high efficiency units and a shift from oil to natural gas fuel reduced heating costs at the school by 30%.

To offset the cost of heat energy lost through the walls, consider the "embodied" energy represented by the existing building. The energy used to create an existing structure years ago, and therefore considered as stored therein, is immense! To remove an historic masonry structure is also an awesome undertaking creating tons of debris, only some of which can be efficiently recycled. In addition, that work will incur even more manpower, machine, and fossil fuel transportation expense.

FIGURE 7. Church basement before.

FIGURE 8. Church basement after.

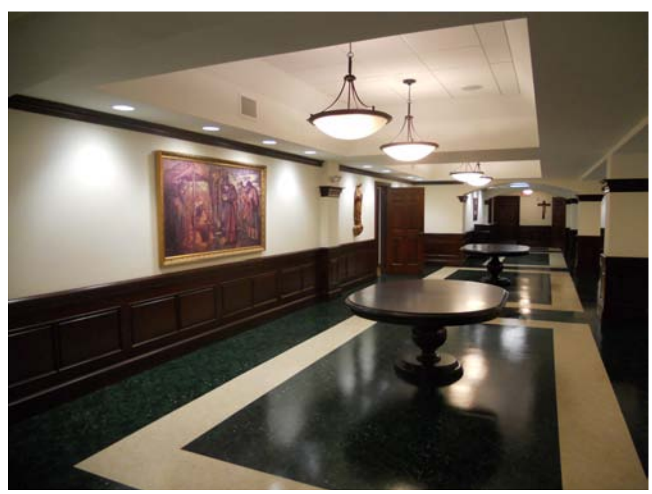

FIGURE 9. College dorm as offices before.

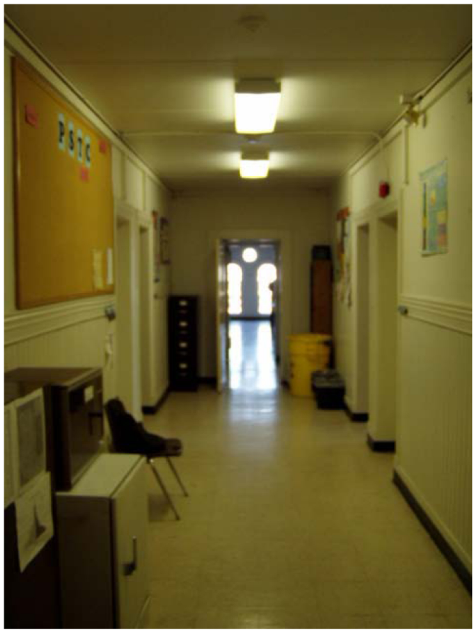

FIGURE 10. Period interior works well after.

BUT WE HAVE TO INSULATE THE WALLS . . .

When necessary, we have had success with permeable open cell polyurethane spray-applied insulation in wood stud walls.[4] Once the expanding foam stops air infiltration paths, the largest moisture conveyors in a wall system, the need for an additional vapor retarder is also reduced. It is important not to frustrate the "breathability" of the walls, allowing the inevitable leaks in older building shells to dry out to one side of the wall or the other (which changes, by the way, in our temperate zones from season to season). The addition of humidification in winter and air conditioning in summer complicates this pressure-driven moisture transfer dramatically. The solid masonry mass wall is also resistant to the simple application of modern R-value in an insulation sheet, and cannot long survive an impervious coating. While this article will not attempt to fully describe the fluid mechanics of moisture vapor, suffice it to say that the simplistic addition of 6 mil poly to the interior face of an exterior wall so popular in the 20th century code literature does not adequately satisfy our buildings' need to exhale. Energy-modeling of existing walls is highly recommended when insulation is being considered. Both summer and winter conditions must be considered, with likely variation of the interior building temperature.

FIGURE 11. Mill building monitor before.

FIGURE 12. Adds light to interior after, even with perimeter office requirements.

ADDITIONS TO EXISTING FACILITIES CREATE OPPORTUNITIES FOR EFFICIENCY

Sometimes a new wing or addition can aide its older neighbor. At a Fire Headquarters and Rescue Station headed for LEED Silver certification, the newly-efficient mechanical and electrical systems were extended backward to re-serve the existing Engine and Hose Company Fire Station next door at reasonable expense. At a new church parish hall, our highly-efficient new boiler plant was used to back-feed heating systems in the existing church with only minimal upsizing. At the same church addition, air conditioning fan units were pulled out of the existing worship space to rumble much less obtrusively within the ceiling of the new entry gathering hall. Although acoustical quality is not yet a fully acknowledged environmental indicator, this change did allow the choir to return to use its upper rear choir loft without air-noise interference.

