A SUPPLEMENT TO BUILDING DESIGN+CONSTRUCTION

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BUILDING DESIGN +CONSTRUCTION®
Inspiring the Building Team

High-Performance Reconstructed Buildings: The 99% Solution

9th in a Series of White Papers on the Green Building Movement

Making the Most of the Reconstruction Boom

Reconstruction in its many forms—tenant improvements, retail fitouts, adaptive reuse, historic preservation, gut rehab, and so on—is keeping many design and construction firms solvent.

The collapse of the U.S. housing market in 2007-2008 precipitated a nearly commensurate downturn in new nonresidential construction in the United States. Filling the gap, at least to some extent, has been reconstruction.

Architecture, engineering, and construction firms that once realized less than 20% of their revenues from renovation work are now performing 30-40% of their work in reconstruction. Another telling metric: LEED for Existing Buildings has now surpassed LEED for New Construction in total floor space. It is no exaggeration to say that reconstruction is keeping many AEC firms afloat.

This chain of events has created an excellent opportunity for the design and construction industry to seek ways to take reconstruction to the next highest level: from 20-30% energy and water savings, for example, to 40-60%—what those in the field are calling "deep energy retrofits."

This White Paper details the obstacles to achieving high-performance reconstructed buildings and describes the promising opportunities available to AEC firms in this sector of the green building market.

The editors argue the case that existing and reused buildings represent "the 99% solution" for reducing energy, water, and materials waste in buildings and cutting the share of greenhouse gases produced by nonresidential buildings.

As in our eight previous White Papers, we conclude with a set of specific recommendations—an 18-point Action Plan—for stakeholders in the built environment to consider.

The editors welcome your feedback. Please contact Robert Cassidy, Editorial Director, at 847-391-1040; rcassidy@sgcmail.com.

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The greatest opportunity for energy savings in America is right beneath our feet! I'm not talking about something you have to drill out of the ground. I'm talking about the 5 billion square feet of existing commercial building space that is ripe for energy efficiency retrofits.

While the 1% of space newly constructed every year meets increasingly stringent energy codes, even striving for net zero energy in some cases, the other 99% of commercial building space is responsible for a large share of total energy use in this country. Targeted energy efficiency upgrades across these many properties can have an enormous cumulative effect.

The North American Insulation Manufacturers Association (NAIMA) is a leader in promoting energy efficiency in both new and existing buildings. NAIMA is the trade association of North America's leading fiber glass, rock wool and slag wool insulation manufacturers. NAIMA has an 80-year history in the energy efficiency arena, and its fundamental objective is to promote energy efficiency, sustainable development, and environmental preservation through the safe use of high-performance fiber glass, rock wool and slag wool insulation.

Adding insulation should be at the top of the list when considering options for reconstructing, renovating or retrofitting an existing building for increased energy efficiency. Adding insulation improves occupant comfort, provides a healthier environment, provides added sound control, and of course helps lower energy bills.

NAIMA maintains a large literature library filled with free (and many downloadable) specification tools, scientific research, installation recommendations, and codes and standards information. In addition, our website (www.naima.org) maintains current information on the status of building energy codes, federal and local tax incentives as well as links to our members, who offer advanced insulation thermal envelope systems.

NAIMA is active in the Commercial Buildings Consortium and other formal and informal dialogues on the topic of energy efficiency in buildings. As an industry leader in the energy efficiency discussion, NAIMA has always taken an active role in the many leading U.S. and global organizations that are helping to develop policies and implement educational programs that will drive energy savings in new and existing buildings.

Insulate today. Save tomorrow.

Kate Offringa

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1. Reconstruction: 'The 99% Solution' for Energy Savings in Buildings

In the last few years, reconstruction has been on the rise as a share of total construction in the U.S. and Canadian commercial, institutional, industrial, and multifamily market sector. With the exception of a few anomalous hot spots—for example, the Washington, D.C., metro area, which benefits from federal spending, and North Dakota, where the energy boom is fueling growth—new construction in the United States has been hobbled by the downturn in the U.S. economy since 2008. Meanwhile, reconstruction in its various forms—tenant improvements, office fitouts, retail renovations, adaptive reuse, renovations with additions, historic preservation, even gut rehabilitation—has, quite frankly, been keeping many architects, engineers, and construction professionals off the unemployment lines.

Reconstruction is, indeed, of increasing importance to many firms, notably those in our "Giants 300" rankings—the 300 or so largest firms, which perform the great bulk of the dollar volume of all design and construction work in the U.S. and Canada. AEC firms that used to do 10-20% of their revenues in reconstruction now see that figure more in the 30-40% range—again, largely due to the downturn in new construction. In the current climate, many firms are seeing reconstruction as the bulk of their business—and they're glad to have the work.

This publication has long been an advocate for reconstruction. For nearly three decades, we have honored those Building Teams whose reconstruction projects represent the very best in the field with our annual Reconstruction Awards—the only such recognition program in the AEC industry.[1] Through technical articles and AIA CES-approved continuing education courses, we continue to focus on reconstruction; in fact, we have proclaimed 2012 to be "The Year of Reconstruction."

Data supporting the importance of reconstruction also comes from the U.S. Green Building Council. The USGBC's LEED for Existing Buildings: Operations + Maintenance rating program has, in the last few years, surpassed LEED for New Construction in total project registrations and, more recently, in total square footage. The Green Building Initiative's Green Globes rating system has experienced a shift toward reconstruction.

It is by no means a stretch to say that reconstruction is, if not the lifeblood of the U.S./Canadian design and construction industry, at least a significant factor in the success of thousands of AEC firms, large and small.

But what, then, do we mean when we refer to reconstruction as "the 99% solution"? To grasp the meaning of that phrase, we need to do a little math.

According to the U.S. Energy Information Administration (Green Building Facts, USDOE, 2009), operations for buildings of all types account for 41% of U.S. primary energy consumption, as well as 72% of electricity consumption, 38% of CO_2 emissions, and 13% of potable water use. Single-family residences account for 22% of total energy consumption, with nonresidential commercial buildings responsible for 19%. In other words, energy use from commercial buildings accounts for nearly half (46%) of the total energy use attributable to buildings in the U.S.

Commercial, institutional, and industrial buildings comprise about 71.6 billion square feet of space, according to the Energy Information Administration.[2] In a good year—pre-2008, that is—new construction would have added perhaps two percent to the total square footage of commercial buildings in the U.S. and Canada, but that figure has been more like one percent in recent years. Thus, the nonresidential structures that are already in the ground constitute 99% of the commercial space in any single year and, theoretically at least, contribute 99% of energy and water waste and GHG emissions associated with buildings.

Therefore, to launch an effective attack on the environmental problems associated with commercial buildings—energy and water consumption, electricity use, carbon emissions—the primary target has to be *existing* buildings, not new buildings, even though new buildings usually garner the lion's share of publicity in the popular media and in AEC industry professional publications (including, we must admit, this one). If 99% of the commercial space in any one year is already consuming energy and spewing greenhouse gases, it makes sense that any appreciable reduction in energy use and GHGs—say, a 15-20% cut across 15-20% of the vast stock of existing buildings—would have a much greater overall impact than trying to push all new commercial buildings toward the 60-70% range in energy reduction.

In fact, we can—and should—have it both ways: that is, we should be striving for the highest possible energy performance in new buildings, even to venture as far as "net-zero" energy use, while at the same time

1 See "28th Annual Reconstruction Awards," at: http://www.bdcnetwork.com/bdcs-28th-annual-reconstruction-awards.

2 See "The Greenest Building," Fig. 8, p 19. Source: U.S. Energy Information Administration.

3 At: http://www.bdcnetwork.com/2011-zero-and-net-zero-energy-buildings-homes.

4 See the Summary Report of the September 2011 Deep Energy Retrofit Summit. Download a PDF at: http://newbuildings.org/deep-energy-savings-existing-buildings-summit-summary.

5 The EPA Office of Solid Waste estimated 925 million sf of residential and nonresidential space were demolished in 1998. "Characterization of Building-Related Construction and Demolition Debris in the United States," EPA530-R-98-010, June 1998, at: http://www.epa.gov/osw/conserve/rrr/imr/cdm/pubs.htm.

6 See Arthur C. Nelson, PhD, FAICP, "Toward a New Metropolis: The Opportunity to Rebuild America," at: http://www.brookings.edu/reports/2004/12metropolitanpolicy_nelson.aspx. See also "Building 'Second America'" for the Next 100 Million," at: http://www.bdcnetwork.com/building-second-america-next-100-million.

7 "The Greenest Building: Quantifying the Environmental Value of Building Reuse," Preservation Green Lab, 24 January 2012. Download PDF at: http://www.preservationnation.org/information-center/sustainable-communities/sustainability/green-lab/valuing-building-reuse.html.

squeezing the most resource waste—energy, water, and materials—out of as many existing and reconstructed buildings as possible. Our 2011 White Paper, "Zero and Net-Zero Energy Buildings + Homes," made a strong case that "NZEBs" can be financially feasible, using today's off-the-shelf technology, the example par excellence being the Research Support Facility at the U.S. Department of Energy's National Renewable Energy Lab, in Golden, Colo., which came in at a cost/sf lower than many comparable LEED Platinum buildings with significantly less energy reduction.[3] Similarly, numerous cases of so-called "deep energy retrofits," with energy and GHG reductions of 40-60% or more—including those seeking net-zero status—are being reported by forward-looking practitioners in the reconstruction arena.[4]

However, just as a new net-zero building or a deep energy retrofit of an existing building might not be to every developer or property owner's taste—the "business case" in their favor depends a lot on how long the owner intends to hold onto the property—we are by no means advocating a strategy of preservation for preservation's sake. Not all old buildings can be "saved" from demolition; in fact, every year, something on the order of a billion square feet of buildings in the U.S is demolished, according to an estimate based on a 1998 EPA study.[5] The truth is, we have little reliable data on the amount of demolition, nor do we know if we are demolishing buildings at a greater or lesser rate today than in the past. (Arthur C. Nelson, of the Brookings Institution, has stated that 82 billion sf of buildings will have to be demolished and rebuilt by 2030 to accommodate the next 100 million Americans—but that's another story.[6])

What is undeniable is that, every year, thousands and thousands of unsafe or uninhabitable buildings have to be torn down, and that thousands more buildings that should have been preserved or reused are demolished as well. That leaves a huge group of structures that lie somewhere between preservation heaven and the wrecking ball, thousands of buildings that constitute a golden opportunity for potential environmental savings.

ARE EXISTING BUILDINGS THE GREENEST BUILDINGS?

This discussion brings us to the recent report by the Preservation Green Lab, a unit of the National Trust for Historic Preservation. In "The Greenest Building: Quantifying the Environmental Value of Building Reuse," the Lab and its research project team analyzed six different building types across four diverse climate zones—Atlanta, Chicago, Phoenix, and Portland, Ore. The team—which included Cascadia Green Building Council, Green Building Services, Skanska USA, and Quantis, a life cycle analysis (LCA) consultant—used LCA to measure four environmental impact categories—climate change, human health, ecosystem quality, and resource depletion—for new and existing buildings over a 75-year lifetime.[7]

The report's chief conclusion: "Building reuse almost always offers environmental savings over demolition and new construction," when comparing buildings of similar size and functionality. Savings from reused buildings range between 4% and 46% versus newly constructed buildings with the same energy performance level. The exception: converting a warehouse to multifamily use generates 1-6% greater environmental impact over new construction in two categories, ecosystem quality and human health impact.

The NTHP study goes on to say, "[I]t can take between 10 to 80 years for a new, energy-efficient building to overcome, through more efficient operations, the negative climate change impacts that were created during the construction process."

The researchers note further that "it is often assumed that new construction will operate more efficiently than an existing building. Indeed, in many cases, this holds true." They state, however, that "when a renovated building that meets a Base Case level of energy performance is compared to a new building operating at a more advanced level of efficiency, the [rehabilitation and retrofit] scenario offers immediate environmental savings for the majority of building types tested … In particular, renovated buildings with fewer material inputs have the potential to realize the greatest short-term carbon savings."

On this matter of materials, the study states that "the quantity and types of material used in a reuse scenario can reduce or even eliminate the environmental advantage associated with reuse … Therefore, care must be taken to select construction materials that minimize environmental impacts."

"The Greenest Building" represents a giant step forward in quantifying the value of building reuse, but the report

Table 1.1
Energy-conservation measures available for retrofits

Controls	Estimated payback (years)
Controls retrofits and control strategies	3-4
Demand control ventilation	2-5
Mechanical	
Variable flow primary/secondary systems with controls, VFDs	2-4
HVAC	
Change constant-speed air handlers to variable air volume	2-4
VAV boxes, control setpoints, boxflow minimums	5 or more
Convert boilers from steam to hot water	5-8
High-efficiency fully condensing boilers	6-8
High-efficiency VFD chiller system	8-12
Lighting	
Install controls to schedule interior systems	2-4
Convert incandescent lighting to CFL	1-3
Replace exit signs with LED kits	<2
Convert T12s to high-efficiency T8s with electronic ballasts	2-5

Source: "United States Building Energy Efficiency Retrofits: Market Sizing and Financing Models," March 2012, p. 8, at: http://www.dbcca.com/research. Based on an analysis by DB Climate Change Advisors and Transcend Equity, 2011; EIA and DOE Building Data Book, 2010; DBCCA Analysis 2011.

The estimated simple payback for various retrofit strategies. Simple payback is defined as the period of time required to recover the initial capital investment from the savings generated by reduced energy use, without additional return. On a simple basis, a five-year payback translates to about a 15% internal rate of return over a 10-year period, if cash flows are relatively consistent through the project term.

does have its shortcomings. While it is encouraging to see a major contractor like Skanska on the team, having a mainstream financial or real estate player on board—say, Jones Lang LaSalle, CBRE, Transwestern, or Davis Langdon—might have resulted in certain unfortunate statements being edited out.

For example, there's the assertion that, if the city of Portland, Ore., retrofitted and reused all buildings slated for demolition over the next 10 years, it could meet 15% of its surrounding county's greenhouse gas emissions target—as if it would be possible, or even wise, to save every dilapidated home and building in Portland. The authors do state that not every existing building can be reused, and that new construction is necessary, but over-the-top assertions like this damage the report's credibility.

The use of life cycle assessment is also problematic. To their credit, the authors explain their LCA methodology carefully, and the LCA experts involved have excellent credentials. But LCA is as much art as science. There can be hundreds, even thousands of variables; how the relative value of each is weighted is often a subjective judgment that can lead to heated discussion.

Similarly, focusing the report on greenhouse gas reduction rather than the bottom-line financial considerations of reconstruction, while noble, is a sure turnoff for many in the real estate industry.*

Still, there is much to praise in "The Greenest Building," not least that it provides a sounding board to open up discussion of reconstruction's benefits among a wide group of stakeholders. The research team acknowledge that relative energy rates, especially those based on coal, are a crucial factor. Their findings about the importance of the quantity and choice of materials will open the eyes of many architects, engineers, contractors, and building owners. The admission that one of the case studies—the warehouse-to-multifamily example—proved not to save GHG emissions in two categories adds to the credibility of the overall findings.

The report's main finding—that rehabilitation and reuse of existing buildings is almost always more beneficial than demolition and new construction—will be quoted extensively and stir welcome debate in the real estate sector. The NTHP report will provide preservationists and green builders with plenty of ammunition to support the case for saving existing buildings.

But what are others saying about the "quantification" issue? For that analysis, we turn to several recent studies.

THE ECONOMIC CONSTRAINTS ON RECONSTRUCTION

In October 2011, the World Economic Forum issued a report stating that 50% of today's existing building stock will still be in use in 2050, and that the available energy savings within this building stock are 20-40%.[8] The report cited several other findings of interest:

- U.S.-based economic consultant Pike Research has projected that energy-efficiency retrofits of commercial buildings in the U.S. could save $41.1 billion a year in energy costs.[9]
- The highly respected consultancy McKinsey & Co. has put a figure of 600,000 to 900,000 green jobs coming from energy-efficiency measures, including retrofits.[10]
- A March 2012 report by the Rockefeller Foundation and Deutsche Bank projected that scaling building energy-efficiency retrofits in the U.S. could open up a $279 billion investment opportunity, with $72 billion coming from commercial real estate and $25 billion from institutional projects. Total potential energy savings over 10 years: $1 trillion.[11]

These forecasts seem to posit a strong case for the economic viability of reconstruction. However, based on experience in the United Kingdom, a good guess is that less than 1% of existing buildings in the U.S. are retrofitted every year.[12] If reconstruction is potentially so lucrative, why isn't it occurring at a greater scale?

It turns out there are many obstacles to reconstruction.[13] Lack of scale is a major factor. In the U.S., nearly three-fourths (73%) of existing commercial buildings are less than 10,000 sf in size, and 95% of all commercial buildings are less than 50,000 sf. Owners of small properties are reluctant to put up the cash for renovation, particularly if it negatively impacts their individual or corporate balance sheets.

Furthermore, owning the building is often not the small building owner's primary business, so property improvements are low priority. Repairing a burst water pipe is one thing; installing a new high-efficiency furnace just to save energy (or, worse, "to save the planet") is quite another. As the World Economic Forum report puts it, "Building owners will rarely make retrofitting a priority unless government makes it a priority and businesses see it as a clear return on investment."

Such inertia is not exclusive to property owners. Key financial players also have trouble seeing the silver lining in reconstruction. Utilities, in general, will get involved only when forced to do so by government mandates for demand-side energy management. The valuation industry has been reluctant to view retrofitting as enhancing the long-term asset value of reconstructed buildings; only recently has the Appraisal Institute begun to consider giving higher valuations to sustainably designed homes—and it has not gone that far with commercial buildings.[14] The disaggregated nature of commercial property ownership in the U.S. and the relatively small size of retrofit projects also make reconstruction less appealing to most banks or private investors.

** See our White Papers on these topics, "Life Cycle Assessment and Sustainability" and "Green Buildings + Climate Change," which can be accessed (along with our other White Papers) at: http://www.bdcnetwork.com/whitepapers.*

8 "A Profitable and Resource Efficient Future: Catalysing Retrofit Finance and Investing in Commercial Real Estate – A Multistakeholder Position," World Economic Forum (Retrofit Finance & Investing Project), October 2011, page 8, at: http://www.weforum.org/reports/profitable-and-resource-efficient-future-catalysing-retrofit-finance-and-investing-commercia.

9 http://www.pikeresearch.com/newsroom/energy-efficiency-retrofits-for-commercial-buildings-could-save-41-1-billion-per-year-in-energy-costs, 22 July 2010.

10 http://www.mckinsey.com/en/Client_Service/Electric_Power_and_Natural_Gas/Latest_thinking/Unlocking_energy_efficiency_in_the_US_economy.aspx, July 2009.

11 "United States Building Energy Efficiency Retrofits: Market Sizing and Financing Models," March 2012, page 13, at: http://www.dbcca.com/research.

12 "Financing Energy Efficiency in European Buildings: How to Boost Large-Scale Retrofit? Conclusions of the Buildings Performance Institute Europe European Roundtable," 16 November 2010, at: http://www.ectp.org/cws/params/ectp/download_files/36D1497v1_BPIE_Chairman_Conclusi.pdf.

13 This section is based largely on the World Economic Forum report, pp. 13-15, and "Deep Savings in Existing Buildings: Summit Snapshot," New Buildings Institute, February 2012. See link at: http://newbuildings.org/deep-energy-savings-existing-buildings-summit-summary.

The Vinyl Institute

The Vinyl Institute has long supported Building Design+Construction's series of white papers, which have been thought leaders on issues we all face as we try to build a better future. In an industry as fast-paced and far-reaching as this one, it is critical not only to encourage and support stimulating new ideas but also to understand how to bring them to fruition in meaningful and effective ways.

BD + C's 2012 focus on Reconstruction is timely. While so much attention is placed on new construction, most of our activity – and impact – occurs in existing buildings. A tremendous opportunity exists to overhaul and update the places in which we live and work.

Reconstruction is complex, but also full of possibilities. From landfill avoidance, life cycle assessment and energy efficiency, to product take-back programs, maintenance, and durability, professionals at every point in the process are looking for new solutions. Vinyl can offer a powerful one. Vinyl is tried and true, and yet, as the market shows over and over, adaptable to new solutions.

Many durable products can be reused, and a growing infrastructure for recycling and product take-back means products that aren't reused find a new home. Furthermore, the breadth of vinyl building products that contribute to successful reconstruction is immense. Energy-efficient replacement windows, reflective and living roofing technology, water delivery infrastructure and grey water collection systems as well as innovative fabrics, wall covering and resilient flooring all contribute to reconstructed buildings.

The Vinyl Institute is committed to moving the conversation about the built environment forward. From our support of the Green Building Initiative's programs for existing buildings, to inspiring young designers to consider innovative uses of vinyl through design competitions and materials symposia, when the goal is maintaining the characteristics old buildings are known for – durability, integrity, and comfort – vinyl is the material for reconstruction.

Richard M. Doyle
President and CEO

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vinyl
The Material for Reconstruction

BREAKING THROUGH THE BARRIERS TO RECONSTRUCTION

There is, happily, a much brighter side to this scenario. The World Economic Forum sees certain "market-specific factors" accelerating demand for reconstruction: first, the sense among property owners that owning a building that has not been retrofitted for sustainability and at least minimal energy improvements will put them at a disadvantage in the marketplace; and, second, the belief that building owners, developers, banks, and appraisers are waiting for some signal from government to set a predictable policy on reconstruction before making investments. The World Economic Forum report states that "the strongest signals for demand [for retrofits] are in the Class A market."

Despite the substantial obstacles, property owners are taking the plunge into the reconstruction pool. In a report to the Northwest Energy Efficiency Alliance, the New Buildings Institute found evidence that the real estate industry is repositioning assets, largely because improving existing buildings is an owner's best investment—at a time when T-bills are yielding almost nothing. The NEEA report also found that public firms and "green" organizations are continuing to renovate their buildings, even during these parlous economic times.

The NEEA study found five common characteristics in the business views of those responsible for determining a building's energy-efficiency aspects:

1. They valued the economic and environmental benefits and market expectations that made pursuing energy efficiency essential.
2. They were goal-driven. Their buildings' energy use intensity ranged from 32-66 kBtu/sf/year, with five below 40 kBtu/sf/year. Their projects earned 13 LEED certifications, all but one Gold or Platinum.
3. They made the best use of government, utility, and other incentives and tax credits.
4. They track energy outcomes and conduct "continuous commissioning" to improve building performance.
5. They publicized the energy improvements of their buildings as part of a conscious strategy for increasing the value of the properties.[15]

In the following pages, our consulting experts and contributing editors discuss the most critical issues related to high-performance reconstructed buildings. We begin with a look at a number of exemplary projects that show what enlightened property owners and innovative Building Teams are doing to make high-performance reconstruction a reality. +

14 The Appraisal Institute (http://www.appraisalinstitute.org) is offering its members courses in valuation practices for both residential and commercial green buildings.

15 "A Search for Deep Energy Savings," Final Report, August 2011, at: http://www.betterbricks.com/sites/default/files/Design & Construction/final_neea_meta_report_on_deep_savings_nbi_8-3-11.pdf. See also: Eleven Case Studies from: A Search for Deep Energy Savings," at: http://newbuildings.org/project-profiles-search-deep-energy-savings.

The Sarnafil roofing system that UC Davis chose in 1981 has been protecting critical learning spaces at Robbins Hall for more than three decades.

2. Exemplary High-Performance Reconstruction Projects

By Barbara Horwitz-Bennett, Contributing Editor

From the transformation of a vacant army warehouse into a high-performance government office building, to the incorporation of a prominent exhibit hall inside a historic library building, progressive Building Teams are proving that it is possible to renovate existing structures into remarkably high-performing buildings.

"There is a common belief that existing buildings can't be renovated to 'deep energy retrofit,'" meaning 30% energy reduction or more, says William T. Maclay, AIA, LEED AP, founding principal of Maclay Architects, Waitsfield, Vt. (www.maclayarchitects.com). While Maclay acknowledges that "there are very few examples of this being done, especially in larger buildings," his firm recently completed two such projects. "The greatest thing that we learned is that existing buildings can be taken to the same standards, in terms of energy, as new buildings."

High performance in the Green Mountain State. Through the use of a new high-performance building enclosure, wastewater treatment system, green roof, and off-site solar photovoltaics, Maclay's team took an early 1980s building at the University of Vermont—the George D. Aiken Center, in Burlington—and reduced its energy usage from 89 kBtu/sf/year to 25 kBtu/sf/year. The 40,000-sf building, which now houses the Rubenstein School of Environment and Natural Resources, was completed earlier this year, and is expecting LEED Platinum certification.[1] University officials estimated that building new would have cost $5-7 million more than the $13 million for reconstructing the Aiken Center.[2]

Meanwhile, with the specification of a geothermal heating system, air-source heat pumps, high-performance windows, and significantly increased insulation values, Maclay and RicciGreene Associates are transforming an old Vermont state office building, operating at 110 kBtu/sf/year, into the new Bennington Courthouse and state offices, modeled at just 23 kBtu/sf/year.

One unconventional design decision that helped the Maclay team achieve such low energy levels on both projects was insulating the exterior of the building envelope, which was determined after a careful cost analysis of four different options.

Making water do double duty in Iowa. In the case of the historic public library in Des Moines, Iowa, a new drainage system collects rainwater from the roof, stores it in an 8,000-gallon tank under a reconstructed exterior stair, then uses the graywater for flushing toilets and urinals and irrigating the garden, explains Scott C. Allen, AIA, a partner in the firm RDG Planning & Design (www.rdgusa.com), Des Moines, which teamed up with the Weidt Group (twgi.com), Minnetonka, Minn., on the Old Des Moines Library project. "This cistern becomes a tool for the docents of the building to teach the value of water usage, as this building is also along a river that has flooded portions of our city in the past."

The $29.8 million renovation, which also incorporates a ground-source heat pump system and PV rooftop panels to support the new Dr. Norman E. Borlaug Hall of Laureates inside the library, is anticipated to reduce energy costs by 63% in this century-old structure.[3]

"We created a vault outside the building to manage the large number of pipes drilled through an existing foundation wall. Whereas newer buildings are able to adjust the building shell in small degrees to work with such systems, older buildings, built before the systems were invented, require such creative measures to integrate new systems," notes Allen.

SALLY MACAY

Triple-pane windows provide natural light to significantly reduce electricity use at the renovated George D. Aiken Center at the University of Vermont, now home to UVM's Rubenstein School of Environment and Natural Resources.

1. See "Green Renovated Aiken Center," at: http://www.uvm.edu/rsenr/greening-aiken.

2. "Reborn Aiken Center an Energy Star; Serves as National Model for Green Renovations," at: http://www.uvm.edu/~uvmpr/?Page=news&storyID=13046.

3. The building honors the late Norman E. Borlaug, the plant scientist credited with developing the Green Revolution, for which he won the Nobel Peace Prize, in 1970.

4. See "Zero and Net-Zero Energy Buildings + Homes" for a review of NZEBs, at: www.BDCnetwork.com/whitepaper/2011.

WHAT BUILDING TEAMS LEARNED FROM EXEMPLARY RECONSTRUCTION PROJECTS

The Building Teams involved in these case studies derived some valuable lessons from navigating through these complex projects.

Be aware that timing is everything. It's crucial to approach the community affected by the proposed project—neighborhood groups, end-users, public officials, etc.—at the right time before you begin the more intensive dialogue. "You want to have the vision in place, but not have so much resolved that people feel left out of the process, which is where trouble can set in," warns EHDD's Marc L'Italien.

Get early buy-in from clients. "Get the clients to buy in as early as possible during the design concept and development stage, lock in the floor plate, then allow the shell or base building to be completed while the client selects finishes," suggests the GSA's Dean Smith.

Focus on heating and cooling load reduction first and foremost. Only after your team has reduced energy use to the fullest possible extent should you consider advanced technologies and on-site renewables, according to the GSA's Jason Sielcken. Once you've reached that stage, however, get creative. "One thing we would have pursued is to bring in more innovative ideas through solicitations for new technologies for renewable resources as an option during the bid review process," says the GSA's Smith.

Fully exploit your trust relationship with building owner or developer. For the Oregon Department of Transportation to give the green light on a hydronic radiant system, when only a couple of such systems were operational in the entire U.S., required a great deal of trust on ODOT's part. "The client needs to be comfortable with the technical prowess of the design team to be able to deliver more progressive technologies," says SERA Architects' Stuart Colby.

Think beyond "been there, done that" solutions. "Establish your essential goals and ask yourself the tough questions at each step along the way: Are we achieving the goals? Are we creating a great environment for the users? Are we using resources wisely?" suggests Lake|Flato's Robert Harris.

Have faith that existing buildings can be taken to the same energy use standards as new buildings. "We began both of these projects believing this was possible, but we were having a hard time of convincing anyone else, because this was not the conventional wisdom, even in the architectural world," says William Maclay. He says his firm's two projects in Vermont "prove that this is possible."

GSA / WESTLAKE REED LESKOSKY / THE BECK GROUP

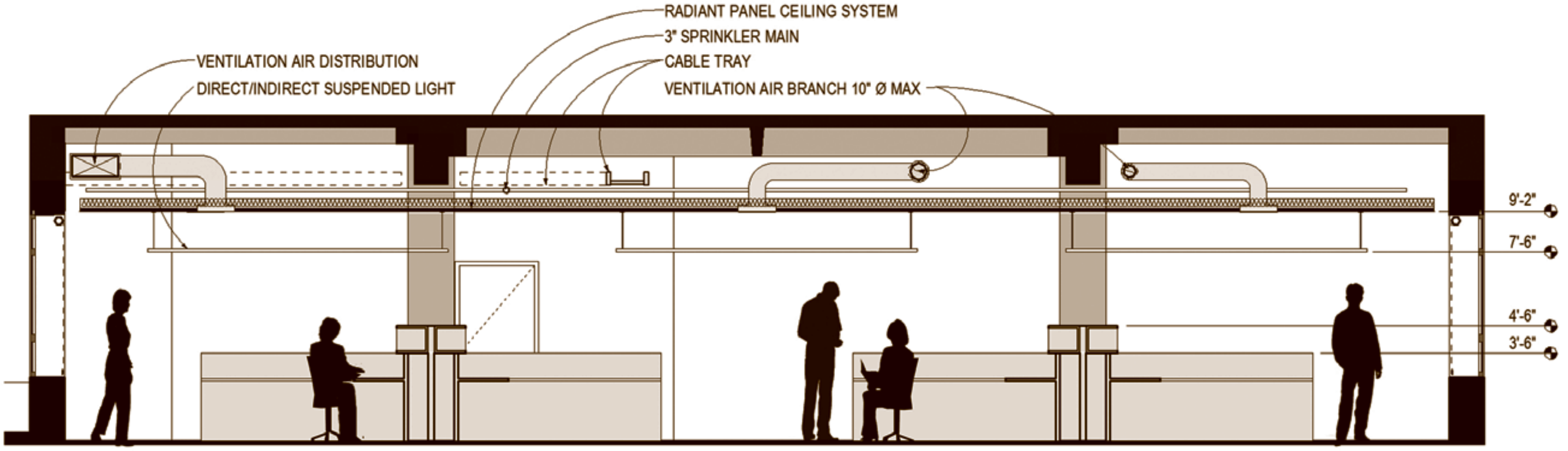
Just beginning reconstruction, this 1918 government building (top) will be converted into the new Wayne N. Aspinall Federal Building and U.S. Courthouse in Grand Junction, Colo. The reconstructed 41,562-sf courthouse will feature a 115 kW roof and canopy-mounted PV array and a geo-exchange system. The Building Team is headed by architecture firm Westlake Reed Leskosky and design-build firm The Beck Group.

Going down to zero on government work. Another high-profile project currently under reconstruction is the Wayne N. Aspinall Federal Building and U.S. Courthouse (1918), in Grand Junction, Colo. This was not originally intended to be net-zero, but the GSA challenged the design-build firms competing for the project to see how far they could go on energy savings—within the budget.

The winning team of Westlake Reed Leskosky and the Beck Group came up with a highly energy-efficient design featuring a geo-exchange system tied to a variable refrigerant flow mechanical system, enhanced insulation, an advanced metering and monitoring system, a 115-kW roof and canopy-mounted PV array, and high-performance lighting systems.

GSA Project Manager Jason Sielcken notes that, thus far, most net-zero buildings have tended to be small in size with relatively few full-time occupants, with the exception of the Research Support Facility at the National Renewable Energy Lab, in Golden, Colo.[4] That's what makes the Aspinall project interesting. "At 42,000 square feet, there is truly no other project which is a blueprint for what we're trying to accomplish as we work to balance new technology, historic preservation, tenant needs, and agency requirements, essentially navigating new terrain," he says.

Heating and cooling hydronically. Yet another noteworthy reconstruction project is the 1950s-era Oregon Department of Transportation building on the Capitol Mall, in Salem. This 147,000-sf project will



The reconstructed Oregon Department of Transportation headquarters in Salem will feature one of the country's few hydronic radiant systems, in which a water-based heating and cooling system pipes water to radiant panels at the ceiling level.

COURTESY SERA ARCHITECTS

Modernization highlights of the renovated ODOT headquarters include an expansive photovoltaic array, rainwater harvesting, wastewater treatment, ground-source heat exchange, radiant ceiling panels, and lighting controls.

be among an elite few in the country with a hydronic radiant panel system. Designed by Stantec, with construction administration and design integration by PAE Engineers (www.pae-engineers.com) and SERA Architects (www.serapdx.com), this water-based heating and cooling system will pipe water to radiant panels at the ceiling level; 100% outdoor ventilation air will be supplied via small ducts, moving just one-tenth the air volume of a conventional system.

"We spent a tremendous amount of time programming the mechanical system, which will ultimately help the building perform 26% better than the Oregon Energy Code and 32% better than ASHRAE 90.1," says Clark Brockman, AIA, LEED AP BD+C, a principal and director of sustainability resources with SERA Architects.

BALANCING RECONSTRUCTION VS. TEARDOWN

The critical question facing Building Teams is how much of the existing structure to save and how much to tear down. Obviously, the answer has a lot to do with simple economics, which is the principle that the Building Team applied toward the adaptive reuse of a 1950s paper warehouse into the Livestrong Foundation, the new headquarters for Lance Armstrong's cancer support organization, in Austin, Texas.

"There was a lot of work to be done but the building was clean, the bones were solid, and we did not need to do much to gain a solid platform for reconstruction," says Robert Harris, FAIA, LEED AP, a partner with Lake|Flato Architects (www.lakeflato.com), San Antonio.

In this case, Lake|Flato was working with a primary structure and foundation, and, as Harris noted, had more or less a clean slate for such elements as the mechanical systems, interiors, and insulation. However, the enclosed warehouse shell made it difficult to create a pleasant, daylit interior environment. This was resolved by removing portions of the existing roof structure to make way for a north-facing saw-tooth clerestory, which opened up the interior to natural diffused light. The old wood structure was salvaged and reused to create the interior meeting and workspaces, according to Harris.

The building registers an energy use intensity of 38.6 kBtu/sf. Eighty-eight percent of materials from the original warehouse were recycled or reused, with most of the concrete being repurposed for retaining walls, walkways, and fountain and garden elements. The project won a 2011 AIA/COTE award.

Making the most of existing materials. For the adaptive reuse of a 1940s Seattle army warehouse into Federal Center South, a new office space for the U.S. Army Corps of Engineers, much of the effort went toward reusing existing materials—notably salvaged structural timber—to the greatest extent possible. Duane Allen, GSA project manager based in Auburn, Wash., explains that the construction firm, Sellen (www.sellen.com), and architectural millwork firm GR Plume (www.grplume.com) determined that the original timbers in the building could not be sawed, because sawing the timbers into new sizes would result in cracked and unusable lumber. The design firm, ZGF Architects (www.zgf.com), committed to figuring out how to use the existing sizes as they designed and engineered the application of the timbers.

Before the timbers could be put in place, however, 190,000 board feet of timber and 150,000 board feet of 2x6 decking had to be carefully removed and shipped to GR Plume for reworking and recovery. "The modernized building at Federal Center South will end up using at least 140,000 board feet of timber that will be installed in the heart of the building," notes the GSA's Allen. "The reuse of the timbers is not only environmentally friendly, it also preserves a part of the history of the original warehouse."

Hitting the 95% mark for recycling. For the restoration of the 1922 Beardmore Block building in Priest River, Idaho, Seattle-based architect Brian Runberg, AIA, reused salvaged wood and just about anything else that was not damaged beyond use in reusing an impressive 95% of original building materials. Plaster was used as parking lot underlayment, water-damaged flooring was planed deep enough to reuse as wainscoting, and toilets were reconfigured and refinished. Even old boiler metal pieces were cut up and reformed into metal art sculptures and furniture.

Sometimes, however, it's just not physically possible for Building Teams to preserve as much as they would like to. For the Bennington (Vt.) Courthouse project, the team ultimately had to yield to mold and moisture conditions in much of the existing building material. Another difficult choice had to be made regarding a one-story section of the original building. In the end, it was torn down to make way for a better performing three-story section.

COURTESY ZGF ARCHITECTS

A 1940s warehouse building, originally constructed by the U.S. Army and subsequently owned by Boeing and the GSA, will soon become a high-performance office building for the U.S. Army Corps of Engineers in Seattle. It will be the first building in the Northwest region to combine geothermal with structural piles.

MYSTERIES AND SURPRISES BEHIND THE WALLS

In any form of reconstruction—gut rehab, renovation, adaptive reuse, historic preservation, interior fitout—Building Teams often find themselves having to rethink their strategies upon discovering unknowns behind the walls. "Existing buildings always have conditions that are surprises," says RDG's Scott Allen. "You're just not able to see through the walls and floors."

For instance, during construction inside the Old Des Moines Library, the contractor found that some of the structural bearing points were no longer supporting the floor or roof. In this case, all it took was a new structural bearing point for the steel members and the installation of an additional beam to support the load.

However, one of the exterior freestanding sandstone

This 1950s paper warehouse was adaptively converted into the new Livestrong Foundation headquarters for Lance Armstrong's cancer support nonprofit in Austin, Texas. The contractor, SpawMaxwell (a Balfour Beatty company), ran into a snag when the wood ran short. The Building Team found a match in a supply of wood salvaged from the bleachers of the famous Gilley's honky-tonk club in Pasadena, Texas.

COURTESY LAKE|FLATO ARCHITECTS

COURTESY PAUL HESTER/LAKE|FLATO ARCHITECTS

The Livestrong Foundation utilized 88% of recycled/reused materials, remilled salvaged roof decking, and repurposed concrete. It features an opened façade and roof with clerestories, an ultra-high-efficiency variable-volume-refrigerant mini-split system, and lighting controls.

columns supporting the roof over the entrance was found to have a crack. “We placed a monitor on the crack, while at the same time providing temporary shoring to take the load of the roof, while a solution to repair the column was found,” says Allen. “The solution was to pin the column with stainless steel rods and repair the surface of the sandstone.”

Still more surprises awaited the Old Des Moines Library team when they found large portions of damaged or missing clay flooring tile compromising the structural integrity of the historic structure’s flooring system. By placing shoring under the floor—to support the clay while correcting the damaged tile—the contractor was able to insert a metal deck to span the beam spacing, and then poured new concrete to reconnect the floor to the original clay tiles, according to Allen.

One of the most significant federal reconstruction projects is 1800 F St., N.W., Washington, D.C. Designed by New York architect Charles Butler (1871-1953) and completed in 1917 for the Department of the Interior, the E-shaped Neo-Classical structure is on the National Register of Historic Places and has been the headquarters of the General Services Administration (and the Public Buildings Service) since 1949.

Phase I of the 724,000-sf, $200 million ARRA-financed project is being managed by a joint venture of Whiting-Turner and Walsh. Designed by the A/E team of Shalom Baranes, STUDIOS, and Syska Hennessy Group, it has employed heat-reducing glass on the infill, graywater management, and green roof technology. LEED Gold is anticipated.

“The hidden treasures found behind walls can reveal decaying or hazardous materials, unanticipated craftsmanship issues, or conditions different than the as-built drawings would indicate,” says Dean Smith, GSA project executive on 1800 F Street. “We found undocumented abandoned fuel tanks, elements that needed to be brought up to current code, as-built conditions that were improperly documented, and material that had surpassed its usefulness. It’s like the game ‘Whack a Mole’—every time an issue pops up, you knock it out.”

One problem that SERA Architects accidentally stumbled upon during the Oregon Department of Transportation project was interfacing with the city stormwater system. Even though the team had designed a rooftop rainwater harvesting system so that rainwater could be used to flush the facility’s toilets—and keep it out of the city stormwater system—the team was forced to contend with a dilapidated city system well into the project.

In retrospect, Stuart Colby, NCARB, LEED AP, a SERA associate principal and the firm’s government studio leader, says, “It’s unclear that there are ever diminishing returns when it comes to due diligence, even given the challenges of doing so in an occupied, historic building. Once you have 100 to 200 workers on site, the cost of making changes is dramatic.” For those reasons, he recommends doing extra investigation in the early stages of any reconstruction project.

Fortunately, thanks to building information modeling and a full laser scan completed just after demolition of the 1950 ODOT building, other potential surprises were largely obviated. “We worked with the laser scan and Navisworks to make sure the structure matched the historic building drawings, and it was almost spot on, with the exception of a couple of low areas where we had to reroute some electrical conduit,” says Becky Epstein, LEED AP, a SERA project architect.

CODE CHECK: PUTTING UP ANOTHER HURDLE

Working on historic structures also presents the challenge of following preservation guidelines to maintain the project’s historic integrity, which can sometimes conflict with the incorporation of modern technology, as was the case on the Aspinall project.

The design-build team’s original proposal called for a prominent canopy to support a large PV array spanning the entire roof. “The reasoning which we felt met the intent of *The Secretary of the Interior Standards Guidelines for Historic Preservation* was that the canopy structure was not a permanent addition to the building and could be removed as PV technology improved and the original panels reached the end of their useful life,” recalls the GSA’s Jason Sielcken.

However, through the 106 review process—a reference to the section of the Advisory Council on Historic Preservation’s Protection of Historic Properties standard, which requires federal agencies to follow certain guidelines when working on projects listed in the National Register of Historic Places—the decision was made to modify the canopy’s size. By scaling back, the canopy’s impact on the south façade’s prominent site line was minimized; on the east and west façades, the canopy will not be visible from the building’s edge.

The reduction in the canopy’s size actually prompted the design team to reexamine ways to reduce the building’s overall energy use now that the roof’s capacity to support the PV load was being reduced. Ultimately, this led to a higher-performing building envelope, a geo-exchange system, and more elaborate metering and controls. “We were actually able to reduce the overall project cost and keep net-zero a realistic goal,” says Sielcken.

Similarly, the Des Moines library project struggled with PV visibility issues as it related to preserving the building’s historic character. “This was our ‘difficult,’ ‘fun,’ ‘challenging’ element of the project, walking the line between the energy efficiency and historic requirements

Reconstruction: Finding the Fun in the 'Unexpected Surprises'

Those involved in reconstruction and adaptive use agree that the fun and excitement of working on such projects ultimately outweighs the difficulties.

"It's always great to inherit structures from the past. They tell a story," says Marc L'Italien, FAIA, LEED AP, a design principal with EHDD, San Francisco. "I personally find dealing with old structures more interesting because it takes you in directions that are often out of your control. The challenge is to stay open-minded, as renovation projects bring unexpected surprises and you need to adapt to these unforeseen conditions."

William Maclay, AIA, LEED AP, a principal with Maclay Architects. Waitsfield, Vt., says, "The real excitement in working on reconstruction/renovation projects is the major impact we can make on U.S. energy usage."

The original Beardmore Block Building in Priest River, Idaho, designed by architect Brian Runberg's great-grandfather, Charles Beardmore. Runberg learned the history of the building through his grandmother and yearned to reconstruct it to current LEED standards.

Brian Runberg, AIA, a principal with Runberg Architecture Group, Seattle, says he enjoys the process of exploring the building's "bones" and projecting himself into the past to imagine how the building was used and how it functioned. "Every building has a past life, and there is a responsibility to honor, respect, and acknowledge that rich history."

This was especially true for Runberg during his restoration of the 1922 Beardmore Block Building in Priest River, Idaho, as it was his great-grandfather, Charles Beardmore, who built the original building. "This was particularly personal, having known the building as a child and learning its past through my grandmother," he says.

COURTESY RUNBERG ARCHITECTURE GROUP

The LEED Gold-certified Beardmore Block Building features high-efficiency HVAC with economizer controls, enhanced insulation, low-e insulated glazing, a roofing upgrade, and occupancy sensors. The project achieved a 32 kBtu/sf/year measured energy use, coming in at 66% below an average U.S. office, for an annual cost savings of $23,370.

for the many grants used to assist in funding the project," says Scott Allen.

Although the University of Vermont and Bennington Courthouse projects were not strictly historic preservation projects, Maclay Architects had to deal with another code issue: meeting current earthquake standards. Because the building envelope was such an essential component of both projects, and the code required the addition of a seismic joint connecting the old and new building sections, detailing was critical.

"This became an incredibly complex part of the design as the new codes required designing for quite a large amount of movement between the existing and new building sections," says Maclay.

WHAT RECONSTRUCTION TEAMS WOULD WISH FOR

Upon reflecting on these noteworthy high-performance reconstruction endeavors, project teams were invited to make a "magic wish" that would enable such projects to run more smoothly in the future.

A few designers lamented an overall lack of appreciation for the value of existing buildings. "The industry needs a way to talk about the value of existing buildings and why we should keep them," states SERA's Colby.

While the recent National Trust for Historic Preservation study, "The Greenest Building: Quantifying the Environmental Value of Building Reuse" (http://blog.preservationnation.org/2012/01/24/preservation-green-lab-releases-new-report-on-the-environmental-value-of-building-reuse), is a step in the right direction, Colby maintains that having a rigorous methodology to evaluate existing buildings—one that the real estate market can agree to and accept—is going to be critical in the future.

Harris says he wishes that the industry had the tools and data to readily understand the economic, environmental, and social value of revitalizing existing building stock. "With some 300 billion square feet of existing buildings in the U.S. alone, the implications for the future are immense," he states.

The GSA's Dean Smith would like to see an open database where "the wealth of knowledge in dealing with historic materials and solutions developed to integrate the old with the new" would be stored—perhaps under the National Building Museum, the National Science Foundation, or a similar agency or organization.

SERA Architects' Clark Brockman raises the perennial concern about building owners' shortsightedness when it comes to investing in improvements. "There is a massive disconnect between short-term investment and long-term building efficiency and operation," he says. "The value of designing well-built [reconstructed] buildings is simply not understood in the marketplace. We really need to expand the understanding of this point by the public and legislators to create a 'new normal' to really understand what the payback should look like in a 50- to 100-year building." +

3. How Building Technologies Contribute to Reconstruction Advances

By C.C. Sullivan, Contributing Editor

Experience has shown that Building Teams need to consider a number of building technologies—some long-established, others newly emerging—for almost every reconstruction project. From enclosure retrofits for improved roofing, to thermal insulation and air/moisture protection, and on to MEP upgrades for efficient lighting, high-efficiency, low-flow plumbing fixtures, and enhanced building automation systems, these components and systems are mainstays of effective reconstruction. Others include categories developed largely for recurring reconstruction needs: replacement windows, overcladding, and low-voltage controls, among others.