EXISTING MATERIALS OFTEN ARE OF HIGHER QUALITY

Some materials used in older buildings are irreplaceable. Some stone and slates are no longer quarried, while old growth wood stock will continue to resist rot and insects much better than their synthetically-fertilized, genetically-modified modern cousins. I once saw a full 2″ thick by 10″ deep pine radius-head window frame removed from an 18″ thick brick wall. This window served for 110 years without flashings in fully-keyed contact with brick and mortar. The frame was unblemished and sound, almost petrified, with growth rings so tight that the stock must have come from a tree slowly growing for over 500 years.[3] It is no longer possible to replace such material "in kind" or "to match." Its "equal" is no longer available. I have observed many modern wood window frames, even with preservative treatments, well into a rot cycle before 25 years had passed. Only the temporal nature of our modern building occupancy patterns allows satisfaction with such short-term construction. Our older buildings are treasure-stores of superior construction materials that we will never see again.

This is an area where the Preservation and Green communities' interests clearly overlap. The preservation dictum of saving as much "existing fabric" of the original building as possible supports the green goals of reuse. Designing to reuse large pieces of existing structures provides greener cost, structure, and durability arguments that parallel the philosophical one of saving historical material as a record. While this record-keeping attitude is difficult to justify when looking at rotted window muntins or fascia boards that have exceeded their useful life, it is completely in sync with common sense when viewing older masonry, timbers, glass, good slates, and quality metalwork—a stockpile of useful history with which our institutions are blessed.

NEW AND SYMPATHETIC TECHNOLOGIES ALLOW "GREENER" RENOVATION

Many newly green technologies can be imbedded in our historic buildings in unobtrusive or invisible ways. Also, the adaptive reuse for new interiors of otherwise historic shells opens the door for application of the entire range of sustainable materials in any new layer of construction.

Lighting

Progress in lighting allows retrofit and custom fixture designs for historic venues that can satisfy both energy-efficiency and aesthetics. At URI, we replaced 1960s can lights with custom warm-fluorescent chandeliers of deco/arts and crafts lineage more appropriate to this 1910 granite edifice. The new sconces in the building maintain an early deco theatre theme, still meet energy and ADA requirements, and were amended only slightly from stock fixtures (Fig. 13 and 14). Where new codes mandated new types of lighting for this renovation, such as performance lighting for safety path visibility, advanced LED technologies were employed to install low-profile carpet runner edge and stair nosing applications in an incredibly energy-efficient system.

FIGURE 13. Deco chandeliers replaced wagonwheels of can lights.

FIGURE 14. Theatre Sconces, MDF millwork, Corian sills.

FIGURE 15. Office with acoustic cloud.

Daylighting

Daylighting was often a key practical component of older structures, particularly the mill building so typical of New England. Such glazing can be restored, unblocked, returned to useful life, or augmented with 21st century technologies. At a recent mill project, the upper monitor sidewall windows were upgraded to insulated units allowing the interior spaces to benefit from the original designer's intent to bring exterior light all the way into the center of the factory floor (Fig. 11 and 12). Sometimes the original daylighting design is in conflict with new use programs of private perimeter offices—14′ high windows can overwhelm a 10′ wide office space. Here is one solution (Fig. 15)—without impacting the original window, an acoustic cloud was floated 24″ off the exterior wall to reduce perceived height and very real echo from hard existing surfaces. French doors, sidelights, and transoms allowed light transfer to interior corridors and research carrels. Many readers are also familiar with a traditional renovation dilemma—an antique central skylight backlit with electric bulbs once the leaky roof opening is covered. Now it is possible to backlight with the real thing; reflective tube light wells can deliver sunlight to these obscured locations from up to 20 feet away.

Recycled or renewable materials

When new interiors inhabit historic shells, adaptive reuse embraces even more green products: recycled glass fiber insulation and acoustic materials; recycled content steel and aluminum, wool carpets; wood fiber millwork; claddings and flooring materials; post-consumer recycled acrylic, metal shaving, glass, and concrete countertops; acrylic recycled-content sills and trim; and renewable grass boards and fabrics.

Low VOC

Our cheap transportation networks, inexpensive fossil fuels, and love affair with chemicals did not develop until much of our older building stock was created. With the exception of alkyd paints and other resinous treatments, traditional materials and the craftsmanship to work with them are intrinsically very "green." Linoleum, for example, is a natural replacement now for its own prior "improved" replacement, vinyl composition tile. This older flooring is new again, made of post-industrial sawdust and linseed oil but reinforced with recycled glass fiber backing as tile in wonderful colors. Improvements on older materials also abound without sacrificing aesthetics. Carpets would have been wool (and can be again on a large enough budget), but recycled and recyclable nylon and polypropylene also serve well. Millwork once done in mahogany can now be replicated in low-VOC, non-formaldehyde MDF. Slate sills and thresholds can become recycled-content solid acrylic, and wallpaper can be used that is both rapidly renewable, flame-retardant, and breathable to help those historic walls (Fig. 14).