These are the so-called "low-hanging fruit" of reconstruction projects, and the rationale for their use is just as easy to grasp. According to a recent report by the Preservation Green Lab of the National Trust for Historic Preservation (NTHP), "when comparing buildings of equivalent size and function, building reuse almost always offers environmental savings over demolition and new construction"—a fact not limited to reconstructing historic structures. The report shows that it requires "up to 80 years for a new energy-efficient building to overcome, through efficient operations, the climate change impacts created by its construction."

Further, the NTHP report demonstrates that most buildings take only about two to three decades to compensate for their initial, construction-related carbon impacts. Yet the savings offered by proper application of reconstruction technology is significant. NTHP calculates that Portland, Ore., could achieve 15% of its total CO_2 reduction targets for the next 10 years by retrofitting just 1% of the city's office buildings and single-family homes. Rehabilitation work may even be better for the economy, creating 50% more jobs—jobs that can't be outsourced overseas—than new construction, according to the NTHP study.[1]

Building owners and financial institutions are "slowly turning … attention to the existing building stock as a massive opportunity to cut energy consumption and greenhouse gas emissions," according to the 2010 analysis EnOcean Technology and LEED Enabling Sustainability (at: http://www.enocean-alliance.org/en/white_papers/). Further, the paper, authored by the EnOcean Alliance, asserts that the "existing building stock presents a corresponding massive opportunity to apply technology as a means to those ends." The group represents a range of self-powered, wireless reconstruction technologies, including lighting, building automation systems, and electrical controls.

According to the NTHP study, reconstruction projects can still shoot themselves in the foot. If many new materials are required, says the group, the benefits of reuse may be totally negated. "By minimizing the input of new construction materials," the group sums up, "the environmental benefits of reuse are maximized."

HOW RECONSTRUCTION TECHNOLOGY IS BENEFITING FROM AN EVOLVING MINDSET

Energy codes and, to some extent, sustainability standards are shaping how building reconstruction projects trend in terms of deploying technology. Some practitioners, like historic preservation expert Jean Carroon, FAIA, LEED AP, of Boston architecture firm Goody Clancy, see energy codes as "a short-term awareness issue" that may require a decade or so of adjustment before they have nationwide acceptance and impact. In jurisdictions such as Seattle, where "outcome-based codes" are emerging, new performance-based regulations allow Building Teams to meet energy-use guidelines however they see fit, as long as they meet the criteria.

Embedded in these codes are certain ideas or principles related to the opportunities presented by building reuse. For example, different building systems require different levels of service: the structure and shell must last for 100 years, but interior finishes may have a much shorter lifetime. For systems that are expected to be switched out every 30 years or less—due to technological change, use needs, and the like—Building Teams should make them easier to work with, replace, and retrofit.

Along with the new codes regime, the industry is seeing shifting attitudes toward older existing buildings that actually increase the viability of today's reconstruction technologies, says Michael D. Binette, AIA, vice president and principal of the Architectural Team (www.architecturalteam.com), Chelsea, Mass.

On one front, this is increasing the pace of historic building reconstruction. Instead of preventing historic buildings from being torn down or changed significantly—keeping them "frozen in time," as critics would

1 The Greenest Building: Quantifying the Environmental Value of Building Reuse (www.preservationnation.org/issues/sustainability/green-lab/lca/The_Greenest_Building_lowres.pdf).

2 At: http://www.nps.gov/tps/standards/rehabilitation/sustainability-guidelines.pdf.

3 See Figure 6.3, McKinsey Cost Curve for GHG Reduction (page 52), in BD+C 2008 White Paper, "Green Buildings + Climate Change," at: http://www.bdcnetwork.com/whitepapers.

charge—green building technologies and new, energy-saving reconstruction systems are more often seen as consistent with long-term preservation and sustainability goals. "Organizations that champion historic preservation and those that champion green building now largely embrace each other's missions," says Binette, whose work on LEED-rated historic adaptive reuse projects includes the Bourne Mill Apartments, Tiverton, R.I. "It's widely accepted that historic buildings are inherently sustainable, and that embodied energy is an important calculation used alongside evaluations of energy efficiency to determine overall environmental impact and carbon footprint."

Recently published National Park Service guidelines[2] for buildings on the National Register of Historic Places allow flexibility in how the unique conditions of individual buildings can be addressed so that preservation efforts can be aligned with today's energy codes and standards, according to Binette. The guidelines also recommend certain paths to maintaining a building's historical status and significance and dissuade the use of others. Following the guidelines can help the project benefit from the Federal Historic Preservation Tax Incentives program, a 20% tax credit for qualified projects. Some states offer similar incentives, adding 10% to the tax breaks.

WHY RECONSTRUCTION IS UNLIKE NEW CONSTRUCTION

Whether for adaptive reuse, commercial renovation, or reconstruction in general, technology choices reflect the key differences between reconstruction projects and new construction. New building projects allow wide latitude in design, while reconstruction requires an organized assessment of the existing structure, systems, and materials. Furthermore, building conditions discovered during reconstruction must be overlaid with programming needs for new uses. In the process of creating the resulting matrix, several key building aspects must be analyzed:

- Structural integrity, including an analysis for uses intended as well as life cycle assessment
- Accessibility and accommodations, especially for ADA compliance
- Fire protection and life safety, notably fire alarm and emergency systems, as well as security infrastructure
- Potential for hazardous materials, including asbestos, lead, PCBs, etc.
- Indoor environmental quality
- Electrical systems, including distribution systems, especially considering that systems in place for 15 years or more may be insufficient or dangerous for current technology needs

The reconstruction technologies that are easy to implement and indispensable for successful projects start with energy-related upgrades, notably thermal insulation.

Insulating the building envelope. Study after study has shown that, properly engineered, an insulation upgrade is the single most effective and least expensive way to improve energy efficiency in reconstruction projects.[3]

A variety of insulating materials and systems are seen as effective for reconstruction projects, including fiberglass, rock wool and slag wool materials. Using both common blankets and loose-fill or blown-in forms, the relatively inexpensive, mineral-based products are effective as an added layer of insulation or as a fill material to boost assembly R-values, according to the North American Insulation Manufacturers Association. (Note: NAIMA is a sponsor of this report.) Faced batts, with their paper or foil facers, add the integrity of a vapor barrier across a surface up to 70 feet or more in length. The loose-fill formats are seen as especially appropriate for enclosed building cavities and other areas that are hard to reach without added deconstruction or demolition.

The recent trend toward the use of continuous insulation, or "ci"—a blanket of uninterrupted thermal insulation installed outboard of the building structure—has increased the use of rock wool and rigid expanded-polystyrene boards in enclosure retrofits. For overcladding or other situations where the wall rebuild strategy allows for it, adding continuous insulation can offer significant reconstruction benefits. Continuous insulation, typically of R-7.5, is required in six of eight U.S. climate zones as defined in ASHRAE 90.1-2007.

The mandatory requirement for ci covers about 90% of U.S. steel-framed walls above grade. It is required in the 2009 editions of the International Building Code (IBC) and the International Energy Conservation Code (IECC) to match the ASHRAE 90.1-2007 R-values. The new 2012 International Green Construction Code (IgCC) and ASHRAE's standard 189.1 require the

Table 3.1
ROOFPOINT RATING SYSTEM
Section 1: Energy Management

Credit	Title	Primary Intent	Strategy
E1	High-R roof systems	Reduce energy and GHG emissions	Increase roof system R-value
E2	Best thermal practices	Reduce energy and GHG emissions	Reduce thermal discontinuities
E3	Cool roof surface	Reduce energy ,GHG emissions, and heat islands	Install climate-appropriate roof surface
E4	Roof air barrier	Reduce energy and GHG emissions	Install air barrier
E5	Rooftop energy systems	Produce clean energy	Install solar and/or wind energy-producing materials
E6	Roof daylighting	Produce clean energy	Install daylighting systems

Source: Center for Environmental Innovation

Now in its pilot phase, the Center for Environmental Information's RoofPoint rating system covers numerous energy management criteria that can impact reconstruction projects. Rating systems like RoofPoint can, when properly executed, provide a level playing field for the evaluation of building products.

highest ci performance—at least R-10.

Another thermal insulation product that is gaining attention, particularly for use in late 1960s-era institutional buildings with poorly insulated cavity wall construction and no continuous air or vapor barriers, is closed-cell spray polyurethane foam (ccSPF). “When the owner is investing in new high-performance windows and modern HVAC systems, it’s important to make the existing building envelope as tight and insulated as possible,” says Paul J. Arougheti, AIA, LEED AP BD+C, an associate with Philadelphia-based MGA Partners Architects (www.mgapartners.com). Arougheti says a single installation of ccSPF can provide an effective air and vapor barrier with an approximate insulating value of R-6 per inch. “Coating the foam with a spray-applied thermal barrier allows us to install the foam at the exterior wall above ceilings without the need for labor-intensive encapsulation with furring and drywall,” he notes.

Adding thermal insulation to the enclosure generally boosts the energy efficiency of reconstructed buildings. “But it also changes how a building responds to a host of internal and external environmental conditions, most notably moisture,” says the Architecture Group’s Mike Binette. For example, older masonry structures can, if not properly protected against moisture, suffer from mold, spalling bricks, and damaged façades. The key is to follow manufacturer instructions for insulating older building envelopes to avoid condensation or moisture.

Employing air barriers and moisture protection. Along with insulation, air and water barriers are essential to envelope reconstruction. Energy codes increasingly call for barrier membranes and careful joint construction to preclude significant exfiltration and infiltration of air and moisture through the building envelope. The 2012 release of the International Building Code, the International Energy Conservation Code, and the International Green Construction Code—along with California’s CalGreen and other state green building and energy codes in Massachusetts, Wisconsin, Michigan, Rhode Island, Georgia, Minnesota, and Florida—call for sealed joints or continuous waterproof barriers with low or zero vapor permeability.

In addition, both ASHRAE 90.1 and ASHRAE 189.1 specifically call for air barriers that meet such rigorous criteria as ASTM E 2178 (a material standard) and ASTM E 2357 or E 1677 (for multi-component assemblies).

Air transports moisture and water vapor, meaning that barrier technologies such as spray-applied products, membrane sheets, building “wraps” and other air-stop materials help prevent moisture-related problems, too. According to Wagdy Anis, FAIA, LEED AP, a principal with Wiss, Janney, Elstner Associates (www.wje.com), Boston, condensation is mainly caused by air movement into or through building assemblies. The air movement is due to one or more of the following effects:

- Convection looping into building assemblies
- Entraining water vapor to a surface that is colder than the dew point within the assembly
- Infiltration and exfiltration due to air pressure differentials cause by wind, stack effect, or HVAC pressurization

Active glazing offers new approach. A variety of novel glazing technologies has also expanded the horizons of building reconstruction. Examples include electrochromic materials, suspended-particle glazings, and liquid crystal devices.[4]

Among the most effective enabling technologies has been electrochromic glass, which can be engineered to modify light transmission properties in response to applied voltage. In this way, interior daylight levels and thermal gain can be determined and controlled on the fly, thereby controlling interior heat gain and glare. Some visibility and high levels of translucency through the glazing panels can be maintained even when the panels are charged and in their most opaque state.

Most important, the materials are highly efficient, reducing cooling loads by as much as 20% and lighting energy costs by up to 60%. The U.S. Department of Energy’s National Renewable Energy Laboratory, where electrochromics were used in the construction of the net-zero Research Support Facility, estimates that electrochromic glazing could cut 5% of the nation’s total energy budget each year.

Multiple benefits from replacement windows. Technical improvements have also contributed to window unit designs. “In recent years, windows have undergone a technological revolution,” says Southern California Edison’s Gregg D. Ander, FAIA, in the Whole Building Design Guide (wbdg.org). Replacement windows for reconstruction projects can reduce heat loss, air leakage, and the effects of cold interior window surfaces—another source of condensation as well as occupant discomfort. The fenestration systems include high-performance double or triple glazing, specialized transparent coatings, insulating gas sandwiched between panes, and improved frames. “All of these features reduce heat transfer, thereby cutting the energy lost through windows,” says Ander.

A few essential characteristics of replacement windows, storefronts, and curtain walls must be analyzed for an effective building, caution building envelope experts:

- Window U-value
- Solar heat-gain coefficient (SHGC)
- Shading coefficient (SC)
- Visible light transmittance (VLT) of the glass
- Glass tints and coatings

According to Ander, typical projects benefit from low

4 Another technology not directly related to reconstruction feasibility but helpful in reducing O&M labor is self-cleaning glass. These panels have a super-thin titanium dioxide coating that reacts with solar ultraviolet light to help break down organic compounds on exterior glass surfaces. A secondary hydrophilic effect attracts water to the glass surface so it sheets off, taking the organic materials with it.

5 For more on reroofing (and to earn 1.0 AIA CES Discovery learning units), see “Reroofing Primer: In-depth Advice from the Experts,” at: http://www.bdcnetwork.com/aia-continuing-education-reroofing-primer-depth-advice-experts.

U-factors (less than 0.40), but the entire window assembly U-value must be known, not just the glass value, which often may be higher.

In warm and humid climates where air-conditioning is needed most of the year, low solar heat-gain values (less than 0.40) usually are beneficial. In many projects where the intent is to maximize the benefits of daylighting, high visible light transmittance may be desirable (greater than 70%).

As with all envelope upgrades, condensation can occur if windows are specified incorrectly and the glass surface temperature falls below the dew point of interior ambient air. The Architecture Group's Binette adds that historic buildings may require special detailing to meet the criteria of the National Park Service or the various state preservation agencies.

Properly applied, however, high-performance windows can increase passive heating, slash HVAC costs, and improve mean radiant temperature (MRT) at the perimeter, which may preclude the need for perimeter heating. Adding low-e and spectrally selective coatings enhances efficiency and can even reduce ultraviolet damage of interior finishes and furnishings.

Reroofing and replacement roofing. It's hard to think of a major reconstruction project involving any building more than, say, 25 years old where replacing and stabilizing the roof should not be given serious consideration. Roofing systems generally account for about 10% of the total budget in major reconstruction, but their impact on energy performance—not to mention owner and occupant satisfaction—is significant, from the reflectivity and emissivity of the roof surface to the insulation below.

In many reconstruction projects, leaks or damage to the existing roof is so severe that a tear-off replacement is the best alternative. One benefit of a tear-off is that the Building Team can inspect the condition of the roof substrate, which is important when it comes to the warranty, says Shad Traylor, AIA, a LEED Accredited Professional with BRPH (www.brph.com), Melbourne, Fla. "If the load-bearing capacity of the roof substrate is in question, a tear-off also reduces the additional weight of a second roof." On the other hand, simple reroofing is usually faster and less expensive than a tear-off, and overlayment maintains the building's weather barrier, protecting building structure, systems, and equipment below.[5] The choice of tear-off versus overlay is a project-by-project decision.

COURTESY STO CORP.

Overcladding in an existing building (left) using an exterior insulation and finish system (EIFS), with the finished work (right). EIFS can be used as overcladding on a masonry wall as long as the masonry is sound, to stop water penetration and improve the insulation R-value of the wall. Insulated metal panels are another increasingly popular overcladding material.

The use of vegetated roofing and roofing-integrated photovoltaic systems is also on the rise. In North America, green roofs were at least 25% more likely for a reconstruction project, according to a 2011 survey by Green Roofs for Healthy Cities. Use of rooftop PV is also expanding, often in concert with planted surfaces where the weight of the PV array minimizes uplift and vegetation damage while the planted surfaces cool the PV modules, improving their efficiency.

Cool-roof materials also contribute to better roof reconstruction. Climate zones 4-7 on the U.S. Department of Energy climate map generally benefit more from a darker roof material to absorb heat. In other zones, the lighter, low-emissivity materials are more effective.

Overcladding and integrated aesthetic enhancements. As in the case of reroof overlayment, adding new envelope construction over existing masonry, concrete, brick, and other façade materials has become a desirable approach for rejuvenating building exteriors in reconstruction projects. The approach can add new aesthetic materials, new insulation, and even the air and moisture barriers required by owners or jurisdictional authorities.

Exterior insulation and finish system (EIFS) and insulated metal panels (IMPs) are two common ways to overclad, according to Gary Zwayer, RA, a principal with Wiss, Janney, Elstner, Northbrook, Ill. To make EIFS applications successful, says Zwayer, "As long as the masonry wall is sound, EIFS can certainly be used as an overclad to stop water penetration as well as to improve the R-value of the wall."

One city that is seeing a wave of interest in this technology is Toronto, where there is "a movement to facilitate the renewal of high-rise residential buildings, and overcladding is a major component," says Halsall Associates' Kevin Day, a local building science and cladding specialist. Whether it's insulated composite exterior metal panels or another rainscreen-type overcladding, the solution can, he says, "improve not only the performance of the building, but also the comfort of the occupants." The technique also allows Building Teams to update the look of load-bearing segments of concrete and masonry walls without having to undertake expensive reinforcing of structure or the addition of columns and beams or underpinning foundation.

Low-toxicity building products for IAQ. Another important trend in reconstruction projects has been the focus on air quality and human health issues, in particular the chemistry of building products and finishes. This goes beyond interior finishes with low-VOC and no-VOC finishes. "In renovations and restoration projects you often have neighbors and people sharing building spaces, and the careful review and selection of materials ensures there are no chemicals of concern for the occupants as well as neighbors," says Zinder, whose firm routinely specifies no-VOC paints and finishes for reconstruction projects. The next step in this product sector will be clear-finish products that are low in VOCs, followed perhaps by the introduction of clear coatings and sealants with zero VOCs.

Other finish approaches include powder-coating and similar shop finishing techniques, which typically have no VOCs, according to Zinder. The technique melts the coating onto metal surfaces, providing a resilient and highly durable application for miscellaneous metal, built-in furnishings, and the like.

In many older buildings, toxic materials such as asbestos tile must be abated during reconstruction. In selecting replacement products, says MGA Partners' Arougheti, "It is important to select new finishes that are easy to install, require no initial finishing, and need minimal long-term maintenance."

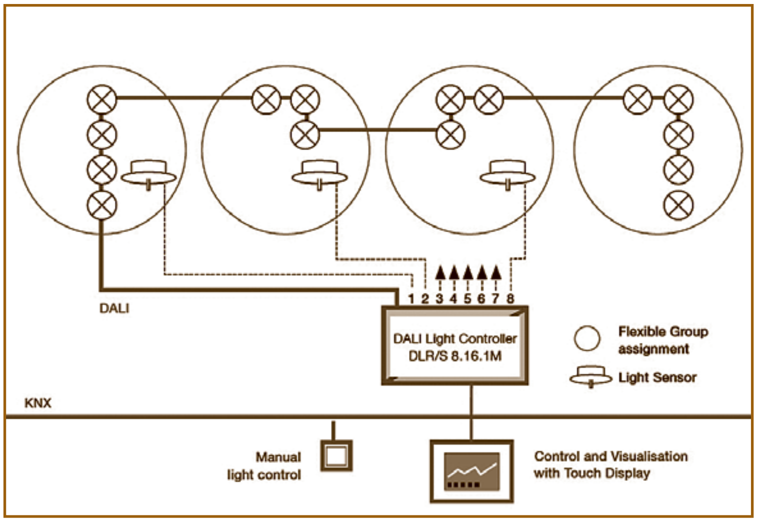
OPTIMIZING BUILDING SYSTEMS IN RECONSTRUCTION PROJECTS

Reconstruction projects are benefiting from technological advances in efficient, integrated, and highly coordinated electromechanical schemes. The options and opportunities on the mechanical, electrical, and plumbing side and on the building automation horizon are quickly expanding. In particular, greater efficiencies have been achieved with retrofit-ready systems such as passive solar design, thermal energy storage, underfloor air distribution, and chilled beams. On the electrical side, energy-efficient lighting and integrated controls, cogeneration, and power metering and monitoring are quickly becoming areas of focus in reconstruction.

High-efficiency plumbing—a must-do in reconstruction. The new codes and LEED credits, such as the pilot credit for cooling-tower water makeup—likely to be incorporated into LEED 2012 as its own credit, say experts—are driving a new generation of low-flow and reuse strategies in reconstruction projects. A 50% reduction in the generation of wastewater and potable water demand is the primary goal.

Many recent reconstruction projects are using rainwater harvesting and graywater as sources of free water, although the installed costs can be high for proper capture and storage of sinks and shower water as well as rainfall. Just as important are maintenance plans for filtering, disinfecting, and treating recaptured effluent. In some jurisdictions, local codes allow for a variety of uses, from irrigation to toilet flushing, once the proper systems are in place and pass inspection.

For low-flow fixtures, the bar to entry is low and the solutions are many. Yet recent thinking in plumbing fixture retrofits emphasizes user behavior over pure



COURTESY DALI-AG

Schematic of a DALI (Digital Addressable Lighting Interface) system. DALI permits interoperability and dimming capability of building's lighting system components. No hardware is needed to reconfigure the system.

technology. Some sensors and timer-based actuators have been shown to be ineffective, while some old-fashioned systems like aerators, laminar-flow fixtures, and pedal-operated faucets have been shown to save water use and maintenance costs. In a typical commercial restroom, a 0.5 gpm aerator can cut annual water draw by 20,000 gallons or more; the laminar-flow types save the same amount and are often preferred because of their sensory appeal. Pedal-operated fixtures are the real sleeper: They provide a touchless washroom but without the water loss or functionality problems sometimes associated with sensor-operated hardware.[6]

Novel systems light the way. DALI, the Digital Addressable Lighting Interface protocol (www.dali-ag.org), is based on the technical standard IEC 62386 and is used purely for lighting. DALI enables the networking of lighting systems in which all components are interoperable and that permit dimming throughout a facility. "The DALI lighting systems are more complex and sophisticated controls that really help provide a better use of daylighting," says Goody Clancy's Jean Carroon. DALI is ideal for reconstruction projects, say proponents, because wiring is only a simple two-wire cable; reconfiguring the system is accomplished by reprogramming—no hardware changes are needed.

According to Craig DiLouie, with the Lighting Controls Association (http://lightingcontrolsassociation.org), Rosslyn, Va., "DALI was introduced to the United States to provide assurance to both specifiers and owners that ballasts and controls from different manufacturers can function as a system." DALI-based control systems provide centralized control operating on a standard protocol. Such systems also provide daylighting and occupant control capabilities, application flexibility, and significant energy savings, he adds. DiLouie cites a market study conducted by Ducker Research indicating that lighting automation is being used in about 65% of new construction and renovation projects in the office and school markets.[7]

DALI systems include self-contained "intelligent luminaires," according to DALI-AG (http://www.dali-ag.org/index.php?n=wz1), the European group that promotes the standard and related systems. The luminaires incorporate a ballast and multisensor to serve as constant light control, passive infrared (PIR) movement detection, and infrared (IR) remote operation. These and other components may be connected to create a fully functional single-channel system, using either the control panel or the IR remote control. The remote control (or Windows software) can be used to configure grouped loads, which can, for example, be individually addressed, if desired, for zoned, localized control of task lighting within a large open-plan office.

Finally, multiple DALI systems can be connected together utilizing gateways to building management systems. DALI can be expanded easily by adding new components anywhere without changing the wiring configuration. Software and controls allow for their use with scene-setting, timeclock, and partition control. Its simple wiring and programmable upgrades—with no hardware changes needed—make DALI a logical technology for many reconstruction projects.

"The greenest building is the one that's already built." So says the Architectural Team's Binette, citing the mantra of preservationists and others who see the value of adaptive reuse, renovation, and reconstruction in taking advantage of the embodied energy in existing buildings and reducing the possible environmental stressors associated with producing new materials for construction. By combining proven technologies like better insulation, high-performance replacement windows, and roofing improvements with newer technologies like DALI, Building Teams will be able to maximize the worth of the building stock that's already in the ground. +

6 For an extensive discussion of water-related sustainability, see "Green Buildings + Water Performance," at: http://www.bdcnetwork.com/2009-white-paper-green-buildings-water-performance

7 "Lighting Controls: Current Use, Major Trends and Future Direction Lighting Controls: Current Use, Major Trends and Future Direction," at: http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0CCgQFjAA&url=http%3A%2F%2Fwww.archenergy.com%2Flrp%2Farticles%2F-Lighting_Control_Study.pdf&ei=1WSET4f-ZIYXig-gfT8bzXDA&usg=AFQjCNFL-NUnVYZozfRG-plW9POM7bevALaw.

4. Business Case for High-Performance Reconstructed Buildings

By Jerry Yudelson, PE, LEED Fellow

Jerry Yudelson, PE, LEED Fellow, is principal of the Yudelson Associates consultancy in Tucson, Ariz., and a Contributing Editor of Building Design+Construction. He is the author of 12 books on green buildings, green homes, sustainable development, and water conservation. His latest, The World's Greenest Buildings: Promise vs. Performance in Sustainable Design (with Ulf Meyer), will be published by Routledge in 2013. Editorial associate Gretel Hakanson, LEED GA, conducted the interviews for this chapter.

The business case for super-green restoration of older buildings ought to be simple. They already exist, so it's generally cheaper to restore them; they are often situated in prime real estate locations; and, in the case of historic renovations, there are often tax benefits and other incentives to sweeten the investment. On the other hand, older buildings are generally harder to work with, since the building envelope, orientation, and much of the floor layout are fixed; in historic renovations, there are often significant constraints on modernizing both the envelope and the interior. From the standpoint of sustainability, of course, it's better not to throw away the embodied energy of all the building materials or to down-cycle them for other uses.

Nonetheless, the business and sustainability case for saving older buildings is more relevant than ever, according to Ralph DiNola, Assoc. AIA, LEED AP, a principal with Green Building Services, Portland, Ore. His firm was on the team that completed the recent "Greenest Building" study for the National Trust for Historic Preservation that quantified the environmental value of the more than 328 billion sf of existing buildings in the U.S.[1] According to DiNola, "The study demonstrates that given a choice between demolishing an existing building and building a new one versus renovating the existing building, in almost all cases, renovating an existing building has a better environmental outcome. The unfortunate thing is that the developer's pro forma does not include many of the advantages or benefits associated with the better environmental performance of reuse."

To get to the bottom of this issue, we looked at five projects in Portland, Ore., a city noted for its commitment to sustainability, on the assumption that if super-green renovation and restoration practices could happen here, they could be applied to the rest of the country. We looked at the following buildings:

1. Edith Green–Wendell Wyatt Federal Building
2. Jean Vollum Natural Capital Center ("The Ecotrust Building")
3. Mercy Corps Global Headquarters
4. Meier & Frank Building (Vestas America Headquarters)
5. Marriott Courtyard Portland City Center

The first is a public building, the next two are for NGOs, and the last two are commercial buildings. Each is successful on its own terms. Each meets the needs of its respective owners and stakeholders. Yet each has different business case elements driving the green restoration.

EDITH GREEN–WENDELL WYATT FEDERAL BUILDING—ELEVATING INTEGRATED DELIVERY

Named in honor of two former Oregon Members of Congress, the Edith Green–Wendell Wyatt Federal Building is in the midst of a $126 million renovation funded by the American Recovery and Reinvestment Act. Built in 1975, the 18-story tower was deemed to no longer meet federal energy efficiency requirements, so it is being completely renovated—down to its bare steel bones—under the direction of the General Services Administration. A 170,000-gallon tank will harvest rainwater, treat it, and supply the building's nonpotable uses; water use will be 60% less than under comparable code requirements. Daylighting, smart lighting systems, regenerative elevators, and energy-saving façade treatments are all part of a strategy that is expected to yield a 40% reduction in electricity use compared to current code requirements. It will also have a floor layout and amenities appropriate to an increasingly mobile and wired federal workforce. A 180-kW rooftop photovoltaic array will offset about 3% of the building's energy consumption. The project should be completed next year. LEED Platinum certification is anticipated.

Portland-based SERA Architects and general contractor Howard S. Wright (a Balfour Beatty company) accepted the GSA's challenge of creating a modern super-green building inside an old skeleton. But according to Patrick Brunner, GSA Supervisory Project Executive, the Building Team had to give up some innovative strategies, notably the use of natural ventilation. Brunner says that, while the GSA has new mandates that favor geographic-specific/geosensitive design—which, given Portland's moderate climate, would have made the project an obvious test bed for natural ventilation—the building's orientation and the narrowness of its footprint made natural ventilation simply infeasible.[2]

The team was undeterred in its efforts to develop energy-conservation measures (with supporting life cycle cost analysis) that scored at a LEED Platinum level. "The business case is money—reduced energy cost and payback based on life cycle cost analysis—but

1 "The Greenest Building: Quantifying the Environmental Value of Building Reuse," National Trust for Historic Preservation, http://www.preservationnation.org/information-center/sustainable-communities/sustainability/green-lab/valuing-building-reuse.html, accessed March 18, 2012.

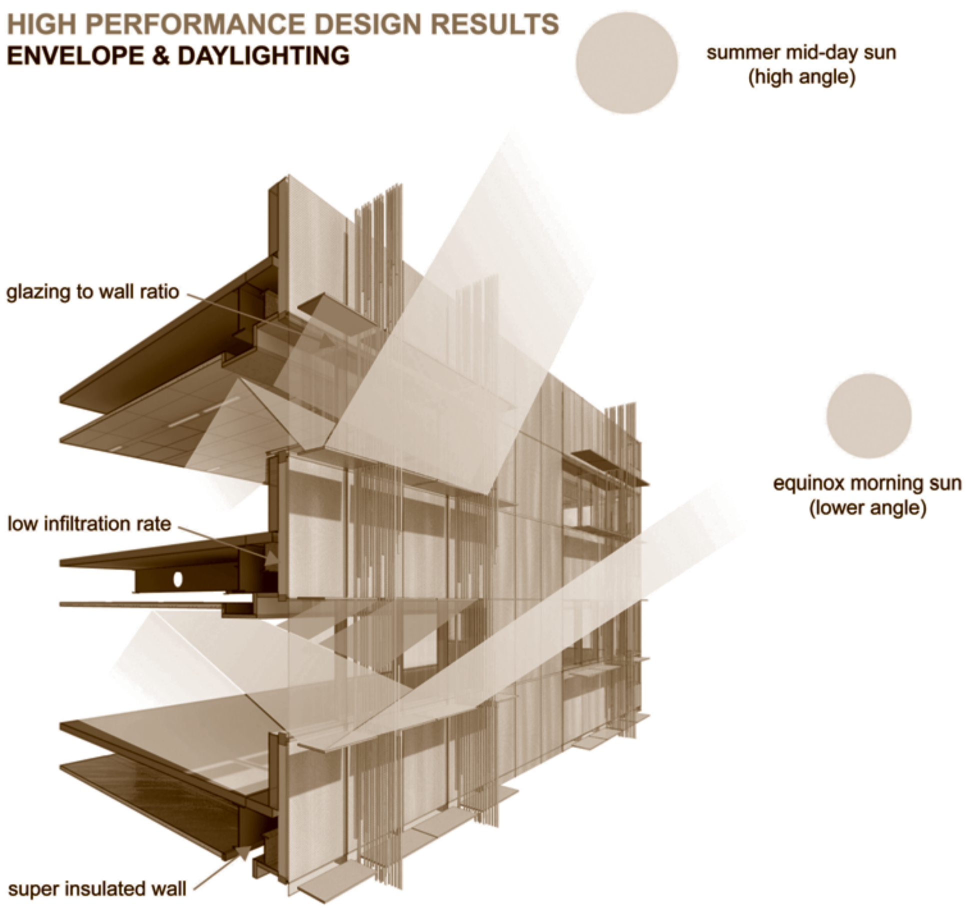
2 Ground-source heat pumps were also ruled out, according to the GSA's Patrick Brunner, because 1) the cost of drilling test wells to verify the volume of water needed from the lower aquifer was beyond the budget, and 2) discharging any water into the upper aquifer would have risked further damage to the upper aquifer, which was already suspected of being contaminated. In tight urban reconstruction projects there is often insufficient exterior space to drill the holes necessary for the employment of ground-source heat pumps.

it's also about productivity," says Brunner. "For this project, we've changed from cooling the building with air, to cooling with water [radiant panels]. Our radiant approach combines with a 100% dedicated outside air system, so the building should be more comfortable and healthier and provide a work environment that increases tenant satisfaction and productivity."

Lisa Petterson, AIA, LEED AP, NCARB, a project architect and associate principal with SERA Architects, described how the Building Team's integrated approach contributed to that solution. "The radiant heating and cooling system is really the biggest energy saver in the building. What is key in being able to incorporate that type of mechanical system was really taking a hard look at the building envelope. Often, we don't see teams taking that long view of looking at the overall energy performance and asking how the building as a whole can work with a much lower energy footprint. In this case, the design of the building façade was intended to reduce solar gain, which then allowed the radiant cooling system to be able to overcome the large solar load on the building. That system wouldn't have been possible if we hadn't mitigated it through [external] shading devices."

Much of the success of the project can be attributed to its innovative delivery approach, says the GSA's Brunner. In a typical integrated delivery scenario, he says, the owner selects the architect and the contractor, then acts as integrator, working with the architect and contractor to build out both of their teams. However, in this case, Brunner says, "Because we already had SERA Architects under contract, we bought the entire SERA team. And because we had a very compressed amount of time under ARRA to get the construction dollars obligated, we issued a solicitation that allowed the prime contractors [bidding for the project] to propose upwards of five first-tier subcontractors with them." The winning contractor, Howard S. Wright, had selected five subcontractors—curtain wall, mechanical, electrical, demolition, and vertical lift—that represented 60-70% of the dollar value of the total contract.

The GSA took further steps toward team integration. "We basically co-located the design and build teams and converted the technical documents from a P100 convention to a more commercial approach," says Brunner. "As far as I'm concerned, this project is as close to integrated delivery as I've gotten with GSA so far."



COURTESY SERA ARCHITECTS

Daylighting model for the Edith Green–Wendell Wyatt Federal Building, named in honor of Rep. Edith Green, a Democrat who served Oregon's 3rd Congressional District from 1955 to 1974, and Rep. Wendell Wyatt, a Republican who served the Beaver State's 1st Congressional District from 1964 to 1975. The renovation of the 18-story structure, which was built in 1975, is seeking LEED Platinum certification.

Edith Green–Wendell Wyatt Federal Building

Owner: U.S. General Services Administration
Lead architect/Interior designer: SERA Architects
Design architect: Cutler Anderson Architects
Mechanical engineer: Stantec
Electrical engineer: PAE Consulting Engineer
Plumbing engineer: Interface Engineers
Commissioning agent: Glumac
Structural/civil engineer: KPFF Consulting Engineers
Construction manager: Howard S. Wright
Gross area: 526,596 sf
Construction cost: $126 million
Anticipated completion: May 2013
LEED Platinum (targeted)

JEAN VOLLUM NATURAL CAPITAL CENTER— A PIONEERING GAMBLE

Originally constructed as a warehouse in 1895, the 70,000-sf Jean Vollum Natural Capital Center was the first historic structure in the U.S. to receive a LEED-NC Gold certification (2001). Ecotrust, a nonprofit conservation organization, purchased the building in 1998. The renovation reflects the original 1895 brick exterior and interior character, while incorporating high-performance features. An aggressive recycling program during construction diverted 98% of project waste from landfill. The building consumes 22% less energy than the Oregon code requirements in effect at the time, owing to energy-efficient windows and lighting fixtures, building and lighting controls, and a high-efficiency ventilation system. The 5,000-sf vegetated roof, along with a bioswale adjacent to the surface parking lot, filters and absorbs stormwater before it runs off into Portland's combined sewer system. Low-flow plumbing fixtures help reduce water use by 16%. The building houses a mix of public, private, nonprofit, and for-profit tenants.

Seeking LEED Gold certification in 2001 was a bold move, according to Sydney Mead, the building manager at Ecotrust. "When we were in the remodel process, we weren't actually going for LEED certification. We really wanted to follow our own checklist," she says. "At that time, we talked a lot about how the building should be a physical manifestation of our mission statement as a nonprofit environmental conservation organization. The other key piece for us is that the building is owner-occupied, so with the energy and stormwater efficiencies, you get that lovely payback in a relatively short time. And by using low- and no-VOC materials, the [improved] indoor air quality enabled us to feel really comfortable in our home."

As the first significant green building in Portland, perhaps the strongest expression of the Vollum Center's economic viability is that Ecotrust has been able to keep the building almost fully leased over the past decade. "The marketing and goodwill PR piece of it is huge," says Mead. "Having that third-party certification was necessary because if we had done the building without certifying it, it would just be our good word."

COURTESY ECOTRUST

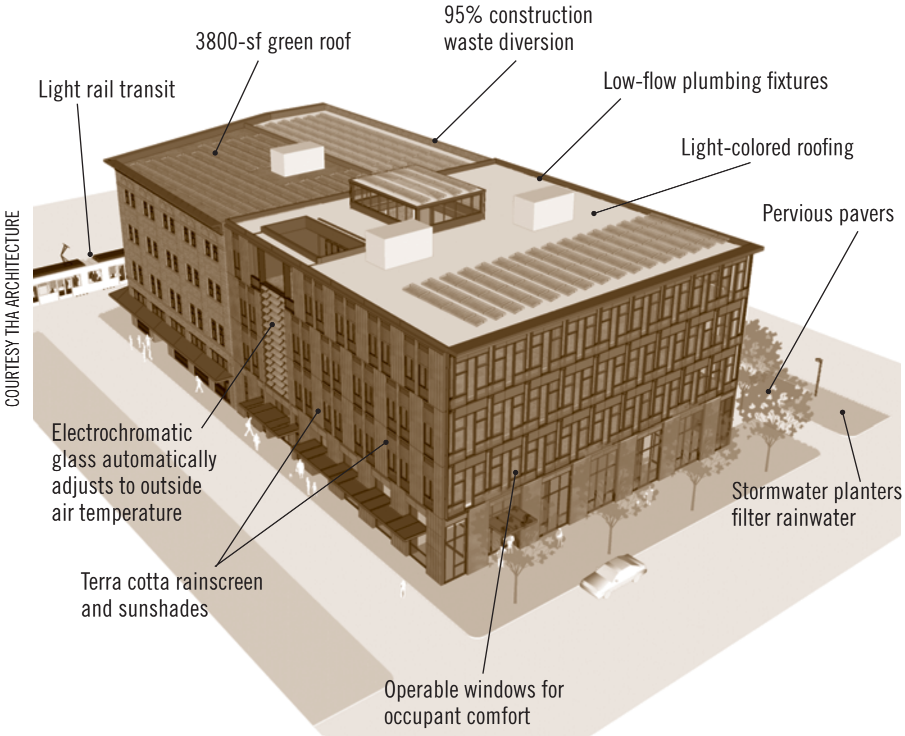
The Jean Vollum Natural Capital Center was the first historic structure to attain LEED-NC Gold status, more than a decade ago. It is considered to be the first significant green building in Portland, Ore., and consumes 22% less energy than state code required.

MERCY CORPS GLOBAL HEADQUARTERS— STRENGTHENING THE MISSION

As with the Ecotrust project, the Mercy Corps initiative represents an effort to renovate a century-old building in a historic but downtrodden neighborhood. Mercy Corps, a global aid agency, not only wanted a building that would reflect its sustainability values but also chose to relocate to Old Town Chinatown, an economically challenged area along the Willamette River, in an effort to spur revitalization there. The project restored the historic Packer-Scott building (1892), a 42,000-sf grocery warehouse, and added nearly the same amount of office space. The addition features a glazed curtain wall that brings natural light into the space and offers views to the river. The red terra cotta of the addition complements the existing brick structure. The LEED Platinum building achieves 51% energy savings over a new building built to code owing in part to new windows, a well-insulated skin, the daylit atrium, and a heat-exchange ventilation system. The project earned all of the LEED Energy and Atmosphere credits, an astounding feat for an old building. An on-site photovoltaic array offsets

Jean Vollum Natural Capital Center ("The Ecotrust Building")

Owner: Ecotrust Properties, LLC
Architect: Holst Architecture
Interior designer: Edelman Soljaga
Structural/civil engineer: KPFF Consulting Engineers
MEP engineer: Interface Engineering
Contractor: Walsh Construction Company
Gross area: 70,000 sf
Construction cost: $12.4 million
Completed: 2001
LEED Gold



Mercy Corps Global Headquarters

Owner: Mercy Corps
Owner's representative: Shiels|Obletz|Johnsen
Architect: THA Architecture
Interior design: DECA Inc.
Structural: ABHT Structural Engineers
Contractor: Walsh Construction Company
Commissioning/MEP: Glumac
LEED consultant: Green Building Services
Landscape architect: Walker Macy
Gross area: 84,700 sf
Construction cost: $21.3 million
Completed: October 2009
LEED Platinum

Schematic of Mercy Corps Global Headquarters showing a selection of its numerous sustainability attributes. In April, the project won a 2012 AIA COTE Top 10 Award from the American Institute of Architects' Committee on the Environment.

7.5% of the building's energy use.

"When we were looking for a space, many people in Portland considered this existing building marginally rehabable," says Mercy Corps' Amy Kohnstamm. There were others who thought the building should have been condemned. "From a business perspective, we had some financial incentives from the City of Portland and particularly from the Portland Development Commission to locate in this part of town and make use of this existing structure."[3]

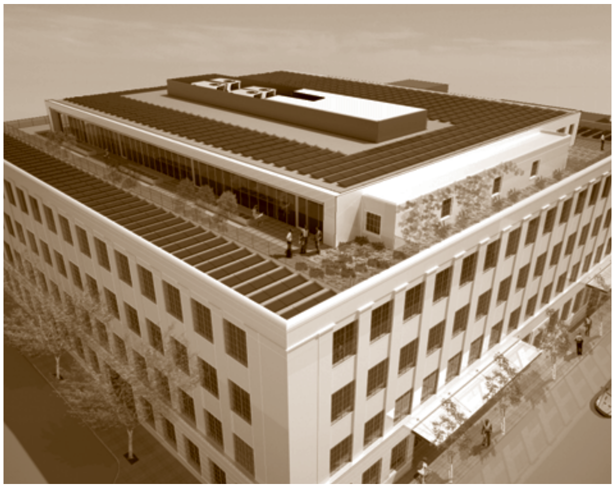
Will Dann, of Portland's THA Architecture, the principal-in-charge, says the client placed "a huge emphasis on being sustainable" but there was also a great concern about being frugal. "They were very concerned that they were raising money for infrastructure and having that compete potentially with their programs in the 33 countries in which they work," says Dann. "From the very beginning, the idea was that we were going to do sensible things that were sustainable but we were going to spend the 20% necessary to get the 80% bang out of the buck." The initial plan was to seek LEED Gold, but the Lemelson Foundation stepped in with a $2.5 million investment to become "co-op owner" of its portion of the building. "This paid for those things that were beyond the original relatively modest budget, but that would have long-term operating and sustainable benefits," says Dann. The infusion of funds allowed the Building Team to take the project from a mid-Gold range to LEED Platinum certification.

THA Architects' David Keltner, the lead designer, noted that the project had to go through a complete seismic upgrade, which had an unexpected benefit. "When we stiffened the existing building with a lot of concrete and steel, it became so stiff that we were able to use [it] to hold up the new addition. The new building didn't have to have as much structure or as many solid walls, which reinforced the ability to have big open spaces in the new building," he says. "There's a great symbiotic relationship between restoration and flexibility of the new space." Thus, a costly seismic upgrade had the hidden payoff of allowing a more open, large office addition effectively to lean on the older building, almost the opposite of what would have been expected.

MEIER & FRANK BUILDING— FROM WAREHOUSE TO GREEN OFFICE SPACE

Located in Portland's Central East Side, the Meier & Frank Depot Building (1928) served as a warehouse for the nearby Meier & Frank department store. In 2001, Gerding Edlen Development purchased the building, which is listed on the National Register of Historic Places, and began renovation in 2010. The Danish company Vestas Wind Systems will occupy the entire building for its North American headquarters. The addition of a new fifth floor will bring the total area up to 184,000 sf, including a parking garage. A central atrium will draw natural light into the center of the large floorplates. A rainwater harvesting system will supply more 60% of the building's nonpotable water needs. Although historic preservation restrictions and other regulations prevent Vestas from installing windmills atop the structure, plans are in place for 112-kW rooftop solar array. The project

3 The project generated nearly $15 million in public loans and subsidies, including $3.5 million from the Portland Development Commission for the building itself (plus a $750,000 grant from the same commission), $6.2 million in New Market Tax Credits, and $3.2 million for a Historic Tax Credit.



COURTESY GERDLING EDLAN DEVELOPMENT

The original Meier & Frank Depot Building (left) was built in 1928 and served as a warehouse for the nearby department store in Portland's Central East Side. Renovation on the building (rendering, right), which is listed on the National Register of Historic Places, started two years ago. Upon completion, the 184,000-sf structure, with the addition of a new fifth floor, will become the North American headquarters of Danish manufacturer Vestas Wind Systems.

is targeting LEED Platinum certification and 50% less energy use than a same size building built to code.

Patrick Wilde, vice president of development for Portland-based Gerding Edlen, arguably the country's most experienced LEED project developer, says the project was originally meant to be a multi-tenant speculative commercial office building. "We had leases for about 75% of the building done with our funding in place and were waiting on our historic approvals, when the downturn happened," recalled Wilde. "A few years later, we circled back and Vestas decided that they wanted to be in a very high-performing, historic building. They are a renewable-energy company, so being in a highly sustainable building was a big key for them."

Wilde makes the case for a high level of sustainability in a historic building. "We think there's a good business case for sustainability, first, because for an office user, certainly it reduces operating costs; second, we think it helps makes the building more attractive to a wide variety of tenants because it offers a work environment that helps tenants attract employees. It helps workforce performance and general happiness in the workspace, and a wide variety of tenants are looking for that."

Meier & Frank Building
Vestas America Headquarters

Owner: 14th & Everett RPO, LLC
Developer: Gerding Edlen Development
Architect: GBD Architects
Structural/civil engineer: KPFF Consulting Engineers
MEP engineer: Glumac
Contractor: Skanska USA
Gross area: 184,000 sf
Construction cost: $64 million
Completion date: April 2012
LEED Platinum (targeted)

MARRIOTT COURTYARD PORTLAND CITY CENTER—WHEN DOING THE RIGHT THING PAYS OFF

Once a vacant bank building that had sat empty for 17 years, the Marriott Courtyard Portland City Center went on to achieve LEED Gold certification with a renovation completed in 2009. The 1980s-era former office building and adjacent site now contain 256 guest rooms, meeting and convention space, a fitness center, and a restaurant. The renovation included a new shell, three additional floors, and new mechanical systems. The hotel uses 28% less energy than a property of comparable size due to daylighting, efficient air-handling systems, and heat pumps in guest rooms and meeting spaces. According to the designers, SERA Architects, the construction cost premium to build the hotel to the LEED Gold standard was 1.2%. Factoring in state and local incentives reduced the premium to 0.25%. Dual-flush toilets contribute to an estimated 26% less water use. The estimated payback from water and energy cost savings is 18 months, and the hotel will save about $600,000 in operating costs over 10 years.