Locally-sourced materials

When adding or replacing interior finish, restoration projects can adhere to the same green principles as other LEED projects. Locally-sourced materials are often even more authentic for pre-1910 structures. Italian tiles and bricks from 3000 miles away are not restoration appropriate, take advantage of cheap transportation networks that did not exist when our buildings were created, and are definitely not "green." Restoration with the types of local masonry, tile, and foundry-work found within the LEED-radius is often more authentic than our current global palette of amazing products. Restricting the design to a local vocabulary considered from the project's very inception, supports green initiatives of reducing energy costs, keeping local jobs, encouraging skilled trades-people, and supporting material appropriateness.

ERV and mechanical system components

Wonderful energy-recovery technologies, in smaller and smaller unit sizes, can be added to our existing building stock without impact to the historic fabric. We have recently used ERV units by Greenheck that fit above ceilings and wall-hung condensing boilers by Viesmann that are each smaller than a suitcase. Although upgrading the electrical service is sometimes difficult, existing ductwork and louvers are often available and under-utilized. Space in furnace rooms and attics is being freed up as older mechanical dinosaurs are abated and removed.

Rainwater recovery/reuse

When preserving an older building, it is often found that old drywells are silted full, or older sewer connections are collapsed. In many historic locales in urban settings where surface drainage is problematic, reconnection to combined sanitary/storm sewers is often not allowed. The goals of preservation and environmental communities once again align—rainwater harvesting and storage is a fortuitously green option for what would otherwise be a disposal problem. Our system uses have included rescue vehicle washdown, municipal vehicle cleaning, and educational garden irrigation. These systems can be invisible or highly celebrated as educational opportunities.

Solar/Geothermal

As solar technologies develop, we may have discovered a way to avoid the impossible clash of solar arrays on historic buildings. Film technologies may allow the application of flat arrays on low slope roof areas of any historic structure with a parapet. The two recently re-roofed schools mentioned earlier each received 30,000 SF of solar-ready film base white granular modified bitumen. When funding is available, the film layer will be bonded to the capsheet, creating invisible PV generation with grid connection. Geothermal below-grade systems can also add energy-efficient climate control to historic facilities without large, loud, and unsightly exterior condensers. The John Brown House Museum in Providence, circa 1788, has just completed such an installation.[5]

IN SUMMARY

Let us consider a simple analogy:

Older leather shoes of high quality often have expenses—frequent shining, re-soling, new laces. But there are off-setting advantages as well. They are "broken-in" and feel good, will last a long time, are often very attractive, and frequently can no longer be replaced with equal quality for the same price.

Renovated older buildings are much the same—they have maintenance costs and require annual attention. However, they are frequently beloved landmarks in a community, last for generations, are often beautifully designed, and cannot be replaced with construction of comparable quality today for anything close to a reasonable price.

Yes, older buildings have higher annual maintenance costs, but replacing them at higher first cost to lower annual operating expenses ignores the more intrinsic but harder to measure values described in this article. It is still the greener choice to adapt, renovate, and reuse.

NOTES

1. We have prepared case studies on several of the listed building projects that prove this point. Should interest warrant, a follow-up article could present these specifics.
2. We have found that adding insulation at the attic level combined with repaired windows and doors and a high-efficiency furnace gives excellent improved energy results, but alas, will not fully satisfy LEED. It does, however, protect the historic building fabric. We'll continue to work on those LEED-Existing Building standards. The argument is that building shell reuse in a wise, sustainable way (i.e., doesn't make it rot sooner or mold) is the ultimate green compromise that should moderate concerns for short-term energy use.
3. The plan had been to replace these wood windows with new aluminum, historic profile units. Because of this happy observation, the client university agreed to allow the wooden frames to remain and retrofitted them with insulated glass in simulated divided-lite wooden sash. The sash jambs were lined with a bronze sheet that included an interlocking weather-strip sash guide. Weight pockets were filled and sash operation limited to spring loaded single hung in the now fully air conditioned building. This work was done while the author was a Project Architect for William Kite Architects of Providence. The project received numerous local design and preservation awards as wall as a National AIA Honor Award for Interior Architecture.
4. When renovating a private residence in RI circa 1893, built in an Italianate style with stucco exterior on wood studs, open walls received Icynene insulation, Classic formulation. Icynene was chosen for its complete and speedy off-gassing and permeability.
5. This innovative project was coordinated by Providence architect Cornelis J. DeBour with Landmark Facilities Group from Norwalk, CT. Major grant funding for the effort was provided by The Champlin Foundations and Save America's Treasures through the National Park Service. The author is a member of the Board of Directors of the Rhode Island Historical Society, owner of the property.