SERA project architect and associate Gary Golla, LEED AP, NCARB, an expert in hospitality design, says there usually four key stakeholders in hotel projects: the developer, the owner, the hotel brand, and the operating company, each with a potentially different set of goals for the project. That makes it essential for the Building Team to articulate the business case in different ways for each stakeholder's frame of reference.

"Often developers may not be interested in the energy savings if they're going to flip the building," says Golla. "But if they're going to be part of the ownership or management group, then they become interested in saving operating costs, and the biggest part of that is usually from energy savings. That's where it makes sense to put additional money in up front, because you can show that it pays back over time. The other place where they have shown interest is in available incentives," which in Oregon at the time of the Marriott project were considerable for projects that attained at least LEED Silver certification.

Golla noted that it is important to understand how to engage developers in such projects. "If you lead with energy savings and making a better building and how it can help their investment, they really listen," says Golla. "But if you go in and say, 'You should do a sustainable building because it's really great for the environment,' and you give them all the 'right' reasons to do it, they often don't pay attention. [When] you can prove there's a financial reason do it, then they can be convinced."

TO MAKE THE BUSINESS CASE, MEET THE OWNER'S NEEDS

From these examples, the chief conclusion that can be drawn about the business case for high-performance reconstructed building is that it depends primarily on the needs of the owner. For a federal agency, there are Presidential directives to achieve at least LEED Silver, but each project has to meet at minimum 6% return on investment, limiting overall costs for green. For nonprofit organizations, client needs are often mission-driven, with the added desire to provide an excellent workspace to employees who may not be paid as well as those in the private sector. For the for-profit owner, the most important selling point may be employee recruitment and retention.

Building Teams seeking to attain LEED Gold and Platinum certifications for their reconstruction projects need to be creative to keep cost premiums to a minimum.

The biggest hurdle can be optimizing daylighting and thermal performance, but even this can be overcome through well-conceived planning and design. "I would make the bold statement that doing a [reconstructed] LEED-certified building doesn't cost you a nickel more than what it would it be to do a standard building, *if* you are smart about what you are doing," says THA Architects' Keltner. "Furthermore, if you want to go to high levels of LEED certification, you can get really far with an added 5%."

THA Architecture's Will Dann points out that renovating older buildings not only aids in revitalizing downtown neighborhoods but also takes advantage of existing infrastructure, rather than building on greenfields outside of the city where infrastructure has to be added, at great cost.

Patrick Wilde, Vice President of Development of Gerding Edlen Development, puts it this way: "We think greening existing buildings is important not only from the standpoint of just being responsible [developers] but also from the standpoint that it can definitely help performance on a financial basis and also on an employee retention and attraction basis. And it's not just renewable energy companies that are interested. It's law firms, banks, and the traditional core companies that would be leasing typical office space that are now paying more attention to those building attributes and saying, 'That's the kind of space we want to be in.'"

That sentiment is echoed by Ralph DiNola, of Green Building Services. "One of the greatest financial incentives [in reconstruction] is improving the outcomes that benefit the occupants of that facility—better health, productivity, less turnover. Focusing on the occupants has the most significant financial return to an organization," he says.

DiNola goes on to put reconstruction in a larger context. "Reusing existing buildings is the closest thing to a silver bullet in terms of affecting climate change with one sector," he says. "If the building sector is going to really be the linchpin of addressing climate change, building reuse is a big part of the answer." +

MICHAEL MATHERS

The Marriott Courtyard Portland City Center, which was brought up to LEED Gold standards for a construction cost premium of 1.2%. The 1980s-era office building was converted into a 256-room hotel with convention space, a restaurant, and a fitness center. Reconstruction included a new shell and new mechanical systems, and three new floors were added. Energy savings of 28% were achieved.

Marriott Courtyard Portland City Center

Owner: Cornerstone
Developer: Sage Hospitality Resources
Architect/Interior designer: SERA Architects
MEP engineer: PMC Mechanical & Oregon Electric
Structural/civil engineer: KPFF Consulting Engineers
LEED consultant: Brightworks
Contractor: Hoffman Construction
Gross area: 199,200 sf
Construction cost: $44 million
Completed: September 2009
LEED Gold

5. LEED-EB and Green Globes CIEB: Rating Sustainable Reconstruction

By Pamela Dittmer McKuen, Contributing Editor

When green building rating programs were launched about a decade ago, their primary objective was to reduce environmental impacts from new construction. Over time, as the U.S. Green Building Council's LEED system and the Green Building Initiative's Green Globes program evolved and expanded, the focus started shifting to existing buildings, either for ongoing sustainable operations and maintenance—office fitouts, hotel room renovations, lighting upgrades, etc.—or for more wholesale repurposing—more elaborate reconstruction, adaptive reuse, renovation plus addition, etc. In recent years, certifications for existing buildings have rapidly outpaced those for newly built ones, according to both the USGBC and the GBI.

The tide turned in 2009. That's when the certifications for the USGBC's LEED for Existing Buildings: Operations + Maintenance program surpassed those for new construction. By the end of 2011, the cumulative footprint of LEED-EB:O+M exceeded LEED-NC by 15 million sf.

The GBI has witnessed a similar pattern in its Green Globes program. As of March 2011, the organization had granted 333 certifications for projects on its Continual Improvement of Existing Buildings (CIEB) track and 105 projects for New Construction.

UNRAVELING THE MULTIPLE FACTORS BEHIND THE EXISTING BUILDING TREND

Interest in sustainability for existing buildings has been propelled by a number of factors, primarily the economic downturn, which derailed billions of dollars' worth of new construction projects. While owners of existing buildings certainly felt the pain of the economic collapse, many of their properties reached a point where substantial maintenance, renovation, or reconstruction was called for. Given a decade's worth of publicity about sustainability practices, products, and programs, a significant portion of owners apparently opted for going green with their reconstruction projects.

Government mandates were another important motivator. At the state level, where most coffers are seriously strained, lawmakers more and more are requiring sustainability measures for both new and renovated public buildings. These green mandates are often in lieu of tax incentives or prerequisites for receiving grants. More than half the states specifically name LEED, Green Globes, or both in their legislation.[1]

Federal agencies must meet the Guiding Principles of Executive Order 13514—Federal Leadership in Environmental, Energy and Economic Principles (5 October 2009).[2] EO 13514 requires each federal agency to have 15% of its existing leased or owned space greater than 5,000 sf in compliance by 2015.

RAISING THE BAR ON PERFORMANCE

Repeat business is also spurring growth. Satisfied early adopters are recertifying and signing up additional properties. Fall-off rates are low. Both the USGBC and GBI report an influx of portfolio—or *volume*—projects, notably retail chain stores, bank branches, and property management firms' leased office space. The GBI currently is working with seven colleges and universities, including the entire Drexel University campus in Philadelphia.

Seasoned clients are likely to push for higher ratings in subsequent go-rounds, say, from Silver to Gold or from two Green Globes to three Green Globes. They often become more creative as well. Standout initiatives from LEED-EB:O+M clients take a holistic approach by integrating their buildings into the larger community, such as by hosting onsite farmers' markets or inviting neighborhood groups to use the facilities for community activities.

LEED-EB:O+M – FINDING A GROOVE WITH OWNERS

LEED for Existing Buildings—LEED-EB, as it was known at first—came out in 2002; it became LEED-EB:O+M in 2008. The number of buildings to earn LEED-EB:O+M certification, as of 15 March 2011, was 1,628. Of those, most attained Silver or Gold ratings.

Registrations for LEED-EB:O+M more than doubled after a major 2008 revision that removed design and construction requirements, over which owners and operators of existing buildings said they had little or no control, and replaced them with energy-savings and performance measures. In 2009 the point scale for LEED-EB:O+M was "harmonized" at 100 points along with the other LEED rating programs.[3]

Once again the program is undergoing revision, with LEED 2012 planned for release at Greenbuild (San Francisco) in mid-November. The USGBC's Lauren Riggs, LEED AP, manager of LEED Performance, detailed some of the proposed changes to LEED-EB:O+M:

1 See http://www.usgbc.org/DisplayPage.aspx?CMSPageID=1852.

2 The Guiding Principles of EO 13514: employ integrated design principles, optimize energy performance, protect and conserve water, enhance indoor environmental quality, and reduce environmental impact of materials. At: http://edocket.access.gpo.gov/2009/pdf/E9-24518.pdf.

3 Sustainable Sites, 26; Water Efficiency, 14; Energy & Atmosphere, 35; Materials & Resources, 10; IEQ, 15.

4 They are: Arkansas, Connecticut, Delaware, Florida, Hawaii, Illinois, Kentucky, Massachusetts, Minnesota, Nevada, New Jersey, New Mexico, New York, North Carolina, Oklahoma, Oregon, Pennsylvania, Rhode Island, South Carolina, South Dakota, Tennessee, Utah, Virginia, and Wisconsin.

- Additional compliance paths for schools, retail, hospitality, and data center projects.
- A whole-building water meter requirement in addition to the previously required whole-building energy meter.
- New occupant engagement and site improvement options in the Pilot Credit Library.
- New alternative compliance path for buildings that demonstrate improved energy efficiency of 20% over 12 months.
- Streamlined data reporting for recertification.

LEEB-EB:O+M clients are an even blend of public and private enterprises. Commercial office buildings make up the largest base (in square footage), followed by retail chains, big boxes, and property management companies. Clients include such brand-name entities as Kohl's, Target, the U.S. General Services Administration, and Vornado Realty Trust.

One notable project: the National Geographic Headquarters in Washington, D.C. The 746,000-sf complex, mostly office and exhibit space, was built in three stages over the course of a century, starting in the 1880s. It earned a LEED-EB Silver rating in 2003, and has twice been recertified Gold. Among its performance achievements: an overhaul of the mechanical system decreased energy use by 20%, and water use from plumbing fixtures has been reduced by 36% over what LEED requires.

The project is significant because it shows that a building with both older and newer components can attain a high level of sustainability, says Michael Arny, president of Leonardo Academy, Madison, Wis., and LEED consultant to National Geographic. Arny chaired the LEED-EB development committee and has been a major contributor to the program since its inception.

GREEN GLOBES – MAKING A SPLASH WITH THE VETERANS ADMINISTRATION

The Portland, Ore.-based GBI began awarding its Green Globes for New Construction certification in 2004; Green Globes for Continual Improvement of Existing Buildings followed two years later. It is possible to earn one to four Green Globes, correlating roughly to LEED's four-tier scale. Most projects achieve two or three Green Globes.

GBI's client roster is a mix of office buildings, colleges and universities, corporate headquarters, manufacturing plants, warehouses, medical facilities, and parking garages. Chicago's Civic Opera House is a Green Globes CIEB client. The mix is divided 50/50 between private and public projects, but on a building-count basis, the 200 facilities from the U.S. Department of Veterans Affairs skew the ratio closer to 30/70. About one-third of GBI clients are repeat users, says GBI vice president Sharene Rekow. Twenty-four states recognize Green Globes for certifying state-owned buildings.[4]

Starting in 2009 the VA submitted 21 buildings, mostly healthcare facilities, for Green Globes certification, then added 180 more. All were certified. When the federal Guiding Principles were announced, the VA hired the GBI to develop a compliance tool. As an extension of that experience, the GBI in 2011 rolled out its most recent module, CIEB for healthcare facilities.

Other recent projects of note are the 57-story IDS Center in Minneapolis and the sprawling Medtronic World Headquarters in Fridley, Minn. Three more Medtronic projects are in the works.

Also on the list are unusual or specialty projects, such as water treatment facilities and parking garages that might not be appropriate for LEED. Green Globes, for example, recognizes Sustainable Forestry Initiative-branded lumber; LEED does not. Green Globes' cost is lower, too—less than one-third of the cost of LEED. Some buildings, like the William J. Clinton Presidential Center in Little Rock, Ark., and the Hands On Children's Museum in Olympia, Wash., have earned dual certifications.

ONWARD AND UPWARD WITH CERTIFICATION PROGRAMS

While certifications for existing buildings are expected to keep climbing upward, they are still only beginning to make a dent in the vast inventory of more than 60 billion sf of existing commercial buildings in the U.S. Both the USGBC and the GBI are looking to cultivate international clienteles, although translating and standardizing local business codes, products, and materials to foreign

Global Survey Confirms Owner Interest in Energy Efficiency

The 5th JCI/IFMA/ULI Annual Global Energy Efficiency Survey of nearly 4,000 building owners worldwide revealed the following:

- Energy management is important to 70% of managers.
- Average energy-reduction target of owners: 12%.
- 80% of owners said (June 2011) they foresaw a >10% energy price bump within a year (they were right).
- 39% of building owners plan to pursue green certifications for existing buildings in the next year.
- Energy cost savings, government incentives, and enhanced public image were the biggest motivators for energy-efficiency investments.
- The green building movement reaches new heights, with nearly four in 10 respondents achieving certifications, twice as many as the previous year.
- North America building owners expect lighting and smart building technology to play major role in the future.
- Seven in 10–up from six in 10–indicate that energy management is important to them, with respondents in India (89%) and China (85%) expressing the most interest, followed by U.S./Canada (66%) and Europe (61%).
- Three out of four have set energy or carbon reduction goals.
- Nearly four in 10 have achieved at least one green building certification, twice as many as the prior year. An additional 32 percent (32%) have incorporated green building elements.
- Building owners planning to pursue green building certifications for existing buildings (39%) slightly outpaced those with plans to certify new construction (35%).
- Lighting and HVAC controls improvements continued to be the most popular energy-efficiency improvements made during the previous year (2010).
- Building owners have greater access to energy data, but few are taking advantage of it. More than eight in 10 measure and record data at least weekly or monthly, but fewer than two in 10 review and analyze that data at least weekly. Those who have implemented smart grid/smart building technology such as advanced energy metering and management systems are nearly three times more likely to review and analyze their data frequently.
- Organizations that set a reduction goal, analyze energy data frequently, add internal or external resources, and use external financing were found to implement four times as many improvement measures as those who employed no such measures.

Source: "Fifth Annual Global Energy Efficiency Survey," Johnson Controls' Institute for Building Efficiency, the International Facility Management Association, and the Urban Land Institute, 17 June 2011. Summary at: http://www.uli.org/News/PressReleases/Archives/2011/2011PressReleases/2011JohnsonControlsEnergyEfficiencySurvey.aspx shores can be difficult.

Michael Arny, the "godfather" of LEED-EB, predicts building operators will exert increasingly greater pressure on their supply chains to be more sustainable. Vocal elements of the public, too, will be pressuring the companies they do business with to do the same, or they'll take their business elsewhere. +

ADDITIONAL RESOURCES ON CERTIFICATION FOR EXISTING BUILDINGS

"A Comparison of Two Environmental Rating Systems Using Dual Certified Buildings," Harvey Bryan, PhD, FAIA, and Jiri Skopek, AADip., RIBA, MCIP, OPPI, OAA, at: http://www.thegbi.org/green-resource-library/pdf/Final-SB-2008-LEED-GG-paper.pdf;

Operation & Maintenance Reports, Energy Star, at: http://www.energystar.gov/index.cfm?c=business.bus_om_reports;

Energy Efficiency Calculator, at: http://www.sba.gov/content/energy-saving-calculators-energy-star;

"Current Trends in Green Real Estate—Summer 2011 Update," at: http://www.costar.com/webimages/webinars/CoStar-Webinar-CurrentTrendsinGreen20110621.pdf

Security Factors in High-performance Reconstruction Projects

By Martin Denholm, AIA, LEED AP BD+C, BSCP

COURTESY SMITHGROUPJJR

A landscaped vehicle barrier using water and other natural elements demonstrates the compatibility of aesthetics and security in a high-profile reconstruction project.

Building Teams intent upon achieving high-performance outcomes in the reconstruction of old and historically significant buildings need to address not only the sustainability requirements of these projects but also, in many cases, their significant security concerns. This is especially true in reconstructed government buildings, high-profile commercial office buildings, and special venues, such as national museums.

The two biggest challenges in this effort are requirements for blast protection and protection from chemical, biological, or radiation (CBR) threats. Significant blast protection criteria lean toward brute mass and distance to withstand extreme pressure levels and flying debris. CBR protection leans toward sealed structures and separate systems and controls for different areas of the building.

The key is to identify those design solutions where security and sustainability requirements can strengthen each other or utilize the same design elements to accomplish both goals. Though some aspects of these trends limit the design's ability to attain either the security or sustainable goals desired, there are a number of strategies that allow security and sustainability to cooperate and reinforce each other.

Making blast protection aesthetically pleasing. Where reconstruction or major renovation requires mitigation of blast forces, a building can be reinforced with little or no effect upon its sustainability profile. For instance, a reconstructed building can use a double-wall design to shield the building from extremes of hot and cold temperatures, while at the same time providing blast protection, serving as a crush zone or sacrificial skin. Similarly, when a building can accommodate extra site area for standoff distance, there may be an opportunity to employ sustainable features such as bioswales, water retention ponds, and landscaping as part of a vehicle barrier system.

The typical response to providing such barriers often results in a mixture of hardscape elements that are rather brutish and obvious, such as walls and bollards. However, the use of softscape elements can meet all the requirements for the most demanding vehicle weight and speed parameters, thus meeting two distinctly different purposes with a single design feature that is more aesthetically pleasing.

The design of CBR protection for reconstructed buildings has ramifications for building energy use and interior environments that can limit the ability to implement sustainable features and systems.

The major impact of CBR protection is the method by which contaminants from outside the building are prevented from entering the interior air supply. The obvious response is to seal off or positively pressurize the building to prevent the infiltration of airborne contaminants. This mitigation rules out the opportunity to employ natural ventilation through operable windows or outside air-fed vertical convection through atria. Unfortunately, sensors for detecting contaminants, and in particular biological agents, are not yet capable of detecting and activating closure of windows and intakes fast enough to prevent those agents from entering the interior building air stream.

Outside air intake systems for sealed buildings face a similar problem, but can be equipped with filtering media to prevent contamination. The negative impact on sustainability with such systems is that greater fan power and energy are required to pull air through high-efficiency filters.

Inside the building, Building Teams can achieve CBR protection by sequestering areas such as lobbies, mailrooms, and loading docks from the general building air systems. This is accomplished by employing separate HVAC systems for these areas and creating negative pressure zones for areas most likely to be contaminated. These systems and physical containment areas do not directly conflict with sustainable goals and offer the ability to limit the infiltration of outside air into the general building environment. In a building where outside air is already heavily filtered and conditioned, this separation may provide some small energy savings by easily maintaining the interior environment's temperature and humidity levels.

Finding methods and design elements where security and sustainability can reinforce each other and limit conflicts is critical to attaining totally integrated high-performance design for select reconstructed buildings.

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6. Energy Codes + Reconstructed Buildings: 2012 and Beyond

By Marilyn E. Kaplan, RA, FAPT, and Joseph P. Hill, RA

Marilyn E. Kaplan, a Registered Architect and Fellow of the Association for Preservation Technology, is a Project Manager with NYSERDA – New York State Energy Research & Development Authority. She administers NYSERDA's programs related to the New York State Energy Conservation and Construction Code and is responsible for all code-related training and support efforts at NYSERDA.

Joseph P. Hill is a Registered Architect and Assistant Director for Energy Services with the Division of Code Enforcement and Administration of the New York State Department of State.

In the 1970s energy conservation found a ready home in the regulatory system originally intended to address issues of fire safety and public health in buildings. For the next 40 years, energy conservation has continued along a path of steady and steep advancement affecting all facets of building construction. The U.S. Department of Energy's cooperative role with professional organizations led to the development of the 1975 ASHRAE Standard 90-75, the predecessor of the Standard 90.1 series. In response to the Energy Policy Act of 1992, in 1993 DOE founded the Building Energy Codes Program.[1] Early on, DOE encouraged states to adopt ANSI/ASHRAE/IESNA Standard 90.1-1989 for commercial buildings, and through its most recent efforts associated with the American Recovery and Reinvestment Act of 2009 (ARRA), has remained active in the code development process and in encouraging states to adopt and implement energy codes.

Over the last decade, energy-related improvements, primarily associated with the thermal performance of the building envelope and the efficiency of mechanical and electrical equipment, have dominated the discussion within the communities most directly linked to building regulation, design, and construction. Table 6.1 illustrates the rise of model codes dedicated to energy conservation since ASHRAE's publication of the first energy code, in 1975.[2]

Due to increasingly rapid change in HVAC and building construction technology, in 1999 ASHRAE voted to place the standard on continuous maintenance, which allowed for its update multiple times per year, up to the current standard, ASHRAE 90.1-2010. The updates come from technologies becoming more efficient and the emerging development of newer technologies brought to market.

THE GROWING ROLE OF THE INTERNATIONAL CODE COUNCIL

Since its creation in 1994, the International Code Council has published a family of 15 codes that have superseded the long-standing dominance of unique regional and state codes. The rise of the International codes as a single set of building standards providing uniformity on a national scale deepened the opportunity to expand regulatory discussions to a common platform. The first International Energy Conservation Code (IECC), published in 1998 based on the 1995 edition of Council of American Building Officials' Model Energy Code, was updated in 2000, 2001, 2003, 2004, 2006, and 2009. The 2009 edition became the ideal vehicle for higher energy performance in buildings as encouraged by ARRA, in essence becoming the backbone of the federal government's response to global politics, energy independence, and climate change.

ARRA, THE 2009 IECC, AND STANDARD 90.1-2007

The passage of ARRA represented a significant step in improvements in required energy performance. Of the $787 billion in the ARRA budget, $3.1 billion was set aside for energy program grants to states agreeing to update their energy codes for commercial buildings (and residential ones more than three stories in height) to the performance level dictated by the 2009 IECC or ANSI/ASHRAE/IESNA Standard 90.1-2007 (Standard 90.1).

Both the 2009 IECC and Standard 90.1-2007 present several compliance paths for residential and commercial construction. Traditional prescriptive paths establish specific minimums with variations that permit the trade-off of building envelope elements against each other. DOE-produced software programs (COMcheck for commercial buildings) provide an automated means to identify requirements of the building envelope, although additional mandatory code provisions must be met for full compliance. These software products provide the means to select among various combinations of energy-conservation measures based on climate zone, including insulation levels, glazing areas, glazing U-factors (thermal performance), and in some cases heating and cooling equipment efficiency.

In contrast, performance paths (Section 506 Total Building Performance in the IECC and Section 11 Energy Cost Budget Method in Standard 90.1) use computer models of building-specific parameters to determine compliance. Although costly, this compliance method, based on the DOE-2 platform of annual energy usage, is the most judicious in terms of energy utilization measurement. Given the specialized task and subsequent high cost of modeling, this method typically is reserved for unique buildings, large structures, and structures that are required to meet performance levels that exceed minimum code. It must be followed for highly glazed buildings with fenestration

1 Then known as the Building Energy Standards Program and later the Building Standards and Guidelines Program.

2 The original standard ASHRAE 90 was published in 1975. Several updates were made in the years between the initial publication in 1975 and 1999, and then again in 2001, 2004, 2007, and its current version of 2010.

percentages exceeding code-determined thresholds.

ARRA's goals, accepted by the states receiving ARRA funds, were to increase, by 2017, energy code compliance to 90% of the standard established by the 2009 IECC. There are different approaches to quantifying progress based on the 2006 IECC baseline. A 30% improvement in performance based on foreseen code updates has been commonly cited as the level of intended improvement between 2006 and 2017, and 5-8% improvement for commercial properties (15% for residential properties) as the intended improvement between the 2006 and 2009 IECC. Three years after passage of ARRA, required compliance evaluations from states have produced varying results on the extent of actual compliance. Heightened efforts by states can be expected over the next five years to meet these and the more aggressive performance goals described in the law.

THE INTERNATIONAL EXISTING BUILDING CODE

Energy improvements to existing buildings will have an increasing share of the marketplace, but present a myriad of different technical and administrative challenges since each building is unique based on its original construction, condition, and the owner-elected scope of intended improvements. The International Existing Building Code (IEBC) establishes code requirements according to the scope of owner-elected work, delineated as the work area. Work is classified as a Repair, an Alteration (Level 1, 2, or 3), or a Change of Occupancy. The IEBC requires energy-conservation improvements consistent with the IECC within the work area, except in the case of minor work classified as a repair, or for historic buildings (as defined in the code), providing that conditions do not exist constituting a distinct life safety hazard. Owners of historic buildings share the same goals of energy efficiency as others, although their concern for long-term durability and minimizing adverse effects on historic features and spaces permit greater latitude in selecting appropriate materials and techniques.

The philosophy of limiting required improvements to a project's work area anticipates that, over time, incremental energy improvements will create a compliant building, similar to the incremental approach to accessibility improvements long embedded in the code. However, this stepped approach does not consider the impact a single improvement can have on other building elements or systems, and further research on the interactivity of energy-conservation measures is warranted. For example, in the absence of proper consideration of building ventilation needs, the installation of code-compliant insulation in the building envelope must carefully follow manufacturer instructions to avoid creating conditions that might encourage mold growth or material deterioration. A deeper understanding of such aspects of integrated design by the architectural, engineering, and construction professions will come as a result of building science research and application and the broader use of models evaluating critical items such as wetting and drying of assemblies in particular climatic and use conditions.

NEXT-GENERATION CODES: IECC AND STANDARD 90.1

DOE, ASHRAE, and the ICC agreed that buildings constructed under Standard 90.1-2010 would be 30% more energy efficient than those constructed using Standard 90.1-2004, and that the 2012 IECC would follow suit and be 30% more efficient than the 2006 IECC. The goals of the 2015 IECC and Standard 90.1-2013 will likely be even more stringent, although still based on 2006 performances levels.

Voluntary programs such as LEED or the higher-performance energy codes adopted by states or municipalities are likely to also demand increased performance, with some emerging programs promoting zero-energy buildings and deep retrofits for existing buildings. ASHRAE has indicated that the target goals of Standard 90.1-2013 may be as high as 40% above 2006 performance levels, with the 2015 IECC to follow suit. In reality, although the 2012 IECC and Standard 90.1-2010 are available for adoption, without ARRA's incentives it is likely that jurisdictions will be slower to adopt next-generation codes as minimum standards, and instead will rely on voluntary programs to assist in the move toward less energy-hungry buildings.

ABOVE-MINIMUM ENERGY PERFORMANCE CONSTRUCTION STANDARDS

The IECC, the most widely adopted energy code, establishes the minimum energy performance level permitted. Authorities that adopt the IECC may establish above-minimum requirements, such as the U.S. EPA's Energy Star program, which provides buildings that perform approximately 20% higher than code-minimum buildings. Alternately, certain financial incentive programs may require above-minimum performance, as may municipal, state, or federal agencies. National or

TABLE 6.1. THE DEVELOPMENT OF MODEL ENERGY CODES

1975	ASHRAE Standard 90 - 75: Energy Conservation in New Building Design	Reissued 1980, 1989, 1999, 2001, 2004, 2007, 2010
1998	International Energy Conservation Code (1st edition)	Based on 1995 Model Energy Code (CABO); updated 2000, 2001, 2003, 2004, 2006, 2009, 2012

Sources: ASHRAE, IECC

international green rating systems such as LEED and Green Globes may require above-minimum energy performance to obtain certification.

INTERNATIONAL GREEN CONSTRUCTION CODE

The International Green Construction Code (IgCC), which was published by the ICC in March, translates the broad principles of sustainability articulated in rating systems such as LEED to a code. By providing a framework that adopting jurisdictions can customize to meet regional needs and priorities, the IgCC seeks to improve the long-term performance and safety of new and existing commercial and high-rise residential buildings.

Note: The IgCC is not applicable to single-family homes or multifamily structures of three stories or less above grade.

The IgCC includes criteria such as environmental responsibility, resource efficiency, occupant comfort, and community sensitivity. Provisions include many traditionally associated with zoning or other environmental regulations, such as greenfields, conservation areas, and the promotion of infill green building and urban redevelopment. The IgCC incorporates both *prescriptive-* and *performance-based* choices. Of particular note is the ability to self-select a compliance path option, based on performance, outcome, or energy use intensity (EUI). The IgCC also offers the option to use either the IgCC or ASHRAE/USGBC/IES Standard 189.1-2009.

The code also shifts from focusing on mechanical equipment to energy efficiency, in particular through commissioning requirements to ensure building systems operate as designed, and extensive requirements for metering and submetering. Meters must be installed for all fuel types at the whole building level, including separate (and segregated) submetering requirements for HVAC, lighting, plug, process, and building operation loads for large buildings. (In this initial edition, metering equipment is not required for buildings of less than 25,000 sf.)

Mandatory requirements (detailed in Chapters 4-11 of the IgCC) are uniquely selected from Table 302.1 by the adopting jurisdiction to meet regional goals and priorities. An additional selection by the adopting jurisdiction determines the number of project electives (1-14) from Table 302 that must be met, and whether enhanced performance or reduced flow rates for plumbing fixtures are required. The code user chooses project electives from a 60-item checklist (Table 303.1), provided that the specific elective was not pre-selected by the jurisdiction as mandatory.

Several states (Maryland, North Carolina, Oregon, and Rhode Island), municipalities (Fort Collins, Colo., the District of Columbia, and Keene, N.H.), and the Native American Kayenta Township in Arizona have voluntarily adopted early drafts of the IgCC.[3] Following upon its publication earlier this year, other jurisdictions and entities will explore adoption of the entire document or extracted sections. It is anticipated that full and rapid acceptance may be curtailed while the design and construction industry continues to adapt to the new code-minimum performance increases of the 2012 IECC and Standard 90.1-2010.

BENCHMARKING, METERING, OUTCOME-BASED CODES, AND RETRO-COMMISSIONING

One limitation of the regulatory system is its measurement of code compliance at the moment of project completion rather than having the ability to confirm ongoing compliance. Benchmarking programs, among the progressive efforts being adopted throughout the country, establish the means to quantify savings by evaluating hard and actual data on energy use. A systematic and verifiable approach to long-term savings is created by these benchmark baselines, which establish how much energy is being consumed, followed by energy audits that determine what can be done to reduce energy costs. In addition to providing owners information on the relative costs and value of upgrades (and jurisdictions and utilities data on which to predict future energy needs), benchmarking creates an informed market capable of comparing performance data and operating costs of similar properties—information that will ultimately guide purchasing and leasing decisions. For policymakers, benchmarking provides the ability to monitor progress toward efficiency targets, identify markets with the greatest needs and opportunities, and guide development of future policies and incentive programs.

In New York City, the Greener, Greater Buildings Plan—part of the greenhouse gas emissions reduction goals within PLaNYC to reduce carbon emissions citywide to 30% below 2005 levels—requires annual energy benchmarking of all city-owned buildings and commercial buildings greater than 50,000 sf, submeters in buildings larger than 50,000 sf, online disclosure of building energy ratings, and energy audits and retro-commissioning every 10 years. In Seattle, the Building Energy Benchmarking and Reporting legislation requires commercial and multifamily building owners to conduct annual energy-performance tracking. Since 2007, the states of California, Nevada, Oregon, New Mexico, and Washington and several cities (including Austin and Washington, D.C.) have also enacted energy-benchmarking or disclosure requirements.[4] Variations on rating performance and required disclosure have been adopted in more than 30 countries over the last decade, including members of the European Union, under the EU's 2002 Energy Performance of Buildings Directive (EPBD). Some cities in China have

3 The Keene, N.H., restriction applies only within with the city's Sustainable Energy Efficient Development Zone.

4 The Austin (Texas) 2011 Energy Conservation Audit and Disclosure ordinance (http://www.austinenergy.com/about%20us/environmental%20initiatives/ordinance/index.htm) requires homeowners selling their property to obtain a specialized audit evaluating heating and cooling system efficiency, air infiltration, duct performance, air sealing, weather stripping, windows, and attic insulation. As of June 1, 2012, buildings 75,000 sf or larger must report their energy ratings (using such tools at Energy Star's Portfolio Manager). That threshold drops to 30,000 sf on June 1, 2013, and to 10,000 sf on June 1, 2014.

See also the Institute for Market Transformation chart, "Comparison of U.S. Commercial Building Energy Rating and Disclosure Policies," at: http://www.imt.org/rating.html.

5 The website BuildingRating.org has a neat compilation of these programs at: http://www.buildingrating.org/content/existing-policies.

adopted similar standards, and Australia and Denmark have particularly innovative programs.[5]

Outcome-based codes, such as the initiative promoted by the New Buildings Institute, establish a building's energy use as the metric of compliance.[6] By focusing on actual energy use rather than a theoretical prediction of energy use (as is generated by traditional code application), high-quality data can be derived and used to guide future improvements and operational decisions. As in the case of metering, outcome-based codes create the opportunity to engage building owners, possibly one of the most critical steps in creating a culture that is committed to reducing energy use. Commissioning, long a component of voluntary and incentive programs, is beginning to emerge as a mandatory requirement in the next generation of codes. It is expected that retro-commissioning of existing buildings, with the goal of optimizing performance without full system replacement, will also slowly emerge as a widely adopted regulatory tool.

STRETCHING THE LIMITS OF PERFORMANCE

As mandated energy performance in buildings continues to increase over the next decade, the design and construction community will need to catch up with the aggressive goals of the current and future editions of Standard 90.1 and the IECC. Lessons learned from the real-life application of the more stringent energy codes are also likely to influence future code editions.

Integration of building science. Tighter buildings pose greater risks of condensation and associated

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AchieveGreen – Online Resource for Green Building Teams

The Vinyl Institute has launched an update to AchieveGreen (http://achievegreen.net/), an online resource where design and construction professionals can gather information and gain ideas about the benefits of using vinyl products in their building projects.

The website provides a LEED Green Building Checklist, a downloadable design management tool for projects using the Green Building Initiative's Green Globes rating system, ANSI Standard 1, and LEED for New Construction. The matrix provides links to product manufacturers' websites where data can be obtained on how PVC/vinyl products that are part of building construction systems can contribute to green rating system credits.

Another component, AchieveGreen Reference Tools, provides quick links to green building resources, including NSF Sustainable Product Standards, ASTM International, CSI GreenFormat, and Vinyl in Design.

Case studies demonstrate the proven value of PVC/vinyl products in successful building projects, among them:

- How 200,000 square feet of vinyl graphics for the 2010 Vancouver Olympics has been diverted from landfill and remanufactured into high-recycled content flooring.
- How Turner Construction and Silktown Roofing, Inc., were able to integrate a sloping reflective membrane cool roof with tubular photovoltaic modules that generate 98 kW of solar energy for an elementary school in Greenwich, Conn.
- How C&H Fire Suppression Systems used CPVC pipe to retrofit two assisted-living high-rises with fire sprinkler systems, with minimal disruption to the tenants.
- How the historic 93-year-old Fern Hill Elementary School in Tacoma, Wash., was retrofitted with 100% post-consumer vinyl-backed carpet. A buy-back program will give the school district financial incentives when it returns the carpet for recycling in the future. Students and school representatives traveled to the manufacturer's plant in Dalton, Ga., to witness firsthand how the carpet from their old building was recycled into new product.

For more on AchieveGreen, visit http://achievegreen.net/.

COURTESY MANNINGTON COMMERCIAL

Following the 2010 Vancouver Olympics, Mannington Commercial took 200,000 square feet of vinyl graphic materials by 3M Canada (as shown in photo at left), diverted it from landfill, reprocessed the waste material at its Georgia production facility (center), and recycled it into commercial flooring material that was later installed in a school (right). More such case studies can be found at http://achievegreen.net/.

damaging effects on building materials and indoor air quality, including those associated with radon. Without further study and developments that transfer, to the construction site, the results of scientific and theoretical knowledge of air infiltration materials and techniques, vapor barriers, and insulation selection and installation, significant opportunities for building failure can be created. The need to further integrate building science into the codes and construction practices is already recognized in high-performance buildings, particularly those looking to meet net-zero energy and above-code-minimum levels of performance. In existing buildings, control of moisture flow presents even greater challenges.

It is anticipated that over the next decade, as envelopes continue to tighten to meet ambitious improvement goals of governments at all levels, building science associated with energy performance will more consistently become part of the national model code framework. One example is a study being undertaken by the Preservation League of New York State, supported by the New York State Energy Research and Development Authority and Department of State. This study, using computer modeling to evaluate the wetting and drying of wall and ceiling assemblies as a function of insulation type and thickness, to be followed by installation and monitoring of selected materials, may bring forth important findings that could become the basis of future proposed code changes.

Construction quality and durability. While codes have been slow to progress in their regulation of construction quality and durability, this too has begun to change. For example, in the 2007/2009 ICC Final Action Hearings, the flexible use of permeable vapor retarders entered the International Building Code and International Residential Code. Backed by technical studies, this proposed code change recognized the importance of allowing building assemblies to dry naturally, rather than trapping bulk moisture within cavities. Because the technical understanding of the impact of vapor retarders is not universally understood, it will likely take at least a full code cycle for code users to become fully aware of the benefit of this change.

Code compliance is measured at construction start and completion, when theoretically a building will perform at its optimum. The effects of imperfect construction quality and the possible application of inappropriate or incompatible materials and details are not addressed, and an inferior or poorly applied sealant installed shortly before a blower door test, for example, can test adequately but immediately begin to deteriorate due to incompatibility with mortar or other factors associated with selection or installation. While there is no shortage of reference standards and manufacturers' recommendations to guide proper use and application, it is rare for such detailed directions to be fully transported to the construction site.

Although not explicitly stated in the code, approaches focused on enhanced construction quality have been introduced for residential buildings and are likely to be followed for commercial buildings. Chapter 4 of the IECC identifies 17 separate conditions required for proper installation of insulation and for sealing the building envelope and permits the use of ACH 50 testing as an alternate to these tabular requirements. As a result, a poorly constructed or insulated building should not be judged to be in compliance.

WHO IS RESPONSIBLE FOR ENERGY EFFICIENCY?

Energy-efficiency practices have moved from the 1970s' architects, engineers, and contractors who embraced the first generation of efficient construction, to the 171,271 LEED Accredited Professionals (as of September 2011) and those within the construction industry with certification from the Building Performance Institute. BPI, a U.S. organization involved with certifying individuals and companies associated with energy-efficient, home performance contracting, is deeply involved with energy audits and testing services associated with Energy Star and other high-performance programs. The trades involved with larger commercial construction have no counterpart that is as widely recognized.

For the great majority of new and reconstructed buildings, reaching the minimum standard prescribed by codes remains a challenge for all the actors in the design and construction industry. The newest energy codes required design professionals to explicitly state that the energy code provisions have been met. Compliance studies undertaken to establish baselines for ongoing ARRA-compliance evaluations have established that there is much to be learned by the design and construction industry to translate energy goals into practice, and to better align theoretical buildings (at time of permit) with actual performance. Involvement by design professionals during construction varies from those with minimal or no engagement during construction administration to those with a deep involvement.

Because the design professional's role is to ensure that the intent of the contract documents is met—and since code officials have a specified and minimal role in inspection—the day-to-day tasks of implementation belong to the trades, contractors, and construction managers. Except for high-performance buildings most likely to receive a high degree of oversight during the construction process, in the myriad of coordination tasks associated with large-scale construction, a focus on the important construction details related to energy efficiency is too often lost. Furthermore, the ability of facility managers to operate systems as efficiently as intended is often limited by factors such as the complexity of systems, the lack of proper commissioning, and training and staffing limitations.

Those responsible for construction and regulation also have much to learn. The adoption of more stringent codes, as encouraged by ARRA, has shone the light on code officials. These individuals have tremendous responsibility for fire and life safety, but are typically under-resourced and often lacking in high-level technical training. The combined demands of workloads and needed technical expertise, coupled with the increase in measurable performance of buildings, may move many of the code officials' traditional energy inspection functions to third-party involvement. (In New York State, this option is at the discretion of individual municipalities.) As the role of the "code expeditor" evolved in large cities such as New York to assist with the labyrinth of required permits, and as specialized sprinkler and elevator inspections became part of the overall inspection process, so too will the energy-inspecting world expand the need for those with specific energy experience.

PLACING VALUE ON DURABILITY AND LONG-TERM PERFORMANCE

Long-term performance requires fundamental improvements along the entire design and construction chain. Design professionals must be more diligent in the selection and detailing of materials, better schooled in the codes and building science, and eager to push the integration of the disciplines of architecture and engineering. Owners and construction managers must respect the criticality of technical selections, not accept substitutions of lesser value, and expect and require a consistent level of detail of field installations.

Buildings are used very differently today than in decades past. One primary reason is society's heightened expectation of comfort: How many buildings today are not air-conditioned? As energy costs have soared, in the evolution of building construction, wall and ceiling cavities, historically empty and breathable, have become fully insulated and the envelope sealed. The combination of space cooling and reduced natural breathability effectively changes a structure's moisture profile. In order to avoid long-term degradation, design professionals and code promulgators must further the integration of building science into energy and building codes.

Perhaps the largest issue returns to the value society places on durability, in particular building owners and others who typically using tax depreciation cycles and length of intended ownership to set a standard of performance. In a throwaway society, the challenge of transitioning to a long-term view, facilitated by the integration of life cycle costing applied to building construction and maintenance, cannot be understated. +

7. When Modern Becomes Historic: Preserving the Modernist Building Envelope

By Bradley T. Carmichael, PE

Bradley T. Carmichael, PE, project engineer, develops restoration and rehabilitation solutions for the building envelope at Hoffmann Architects, Hamden, Conn. He has specific experience in the materials, technologies, and building styles of Modern architecture.

A radical break from the architectural modes of the past, the Modern movement resulted in a half-century of bold new ideals, manifestos, and international collaborations. Beyond allegiance to a fixed architectural style, Modernism aimed to achieve purity of design by applying order, logic, reason, economics, and new technologies to a bold reimagination of space that is both organic and purposeful.

Shortly after the Modern movement began in the early 20th century, the field of historic preservation also started to emerge. In 1931, at the same time that Le Corbusier was drafting *The Radiant City* and Walter Gropius was leading the Bauhaus school, the First International Congress of Architects and Technicians of Historic Monuments adopted "The Athens Charter for the Restoration of Historic Monuments," the founding set of formally adopted international principles in the field of historic preservation.

As contemporaries, Modernism and historic preservation make for strange bedfellows. In one sense, they are at cross-purposes, the one seeking to transcend tradition, the other looking to hold on to the past. As Modernist buildings age, however, the two fields of necessity must draw closer together. To protect significant Modern structures from oblivion, Building Teams and building owners of today are faced with the paradoxical task of applying historic preservation principles to self-proclaimed ahistorical architecture.

Learning Objectives

Based on the information presented in this chapter, you should be able to:

1. Identify common threats to Modern buildings - thermal shrinkage, freeze-thaw cycling, water infiltration - and explain how changes in stylistic perception or program requirements can place Modern structures at risk.
2. Establish an appropriate scope for preservation of a Modern structure based on principles consistent with historic preservation standards, the values of the Modern movement, and life cycle assessment (LCA) as a key component of sustainability.
3. Evaluate repair and replacement options for aging glass curtain walls and for the restoration of exposed concrete façades to enable the preservation and reuse of existing facilities.
4. Implement energy upgrades for Modern building envelopes that balance preservation with energy conservation.

IDENTIFYING THREATS TO MODERN BUILDINGS

Changes in program. Modern architecture tended to envision the building as a machine or tool, drawing inspiration from the forms of grain elevators, steamships, and automobiles. Yet just as it is difficult to imagine using

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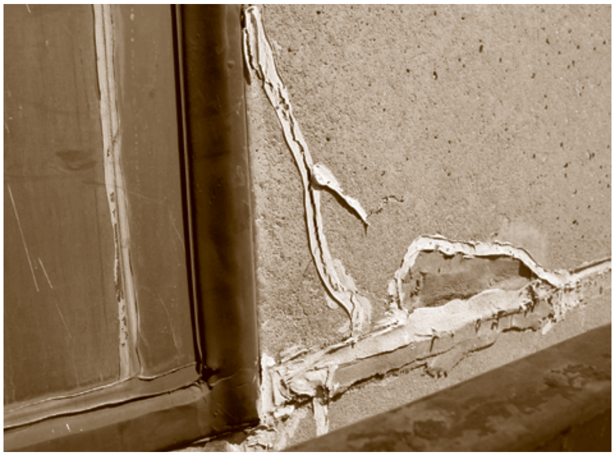
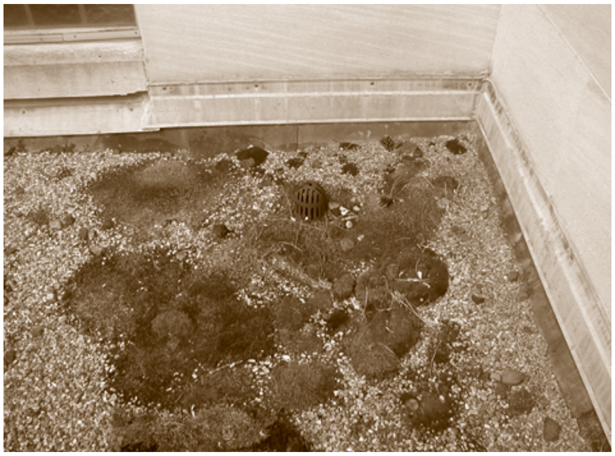


An inappropriate crack repair using surface-applied sealant. Many Modernist buildings used materials and construction techniques that are susceptible to long-term degradation due to corrosion, rot, mold, and ultraviolet radiation.



COURTESY HOFFMANN ARCHITECTS

Organic growth and debris on the built-up roof of a Modernist structure. The materials and techniques of Modern architecture allowed for rapid and prolific construction, which resulted in a historically unprecedented volume of new structures during this period.

antiquated machines in any sense beyond novelty, it is hard to conceive of the unassisted endurance of Modern buildings once they cease to meet the functions for which they were designed. Le Corbusier may have been eerily prophetic when he argued that "it is not right … that we should waste our energy, our health and our courage because of a bad tool; it must be thrown away and replaced" (*Towards a New Architecture*, 1931). Without protection of aging Modern buildings, this may prove to be the case.

Adaptive reuse of a building or district can be effective as a partner in conservation. New York's Cast Iron District in SoHo, an early example of adaptive reuse, evolved from a rundown industrial wasteland to a hub of artistic activity thanks to the outcries of preservationists. However, voluntary adaptive reuse is subject to the current postmodern zeitgeist, or "spirit of the age," and may fall into disfavor as styles and attitudes change. Without preservation ordinances that apply to Modern buildings, the impetus to repurpose existing structures is left to the whims of the moment.

Changes in stylistic perception. A major threat faced by buildings of any era is the perception of their style in the period that follows. Although today we view the cast iron façades of SoHo as cherished architectural landmarks, many people living a generation after their construction viewed the buildings with such disregard that they proposed razing them to build a highway. The transitory stage between "fresh and contemporary" and "vintage classic" is simply "out of date." The perceptions of one time period with respect to the previous one are often reactionary and, to some extent, negative.

In this sense, the Modern movement did itself few favors. Given Modernism's radical break from the artistic styles that preceded it, it is not surprising that, having called into question our perceptions of historical value, Modern buildings have rendered their own endurance uncertain.

Natural forces. One benefit of pre-Modern construction is that the materials, such as brick and stone, tend to be durable enough to last for centuries. In contrast, buildings constructed in the mid- to late-20th century commonly used materials and construction techniques that are inherently susceptible to long-term degradation due to corrosion, rot, mold, and UV radiation.

Redundancy in construction, such as multi-wythe bearing walls and massive pillars and columns, affords older buildings greater resiliency than their Modern counterparts. As developments in material technology and construction methods permitted ever shorter construction schedules, the ability of the final product to withstand decades of exposure to the elements was often compromised in service to expediency.

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Reinforcement corrosion and spalls in *béton brut* ("raw" concrete), an aesthetic feature commonly used by architects of the Brutalist tradition, among them Paul Rudolph. His Art + Architecture Building at Yale University recently underwent a major renovation.

Vertical crack in a glazed brick façade. A major characteristic of Modern buildings was the shift from façades with thick, massive walls and proportionally few windows to slimmer wall construction and more widespread use of glass.

CHALLENGES IN ESTABLISHING PRIORITIES FOR PRESERVATION

In *The New Era* (1930), Mies van der Rohe argued that the industrialization of the Modern age would progress blindly, “irrespective of our ‘yes’ or ‘no,’” unless new values guided its development. He acknowledged that the conditions surrounding Modern architecture have inertia of their own and would stumble ahead aimlessly unless directed by these new standards. For the buildings of Mies’s era, no longer new, conservationists and regulating bodies face the challenge of establishing preservation directives specific to Modern buildings, lest their fate likewise be left to its own blind momentum.

Selecting Modern buildings for landmark or historic designation poses new challenges, as the number of buildings far exceeds that of earlier architectural periods. The materials and techniques of Modern architecture allowed for rapid and prolific construction, which not only helped achieve the social ideals of the movement, but also resulted in a historically unprecedented volume of new structures. To give a sense of scale to this, consider that there are approximately 300 surviving works by Frank Lloyd Wright alone. With many Modernist structures now reaching the age threshold for protection by historic and landmark commissions, the number of buildings and sites classified as Modern that are listed on the National Register of Historic Places is approaching 600—and counting. Still more are listed on state and local registries.

The challenge, then, is sorting through the scores of Modern buildings and selecting works of sufficient value for conservation. One independent organization, Docomomo International (DOcumentation and COnservation of buildings, sites and neighborhoods of the MOdern MOvement: www.docomomo.com), has undertaken the task of establishing criteria specific to the Modern movement. Unlike traditional standards for preservation, which emphasize building age, historic events, and noteworthy people, Docomomo’s criteria for Modern buildings recognize technological merit, social import, artistic and aesthetic merit, canonic merit, referential value, and integrity. Docomomo and similar organizations strive to align selection criteria with the movement behind the buildings’ genesis.

DECISION MAKING: ESTABLISHING AN APPROPRIATE PRESERVATION SCOPE

With the increasing number of Modern buildings protected by landmark registries and watchdog groups, the community has begun to acknowledge the value of these structures—and their fragility. While designation by a historic commission can protect a Modern building from the threats of egregious mistreatment or demolition, landmark status does little to safeguard against the more insidious forces of time, weather, and inept repairs.

The authoritative guide for remedial work in a historical context is the Secretary of the Interior’s *Standards for the Treatment of Historic Properties* (1995), which provides guidelines for historic building preservation, rehabilitation, restoration, and reconstruction. *Standards* recommends selecting an appropriate scope of treatment based on four considerations: 1) relative importance in history, 2) physical condition, 3) proposed use, and 4) mandated code requirements.

As noted by Theodore H.M. Proudon, FAIA, in *Preservation of Modern Architecture* (2008), these standards, which were developed for pre-Modern historic buildings, center on preserving aesthetic value and historic fabric. For Modern structures, where the source of the building’s value may be only tangentially related to particular materials or construction methods, the traditional emphasis on historic accuracy in preservation may not necessarily be appropriate.

For instance, consider what is lost when we compromise function and efficiency for the sake of historical correctness in a building significant primarily for its function and efficiency. If a building’s import rests more on its social impact than on the historic fabric of its curtain wall, rigid adherence to the use of original materials in conservation may miss the point of what is being preserved.

TECHNICAL CHALLENGES TO PRESERVING MODERN BUILDINGS

Aging glazed curtain walls: Repair or replace? As curtain walls age, exposure to ultraviolet radiation degrades gaskets and seals, allowing water to enter the wall. Fatigue due to cyclic loading may also cause seals to wear and fail. The resultant leaks not only damage interior finishes; they can lead to moisture-related deterioration

Hazardous Materials in Modern Buildings

One major challenge in the treatment of buildings constructed in the Modern era is the presence of hazardous materials. Asbestos, polychlorinated biphenyls (PCBs), and lead-based paints were commonly used in construction materials during the mid-20th century. Because abatement is a delicate, complicated, potentially disruptive, and often expensive task, it needs to be carefully weighed into the preservation decision-making process. Before selecting a treatment strategy, consider how the potential presence of toxic chemicals in older building materials may impact the scope and cost of planned work.

CONTINUING EDUCATION AIA

within the wall assembly. Older curtain walls also tend to have poor insulating properties, which can lead to condensation and fogging at interior glazing surfaces and frames.

Additionally, some earlier curtain walls were constructed with carbon steel components rather than aluminum, bronze, or stainless steel, which can lead to corrosion and additional damage over the course of the curtain wall's life cycle.

Stick-built and field-assembled, most Modern era glass-and-metal curtain walls were constructed using components and framing profiles that are no longer available today, requiring custom fabrication of replacement parts. The cost of custom framing and glass can be considerable and may render the option of small-scale and partial replacement of a deteriorated curtain wall infeasible.

Standards for curtain wall construction have also evolved since they were first popularized in the mid-20th century. For example, early curtain wall anchors lacked the locking washers that are commonplace today. As the building vibrates in response to wind and seismic forces, anchor nuts can back off over time, leading to unstable curtain wall assemblies. Newer structures were built with this tendency in mind, but for many mid-20th-century buildings, anchorage failure has become a major rehabilitation concern.

The two available treatment options are to repair the aging curtain wall system in place, or to replace it. Repair has the advantage, generally speaking, of being less expensive, and it leaves the majority of the historic fabric intact. However, while repair methods may resolve some issues, such as water and air infiltration or anchorage failure, they are less successful at addressing other problems like condensation or poor energy performance.

Repairs often rely heavily on field-applied waterproofing sealants to provide a moisture barrier. To be successful, this strategy requires a high level of consistency in workmanship. In reality, sealants are applied in the field under varied conditions, often from unsteady platforms and suspended scaffolds.

Gasket replacement may be possible for some systems, but not all. Field-applied restoration to finishes is also a possibility, but in the past it has a limited track record for durability and long-term success. Consider, too, that while a repaired curtain wall system may meet structural requirements of the codes in effect at the time of construction, new codes are likely to be more stringent. Landmarked or registered historic buildings may be exempt from meeting updated codes, but their owners may not wish to take a chance on a curtain wall that may be less structurally stable than its newer counterparts.

Replacement can address many of these concerns,

The Art + Architecture Building at Yale University. A prior renovation covered architect Paul Rudolph's light wells with a single flat roof. Such misguided "improvements" can destroy both the functionality and aesthetics of Modern-era buildings, many of which are beginning to cross the half-century mark.

COURTESY HOFFMANN ARCHITECTS

Restoration recreated the original aesthetic, admitting natural light while resolving leaks and improving thermal performance. Appropriate guidelines are needed to synthesize accepted preservation practices with long-term restoration options that maintain the values of the Modern movement.

including structural integrity and energy efficiency. Although often more expensive than repairing existing systems, curtain wall replacement can incorporate rain-screen principles, managing incidental moisture without relying on an absolute water barrier. Add to this the higher performance of newer factory-applied finishes, and replacement systems offer decreased reliance on field workmanship—and less chance of human error.

Where curtain wall replacement falls short is in the area of historic accuracy. Building codes and structural considerations for wind resistance and loading, among other factors, may preclude an exact replica of the original design. Frame profiles and materials have changed considerably over the past few decades, so it may not be possible to match the existing system without costly custom fabrication. For instance, many early curtain walls used steel frames, whereas most curtain walls of today are manufactured from aluminum.

By and large, Modern buildings were built with little regard for energy conservation. ... Improving their energy profile can be difficult to reconcile with historic accuracy.

The decision to repair or replace an ailing glazed curtain wall is a complicated one, and each building and situation is different. Given the availability of materials, the condition of the existing curtain wall, the history and extent of water infiltration problems, the structural integrity of the curtain wall assembly, and the rehabilitation budget, owners and their Building Teams must weigh the options and determine what best meets program requirements and preservation objectives.

Restoring exposed concrete façades. Counterpointing the airy steel-and-glass curtain walls of International Style and Mid-Century Modern architecture, Brutalist architects used exposed "raw" concrete, *béton brut,* as an aesthetic feature. Reinforced concrete is a durable material, but it does deteriorate after prolonged exposure to weather. Common causes of concrete cracking include:

- Curing shrinkage
- Thermal shrinkage
- Movement or restrained movement
- Settlement
- Freeze-thaw cycling
- Change in applied loads

Once cracks begin to form in the concrete surface, water is able to penetrate to embedded reinforcing steel, causing it to corrode. As the steel expands, it exerts pressure on the surrounding concrete, and pieces break away, or spall, admitting more water and perpetuating the cycle of deterioration.

Exposed concrete elements can usually be repaired in place at manageable costs, provided a seamless blend with the surrounding facade is not required. When an exact match of the color, texture, and finish of existing concrete is necessary, repairs become more expensive, due to the additional tests, mockups, and samples needed to achieve a precise likeness. In some situations, as when the surrounding concrete is variegated or mottled, a noticeable repair area is difficult to avoid.

Surface treatments, such as penetrating sealers, anti-carbonation coatings, and migrating corrosion inhibitors, may be applied to protect the concrete from further deterioration. However, surface treatments create an ongoing maintenance demand, as coatings must be periodically reapplied. Sealers and coatings can also give concrete a sheen or gloss, which may be undesirable from an aesthetic standpoint.

Epoxy injection into cracks is an effective treatment, but the repair is unlikely to blend in with surrounding concrete. Patching mortars are another crack repair option, although matching the color and finish of the original surface can be difficult. Some Modern buildings used exposed aggregate as a decorative element, which requires any patching efforts to carefully select and place matching aggregate in repair areas.

Restoration can also take the form of a repair overlay or veneer, which permits exposure and treatment of underlying reinforcing steel and recovering with concrete to an appropriate depth. Poor construction practices at many Modern buildings led to shallow concrete coverage over reinforcement, which left embedded steel susceptible to corrosion. Surface restoration allows this defect to be addressed while leaving the bulk of existing concrete intact. The challenge, however, is to develop a concrete mix that holds up well as a thin overlay, matches the color and texture of existing concrete, and handles manageably in what can be demanding field conditions.

ENVIRONMENTAL CHALLENGES TO PRESERVING MODERN BUILDINGS

By and large, Modern buildings were built with little regard for energy conservation. Though structures with historic designations are often exempt from compliance with energy codes, thermal performance is still an important practical consideration. Rising energy costs and increasing awareness of the environmental impact of building energy use have made efficiency a rehabilitation priority for most building owners. However, characteristics inherent to the construction styles and materials of Modern architecture can mean that

COURTESY HOFFMANN ARCHITECTS

An integral part of the balance of light and mass in many Modernist buildings, skylights are also notorious for leaks, condensation, and poor energy performance. Modernist buildings face a unique threat in that Modernism's break with the artistic styles that preceded it have called into question current perceptions of the historical value of these structures. "The perceptions of one time period with respect to the previous one are often reactionary and, to some extent, negative," according to Bradley T. Carmichael, PE.

improving a building's energy profile can be difficult to reconcile with historic accuracy in preservation.

Façades. One characteristic of Modern architecture is the shift from façades with thick, massive walls and proportionally few windows to slimmer wall construction and more widespread use of glass. What comes with this change is decreased reliance on the mass of the wall to separate interior and exterior environments, and increased dependence on insulation and mechanical systems.

Modernist steel and glass curtain walls are generally thin and uninsulated, and they tend to cover large areas of the façade. Heat travels freely across these thermally conductive walls, and the building must consume excessive amounts of energy as heating and air-conditioning systems struggle to regulate temperatures.

Unfortunately, energy upgrade scenarios for metal and glass curtain walls that do not include full replacement are limited. One option is to retrofit the curtain wall by installing additional panes of glass at the interior, similar to storm windows. However, these can be problematic if not properly designed and installed. Two major considerations for this type of retrofit include the potential for condensation between panes and the additional load the glass may place on the curtain wall system. Moreover, retrofits of this type do not address heat transfer across metal frames.

Opaque walls of Modern buildings vary greatly in materials and type of construction. What they do tend to have in common is their low insulating properties. Modern cavity walls are generally uninsulated, and exposed concrete façades provide little resistance to heat loss. Adding insulation to these existing wall assemblies can often be difficult, unless undertaken in conjunction with a larger renovation such as an interior fitout that exposes a portion of the wall assembly for the addition of insulation. If there is some cavity space in the exterior wall assembly, such as a stud cavity, Building Teams have had success adding insulation by opening portholes at the top of the cavities on the interior side and filling the cavity space with blown-in insulation. Care must be taken when pursuing strategies that change the thermal properties of an existing wall to ensure that the new insulation does not adversely affect the existing wall's ability to manage moisture, as an insulation retrofit may change how and where condensation occurs within the wall, the extent and frequency of freeze-thaw cycles in the wall assembly materials, as well as the rate at which the wall will dry out if it does get wet.

Roofs. The widespread use of flat roofs in Modern architecture eliminated the environmental separation afforded by pitched roof attics of earlier architectural periods. Moreover, Modern flat roofs often don't have much space below the deck in which to place insulation. Even where such a retrofit is possible, the added insulation must be correctly designed and installed to prevent condensation problems. Before proceeding, evaluate potential energy savings using the overall R-value of the entire roof assembly inclusive of structural components, rather than the R-value listed for the insulation alone. Where possible, installation of roof insulation continuously above the roof deck, rather than at the underside of the deck, is often preferred. When adding insulation above a roof deck to improve energy performance, consider first the increased depth of the roof assembly. Thorough evaluation is necessary to see that integration with adjacent components will not be adversely affected. At terraces, where the height of adjacent sills, parapets, and railings may preclude a change in deck height, this calculation is of particular importance.

REDEFINING THE TREATMENT OF HISTORIC BUILDINGS

For Modern buildings, in which many of the original construction materials are now reaching the end of their usable life, the common wisdom for historic preservation needs to be reconsidered. Even when the option to repair the historic fabric is available, the appropriate solution may be to preserve Modernism's ideals by not preserving the original envelope. Building materials and construction styles used in Modern structures are generally not as durable as those of the pre-Modern period; few have a demonstrated service life beyond 50 years. Planning for long-term preservation and employing techniques that meet functional and aesthetic requirements is essential as these structures cross the half-century mark.

Further work is required in order to establish preservation standards that are appropriate for the treatment of Modern buildings. Such guidelines should synthesize accepted historic preservation practices with long-term restoration options that maintain the values of the Modern movement. Reevaluation of the treatment of Modern buildings may foster a fundamental change in how we address significant architecture built less and less far back into history. In a sense, a reevaluation of preservation norms could serve not only the concepts of the Modern era, but those of the postmodern era as well. +

> EDITOR'S NOTE

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1. People in one time period are likely to view the buildings of the previous period as:
   - A. Fresh and contemporary
   - B. Historically important
   - C. Dated
   - D. Decrepit
2. Adaptive reuse of a building or district can be:
   - A. Environmentally destructive
   - B. An effective approach to conservation
   - C. Against the principles of Modernism
   - D. Eerily prophetic
3. Selecting Modern buildings for landmark or historic designation poses challenges. Why?
   - A. Rapid construction in the Modern period led to an unprecedented volume of structures.
   - B. Traditional standards for preservation may not be appropriate for Modern buildings.
   - C. The community may perceive Modern buildings as outdated rather than historically important.
   - D. All of the above.
4. True or False: Changes in manufacturing and construction may mean that standard replacement parts for a Modern curtain wall are no longer available.
   - A. True
   - B. False
5. What is the concern about applying the Secretary of the Interior's Standards for the Treatment of Historic Properties to Modern buildings?
   - A. The emphasis on historic accuracy in preservation may not be appropriate to Modern structures.
   - B. The standards are obsolete.
   - C. Modern buildings are not as historically important as are buildings from other periods.
   - D. The standards focus on function and efficiency, whereas Modernism emphasized ornament and flourish.
6. Modern buildings commonly used materials and construction techniques that are:
   - A. Inherently susceptible to long-term degradation
   - B. More resilient than pre-Modern construction
   - C. Inefficient and time-consuming to assemble
   - D. Durable enough to last for centuries
7. Which of the following is NOT true of curtain wall replacement?
   - A. It can incorporate rainscreen principles.
   - B. It offers improved thermal performance.
   - C. It provides better historic accuracy than does repair.
   - D. It meets current codes and standards.
8. Concrete cracking can be caused by all of the following EXCEPT:
   - A. Curing shrinkage
   - B. Freeze-thaw cycling
   - C. Change in applied loads
   - D. Hermetic seal failure
9. Thin concrete coverage over reinforcement can be addressed by:
   - A. Exposing and treating the embedded steel rebar, then applying a concrete overlay.
   - B. Applying a consolidant to the surface.
   - C. Injecting epoxy through the concrete and down to the embedded reinforcement.
   - D. Replacing sealant at adjacent joints, openings, and terminations.
10. Modern architecture's shift from façades with massive walls and few windows to slimmer wall construction and larger areas of glass improved energy performance and insulating properties.
    - A. True
    - B. False

8. High-Performance Reconstruction and Historic Preservation: Conflict and Opportunity

By Jean Carroon, FAIA, LEED AP

Jean Carroon is a Principal at Goody Clancy, a design firm with offices in Boston and Washington, D.C. She is the author of *Sustainable Preservation: Greening Existing Buildings* (John W. Wiley & Sons, 2010) and 2012 Chair of the AIA Historic Resources Committee.

There is no denying that conflicts exist when striving for high-performance reconstruction in historic buildings. This is not to say that one precludes the other, but rather that the combination creates new layers of complexity. In the extreme view, each camp perceives the other as single-issue voters unwilling to recognize the actions required for social, economic, and environmental sustainability.

On the one hand, critics of high-performance reconstruction or deep-energy retrofits caution that a hyperfocus on operational consumption misses the forest for the trees. The cumulative environmental damage of new products—raw resource extraction, manufacturing, transportation, construction, and end-of-life disposal—used to achieve high performance may never be offset by lowered operational energy. Alterations may also cause long-term damage to historic buildings, create shorter cycles of material life, and have adverse impacts on occupant health.

On the other hand, critics of historic preservation contend that preservation standards focus too narrowly on visual integrity, freezing buildings into tidy idealized images of the past and undervaluing the urgency of energy- and water-use reduction. Windows are lightning rods for strong opinions about how historic buildings should be treated. Many believe that window replacement in historic buildings is essential to reduce energy consumption and that, by disputing this, historic preservationists undermine high performance and incorrectly place aesthetics above environmental sustainability.

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The Welcome & Admissions Center at Roger H. Perry Hall at Champlain College, Burlington, Vt., was certified LEED Platinum in 2011. The renovation and addition to the 150-year-old building restored the historic windows and added interior storm windows to achieve an overall value of R-20 with an air infiltration 60% better than code.

These simplified viewpoints are muddied by a shared problem—the relative valuations inherent in the current economic system, which are based on an incomplete assessment of costs for materials, water, and energy. The true prices of these and other building-related components generally do not include so-called "externalities," such as environmental damage, toxicity, and health impacts incurred along the life cycle.

Using a market system that relies on an incomplete assessment of costs encourages the replacement of worn-out materials with less expensive but also less durable products. For example, a slate roof might be replaced with artificial slates or asphalt shingles; terrazzo floors might be replaced with sheet goods. An incomplete assessment of costs discourages the use of new, perhaps more expensive technologies to conserve underpriced water and energy because basing critical decisions primarily on first costs makes the payback unacceptably long. Reduction in energy bills does not usually justify installation of photovoltaics because it takes decades to recover the investment. Life cycle costing is meaningless in judging sustainability when environmental and social externalities are excluded from the analysis. Basing critical decisions about historic buildings purely on an incomplete assessment of economic factors undermines both historic preservation and high-performance reconstruction by encouraging short-term solutions.

Because the two camps are both victims of an economic system that is destructive to the environment and to older and historic buildings, there is an opportunity for a new dialogue between them that shatters entrenched attitudes and advocates for carbon-based costing. To explore this, we must first define the inherent conflicts.

ENERGY VERSUS AESTHETICS: OPENING UP THE DIALOGUE

Although high-performance buildings are not just about energy consumption—just as historic preservation is not simply about appearance—energy and aesthetic issues do provide a framework for comparing proponents' philosophies. The resulting dialogue will, I hope, generate even larger questions about how we define and progress toward a sustainable world.

A common misconception is that historic buildings are energy hogs; this is contrary to the facts. A systematic tracking of the energy use intensity (EUI) of all commercial buildings in the U.S. and Canada finds that those constructed before 1920 actually have a lower EUI than those in any other decade until the 21st century.[1] This is further supported by data from the U.S. General Services Administration, the Architect of the Capitol, and the United Kingdom's Ministry of Justice, which all report that the oldest buildings in their portfolios use the least energy per square unit.[2]

Nor is this the whole picture, because EUI ignores the amount of physical space provided for an activity. That same study of 256 court buildings in the United Kingdom found that while the historic and modern courts had identical EUI, the modern facilities used 68% more energy per courtroom to "provide the identical function of justice" because the new courts are so much larger.

Energy use intensity, when used as a solitary value, is a flawed metric, but reducing energy use and shifting to less-polluting energy sources is an essential goal in environmental stewardship. Strategies for doing so in historic buildings are similar to any design effort and use synergies that offer multiple benefits. Sometimes this means reestablishing linkages. For instance, if the original landscape provided important solar shading but the trees died, were pruned, or simply failed to flourish, spiking cooling loads need to be addressed as part of an integrated design and not just as an undersized mechanical system. Sometimes it means creating new linkages. A new green (vegetated) roof can lower the air temperature at intake valves and reduce heat island effect, which combined with efficient lighting and interior and exterior shading will lower cooling loads.

External design strategies which improve building performance are often the most contentious issues in the adaptive reuse of historic buildings. Visible elements such as green roofs, solar collectors, photovoltaic systems, and nontraditional shading devices are generally discouraged. Review relies on the interpretation of the Secretary of the Interior's *Standards for the Treatment of Historic Properties with Guidelines for Preserving, Rehabilitating, Restoring & Reconstructing Historic Buildings*, the first version of which was released by the National Park Service in 1978. The current publication was codified in 1995 and applies to all historic properties.

The *Standards* are neither technical nor prescriptive, but are intended to promote responsible preservation practices that help protect the nation's irreplaceable cultural resources. It is the subjective interpretation of

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Green vegetated roof installation at the John W. McCormack Post Office and Courthouse in Boston is appropriate for a historic building because it is not visible from the street. The LEED Gold renovation uses 20% less energy and houses 10% more federal workers.

the *Standards* that determines when "visual impact" is unacceptable. The published technical briefs issued by the National Park Service illustrate the thesis that modern technology should not be visible on the building's primary façades or roof line. Following the lead of the NPS, the theme is widely promulgated in materials and guidelines at the local and state levels as well.

Is "visual impact" really what we should be squabbling about? The National Historic Preservation Act of 1966 (NHPA) was intended to create leadership in the federal government to act as "an agent of thoughtful change, and a responsible steward for future generations."[3] A central premise of all historic preservation is "reversibility," which favors changes that can easily be undone. The very concept acknowledges that future generations may "reverse" current actions. Safeguarding the physical fabric of historic buildings, while facilitating change that allows historic buildings to be viable and vibrant, is a more responsible approach in the face of urgent environmental issues. Visible green roofs, shading, and solar technology installed carefully to do minimal harm give a positive and practical message about the past, present, and future.

Negotiating the installation of green roofs or the placement of solar panels creates a gentle breeze compared to the tropical storm spawned whenever "energy" and

1 National Round Table on the Environment and the Economy and Sustainable Development Technology Canada 2009, Figure 7, Geared for Change, Energy Efficiency in Canada's Commercial Building Sector, www.nrtee-trnee.ca, www.sdtc.ca; and U.S. Energy Information Agency, "Consumption of Gross Energy Intensity for Sum of Major Fuels for Non-Mall Buildings" (2003).

2 Office of Business Performance, Public Buildings Service (GSA), "Financing Historic Federal Buildings; An Analysis of Current Practice" (May 1999); communication from the Architect of the Capitol to the author, 18 June 2008; "Age Energy Research; A Study of the Energy Usage of Buildings Relative to Their Age," Jon Wallsgrove, HMCS Estates Ministry of Justice (May 2007).

3 Advisory Council of Historic Preservation, http://www.achp.gov/overview.html, accessed 11 February 2012.

RALPH R. THOMPSON

The University of Virginia chose to renovate rather than replace New Cabell Hall in part due to the significant environmental impact of new construction. PVs were ruled out as not being cost-effective.

New Cabell Hall aerial view, n.d., by Ralph R. Thompson, courtesy University of Virginia Visual History Collection (prints07757). Special Collection, University of Virginia Library.

"historic windows" are discussed in the same sentence. Advocating for retention of original windows might seem to be only about aesthetics, but it is also about weighing low-tech against high-tech, existing materials against new, and known toxins against suspected ones. Scrape back the myopic obsession on appearance, and historic preservation is one of the few counterweights to our toxic throwaway culture.

MEASURING THE MAGNITUDE OF TODAY'S THROWAWAY CULTURE

The sheer volume of material use in our economy has caused concern for decades. In 1992, world leaders participating in the Earth Summit declared that "a principal cause of the continued deterioration of the global environment is the steady increase in materials production, consumption, and disposal," to wit:

- In the last 50 years, humans have consumed more resources than in all previous history.
- In the United States, total material consumption increased 57% from 1975 to 2000, to 6.5 billion metric tons.
- From 1975 to 2000, worldwide consumption of raw materials (not including food and fuel) doubled.
- A smaller and smaller percentage of what is being consumed is renewable (e.g., agricultural, fishery, and forestry products), declining from 41% in the U.S. in 1900 to less than 5% by 2000.

Waste is the physical evidence of the heedless way we utilize natural resources. According to the World Resources Institute, "[O]ne-half to three-quarters of annual resource inputs to industrial economies is returned to the environment as wastes within just one year." Paraphrasing the "Living Planet Report," people are turning resources into waste faster than nature can turn waste back into resources. In economic terms, we are no longer living off nature's interest, but drawing down its capital.[4]

Diverting construction waste is a well-established part of all green building metrics, but this distracts from the problem of resource reduction. The U.S. Environmental Protection Agency suggests that we should be asking not how to recycle or reclaim waste materials, but rather these questions: "Is there a way to eliminate this waste completely, to provide these same services with fewer resources and no adverse environmental impacts? Can we do this by substituting something else that does not wear out so fast, can be reused, that can be fully or almost fully recovered and repurposed?"[5]

Buildings are our largest objects. Reusing or repurposing billions of square feet of building stock avoids the heavy environmental impact of new materials and new construction. New construction in the U.S. is estimated to be responsible for nearly 50% of all raw resource consumption. In global terms, the U.S., with less than 5% of the world's population, uses about 15% of all resources consumed on the planet for new construction.[6] The EPA advocates for the 3R's—Reduce, Reuse, Recycle, in that order. The agency also stresses using low-impact and nontoxic materials. That is easier said than done.

PRODUCT EXTERNALITIES – EXAMINING CARBON EMISSIONS AND TOXICITY

New materials and goods are responsible for 42% of the U.S. Greenhouse Gas (GHG) Inventory, as estimated by the EPA.[7] The impacts on human health are harder to quantify, but as material consumption has climbed, so has environmentally harmful output—notably synthetic and persistent organic chemicals, radioactive compounds, and heavy metals.[8]

There is new attention being placed on individual building products to identify more complete life cycle impacts in terms of greenhouse gas emissions and materials used. These efforts are encouraged by the recent creation of the 2030 Challenge for Products to reduce carbon impacts, the Healthy Building Network, and green building metric systems such as the Living Building Challenge, LEED, and Green Globes. Reporting usually takes the form of an Environmental Product Declaration (EPD), with recent explorations into a Health Product Declaration (HPD). The reporting depends upon life cycle assessments, which track products from cradle to grave, a complex proposition at best.

Using life cycle assessment, the Preservation Green Lab, a part of the National Trust for Historic Preservation, evaluated the climate change reductions that might be offered by reusing and retrofitting existing buildings rather than demolishing and replacing them with new construction. After analyzing eight building types in four U.S. climate zones, the report concluded that building reuse almost always offers environmental savings over demolition and new construction. Cautioning that "it can take between 10 and 80 years for a new, energy-efficient building to overcome … the negative climate change impacts that were created during the construction process," the report stresses that the type and quantity of materials matter in both renovation and new construction.[9]

Measuring the carbon impacts of products is one thing, but trying to assess the toxicity created from cradle to grave and during service life is even more difficult. A very small percentage of all known chemicals are tested for human health impacts, and any exploration into materials reveals worrisome concerns about toxins. The sobering 2010 report, "LEED Certification: Where Energy Efficiency Collides with Human Health," warns that even green building systems can do little to ensure hazardous chemicals are kept out of buildings with our current regulatory and review process. "Building materials are

4 World Wildlife Fund, Zoological Society of London, and Global Footprint Network, "Living Planet Report," 2008, at: http://wwf.panda.org/about_our_earth/all_publications/living_planet_report.

5 "Sustainable Materials Management: The Road Ahead," EPA530-R-09-009, June 2009, p. 31, at: http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0CCQQFjAA&url=http%3A%2F%2Fwww.epa.gov%2Fosw%2Finforesources%2Fpubs%2Fvision2.pdf&ei=D3NzT52sOY3mggfa4dBY&usg=AFQjCNGFDxk7UglA2HiA9jC1gnPQ9qEtWQ.

6 USGS Factsheet FS-068-98, "Materials Flow and Sustainability" (June 1998), at: http://greenwood.cr.usgs.gov/pub/fact-sheets/fs-0068-98/fs-0068-98.pdf.

7 "Sustainable Materials Management: The Road Ahead," EPA530-R-09-009, June 2009, p. 8.

8 "Material Flows in the United States: A Physical Accounting of the U.S. Industrial Economy," World Resource Institute, 2008, p. 2, at: http://pdf.wri.org/material_flows_in_the_united_states.pdf.

9 "The Greenest Building: Quantifying the Environmental Value of Building Reuse," Preservation Green Lab, National Trust for Historic Preservation, 2011, p. vi, at: http://www.preservationnation.org/information-center/sustainable-communities/sustainability/green-lab/valuing-building-reuse.html.

PETER VANDERWARKER

Before/after photos of the undercroft space at Trinity Church, Boston, a National Historic Landmark designed by H. H. Richardson. The renovation created program space in the underutilized basement, increasing functionality without having to build a new addition.

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Detail of the intricate restoration work at the John W. McCormack Post Office and Courthouse, in Boston, a 702,000-gsf project completed at a construction cost of $160 million.

known to include many well-recognized toxic substances …. The final building structure comprises thousands of these chemicals."[10]

The historic preservation industry spends a great deal of money and time relocating identified toxic miracle materials from the past—asbestos, lead, PCBs, to name just a few. Many of these can't be eliminated, so they are sent "away" for dilution or, one hopes, true containment. Given that toxic industrial and agricultural chemicals now show up in every body tested anywhere in the world—even in newborn babies[11]—there is no such place as "away." Nor is there much doubt that today's miracle products will once again prove to be tomorrow's prohibited materials. We live in a toxic world in no small part because of building materials, which brings us back to windows.

The environmental and health impacts of new windows are difficult to assess because of the spottiness of life cycle assessment studies, but available reports are consistent in identifying their relatively short life cycle and high embodied energy. Unfortunately, a comprehensive research project at the University of Minnesota Center for Sustainable Building Research reviewing cradle-to-grave life cycle assessment on 150 window variations in North America was halted for lack of funding.[12]

The greenest, healthiest solution might be a less-is-more approach to windows using combinations of refurbishment, new storm windows, film, and shading devices to achieve the greatest energy-use reduction with the least amount of new GHG emissions, environmental degradation, and toxicity. Tools for evaluating existing window performance and their role in the building envelope are becoming more readily available. Infrared thermography, air infiltration testing, and computer modeling all facilitate before-and-after analysis of how building enclosures are functioning.

Existing windows are as diverse as the buildings they reside in. Original construction, physical condition, and the current and potential role of the entire wall system in energy performance vary from project to project. To assume that replacement of windows should be mandatory, or that it is the most environmentally responsible way to achieve high performance, ignores the complexity of life cycle assessment, whole building design, and energy sources. It creates the same kind of line-in-the-sand position that historic preservation establishes with "no visual impact."

WHOLE BUILDING DESIGN – ACHIEVING HIGH PERFORMANCE + HISTORIC PRESERVATION

Can historic buildings meet the criteria of high performance? The answer is yes, of course. The practice of

BEFORE: GOODY CLANCY; AFTER: © ANTON GRASSL / ESTO

A courtroom in the original John W. McCormack building (top) and the reconstruction (above). The 1933 Art Deco federal building, designed by Cram & Ferguson, was the site of many historic judicial decisions on New Deal legislation. In 1972 it was renamed for the former Speaker of the House from Boston. The project won Silver honors In Building Design+Construction's 2011 Reconstruction Awards.

10 "LEED Certification: Where Energy Efficiency Collides with Human Health," Environment and Human Health, Inc., p. 8, at: http://www.ehhi.org/leed/.

11 "Body Burden – The Pollution in Newborns: A benchmark investigation of industrial chemicals, pollutants and pesticides in umbilical cord blood" (executive summary), Environmental Working Group, 2005. At: http://www.ewg.org/reports/bodyburden2/execsumm.php.

12 At: http://www.csbr.umn.edu/research/lca_windows.html.

historic preservation has always been about managing change. It has never denied new requirements for comfort, universal design, life safety, or security, to name but a few. The drive for high-performance buildings is merely one more evolution in balancing multifaceted and complex goals for our built world.

Historic buildings benefit in equal measure to their nonhistoric counterparts from the new technologies that facilitate less resource consumption during operations, including: water-conserving plumbing fixtures; graywater and blackwater reuse systems; mechanical systems that take up less space, use less energy, and improve zone control, such as chilled beams, radiant heating and cooling, variable refrigerant systems, and dedicated demand-controlled outside air and displacement ventilation; alternative sources of energy (or conservation), such as ground-source heat pumps, solar hot water systems, and photovoltaics; control systems, such as Digital Addressable Lighting Interface (DALI), which allow changes through programming rather than relocation; continuous or stepped dimming of lights; LEDs and other lighting improvements; and daylight/occupancy sensors.

PETER VANDERWARKER

Built in 1798, the Massachusetts State House has remained viable and in continuous service through more than two centuries of changing technology and performance criteria. The National Historic Landmark is a testament to the compatability of historic preservation and sustainable design.

Depending on the period, style, and location of construction, historic buildings may have passive design elements that can be enhanced, including building mass and form, daylighting, shading, and ventilation strategies. Integrated design and whole building thinking are essential in achieving the best possible performance in historic buildings, including considering ways to increase occupant density and reduce underutilized space by creating new rooms in attics and basements, limiting storage, and combining service and amenity areas. As more-efficient mechanical, lighting, and control systems are developed, occupant behavior is monitored and modified, and buildings are routinely retro-commissioned, operational energy, one component of high performance, will continue to decline.

STEPPING INTO THE FUTURE: WHAT LEGACY WILL WE LEAVE?

Embracing new performance criteria does not, in and of itself, lessen the heritage value of a site or a building, but it often necessitates changes that over time are taken for granted. Indoor bathrooms have long since replaced the original privies on the historic University of Virginia campus, a UNESCO World Heritage Site. The Massachusetts State House, a National Historic Landmark, remains in active use after more than two centuries despite no longer being heated with wood or lit with candles. Another century from now, what aspect of current historic preservation and high-performance guidelines will be considered quaint or primitive?

Hopefully, our descendents in the 22nd century will be shocked and grieved that we did not automatically design passive strategies in new buildings and celebrate them in the old; that we used materials so wastefully that we routinely "gutted" and demolished functional structures; that we did not address energy- and water-use reduction holistically; that we did not mandate long service life and repairability in our materials and objects; and that our market system did not account for environmental, health, and social degradation.

The great naturalist John Muir once said, "When we try to pick out anything by itself, we find that it is bound fast by a thousand invisible cords that cannot be broken, to everything in the universe."[13] This is exactly the challenge and the opportunity as we reach for "sustainability" in our built world.

Neither "historic preservation" nor "high-performance" advocates have all the answers, but we can learn from each other. Historic preservationists need to seriously rethink what stewardship means. High-performance advocates must look beyond operational consumption issues to more comprehensive solutions and effective metrics. Both camps should unite behind policies that promote long-term sustainability instead of short-term decisions driven by incomplete life cycle costing. Long-term sustainability must never be far from our thoughts, even as we struggle with short-term urgency. We must strive to be worthy ancestors. +

13 Ronald H. Limbaugh and Kirsten E. Lewis, eds., The John Muir Papers, 1858-1957 MICROFORM, (Stockton, Calif.: University of the Pacific , 1980). With accompanying Guide (Alexandria, Va.: Chadwyk Healey, 1986). At: http://www.sierraclub.org/john_muir_exhibit/writings/misquotes.aspx#2.

Imagine an 18-story icon designed by a Pritzker Prize–winning architect, which is also an exemplar of automated mixed-mode ventilation.

Imagine a busy campus located in the middle of a desert, whose integrated photovoltaic panels produce all necessary electricity. Imagine a similar complex, where the kinetic energy of vehicular movement powers administrative spaces.

Imagine a tired mid-century office fortress transformed into a high-performing green building in part by an unprecedented second skin that wraps the original building envelope.

These buildings are not daydreams.

They are being constructed today, by the U.S. General Services Administration.

GSA is one of the largest public real estate organizations in the world. The agency manages a portfolio totaling 362 million square feet of federal workspace.

GSA also is one of its most progressive landlords. The agency installed its first green roof in 1975, and in the last year GSA has assumed a pole position in the green movement.

We call it Zero Environmental Footprint. ZEF has inspired GSA to raise its minimum LEED rating for new construction and major renovation projects to Gold. ZEF launched an initiative to increase acceptance of innovative buildings technologies and practices—and even beta-test new strategies. And ZEF is the reason why GSA has pursued cutting-edge projects like the Morphosis-designed San Francisco Federal Building, land ports of entry in Columbus, New Mexico, and San Ysidro, California, and the Peter W. Rodino Federal Building modernization in Newark.

ZEF is the uncharted territory of blackwater filtration, enthalpy wheels, trombe walls, and more. But it promises buildings that give back more, too. More energy, more clean water, more natural habitat. Just imagine.

9. The Key to Commissioning That Works? It Never Stops

By James Qualk, LEED AP BD+C, and Steven Harrell, LEED AP O+M, CEM

In the pursuit of high-performance reconstructed buildings, there is no guarantee that the resulting performance will persist for more than a short period of time. Why is that the case?

First, something happens between the end of a facility's construction and the beginning of its operations. Even if the Building Team has miraculously bundled forward-thinking mechanical and electrical design, commissioning, energy modeling, measurement and verification strategies, and renewable energy production, an artificial gap exists where most (if not all) of the professionals involved in designing, installing, and verifying the initial conditions of a building's performance are no longer involved in that building's operations—a phase in the building's life with far greater costs and environmental impacts.

Second, there is no "set it and forget it" button on building systems. Even if the Building Team successfully bridges a building to its operations phase, building systems are complex, interdependent, and subject to changing occupant needs, performance decay, and operator error. A comprehensive, ongoing commissioning program is the only way to preserve energy efficiency and facility performance without a primary focus on retrofits, upgrades, or replacements.

Commissioning firms and other independent organizations regularly report on the problems that typically arise when a commitment to ongoing commissioning is lacking. The problems are often easily found and usually predictable. Sensors and VAV boxes are not currently calibrated or were never properly calibrated at all. Valves and actuators are stuck in one position or other, and there's always the occasional air-handler fan spinning backward. Surprisingly enough, missing equipment regularly makes the list of deficiencies in an existing building commissioning report.

"Recommissioning," "retro-commissioning" (RCx), and "ongoing commissioning" tend to be used interchangeably, but recommissioning and RCx programs are typically provided as a one-time service or event. They specifically do not address the continuing performance decay that mechanical systems inevitably experience or the seasonal adjustments that should be made to maximize performance, not to mention unexpected weather events or changes in the demands on a facility. Typical RCx programs do capture operational improvements and savings; however, over the course of a year or through the seasons, most or all of those improvements can degrade or be lost entirely.

Ongoing commissioning is a continual, systematic approach to optimizing building operations and is, in fact, the best way to combat performance decay, prioritize retrofit or capital improvement opportunities, improve comfort, reduce operating costs, and reduce greenhouse gas emissions related to energy consumption. Furthermore, ongoing commissioning can be implemented in existing commercial, industrial, and institutional buildings, which are responsible for nearly 20% of total energy use in the U.S.

COMMISSIONING FINANCES: SORTING OUT PAYBACKS, COSTS, AND CASH FLOW

The costs for ongoing building commissioning cannot be fairly discussed or considered without including the simple payback and return on investment in the equation. Numerous independent agencies and groups (without the bias exhibited by a provider of services), including the California Commissioning Collaborative, PECI, and others, promote existing building commissioning as the most cost-effective means of improving energy efficiency in commercial buildings.

The Energy Systems Laboratory of Texas A&M University has found that "in Continuous Commissioning projects undertaken in various building types across the U.S., the average annual energy bill savings opportunity is 22% (ranged from 8% to 45%)." The ESL, which licenses its branded Continuous Commissioning system to select engineering and building professional firms (our firm, SSRCx, is a licensee), further claims that Continuous Commissioning provides an average project simple payback of less than two years.[1]

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Steven Harrell is Manager of Continuous Commissioning for SSRCx, a division of Smith Seckman Reid engineering design and facility consulting firm. He is a frequent speaker at conferences regarding energy use and efficiency in existing buildings.

1 See "Continuous Commissioning," Energy Systems Lab, at: http://esl.eslwin.tamu.edu/continuous-commissioning.

Lawrence Berkeley National Laboratory (LBNL) reports that "energy savings from a utility-sponsored retro-commissioning (building tune-up) program targeted to large commercial buildings ranged from 3% to 19%, but those savings may not persist beyond a few years.... The reasons for savings degradation include … sensor and device failures, and operator turnover." For existing buildings, they found median commissioning costs of $.27/sf, whole-building energy savings of 15%, and payback times of 0.7 years, or less than nine months.[2]

Note: Most service providers, including our firm, would state that costs more accurately fall within a range of $.50-.75/sf for a comprehensive ongoing existing building commissioning program, making the payback period more like one-and-a-half to two years—still very attractive.

Several variables impact the total dollars that should be budgeted for most forms of ongoing commissioning. Factors stemming from specific building types (hospitals, K-12, higher education, commercial office space) have to be taken into consideration. For example, a hospital will likely have so many different types of mechanical systems that a list of "20 typical conservation measures" and any resulting economies of scale would be meaningless; a much more granular analysis would have to be made. On the other hand, a commercial high-rise office building will more than likely have several typical floors, making it a prime environment to apply the same optimization routines to multiple pieces of HVAC equipment.

A program of persistent and ongoing commissioning is the best way to address the inherent performance decay in buildings.

Moreover, the financial return from continuous commissioning to owners of reconstructed buildings—whether measured as "return on investment," or "payback period," or "internal rate of return"—is actually somewhat more favorable than is commonly believed, for two reasons.

First, as soon as the commissioning professionals begin identifying and capturing operational improvements—the incorrectly installed air-handler that's blowing hot air into the building in the summer, the hidden pipe that's leaking hot water, and so on—energy and water savings will start being reflected in the next utility billing cycle.[3] Second, most commissioning firms—and this is certainly true for our firm—bill their clients incrementally over the course of the contract period, not 100% up front.

In other words, it is *not* the case that building owners are being asked to pay the full costs of continuous commissioning on day one of the contract, only to have to wait a couple of years to get their money back (in reduced operational costs). The more realistic picture is that savings usually start kicking in within a short period of time after the commissioning work begins, and continue to build over the period of the contract.

The reality of commissioning "payback," therefore, is that building owners pay for commissioning incrementally over time and reap the benefits of commissioning (primarily lower utility costs) incrementally over time—all of which makes the ROI on commissioning existing and reconstructed buildings even more favorable than is commonly believed.

IF COMMISSIONING IS SO GOOD, WHY ISN'T EVERY BUILDING OWNER DOING IT?

With few exceptions facility directors will tell you that their properties could benefit from ongoing building commissioning. A common problem, however, is that they do not budget for such a service until a service provider promotes the idea, the advantages, the benefits, and paybacks, which can mean a delay in executing a plan by as much as a year. Another LBNL report stated, "Some view commissioning as a luxury and 'added' cost, yet it is only a barometer of the cost of errors promulgated by other parties involved in the design, construction, or operation of buildings. Commissioning agents are just the 'messengers'; they are only revealing and identifying the means to address pre-existing problems."

With O&M budgets stretched to their limits and facilities teams often grossly understaffed, the most important message when it comes to commissioning is the need for persistence in any building, above and beyond typical preventive maintenance programs and design and construction best practices. Building systems—mechanical, electrical, plumbing, structural, thermal, and so on—degrade over time, even in the case of recently reconstructed or renovated buildings. Components break or wear out; sequences of operation are "temporarily" changed and never restored; sensors lack regular calibration or do not work at all—all of which cost far more than most building owners realize.

A program of persistent and ongoing commissioning is, from our experience, the best way to address the inherent performance decay in buildings and properly prioritize other operational and energy-related enhancement programs. If we can take this one additional step in the typical standard of care applied to operational programs, commercial, institutional, and industrial building owners will save a tremendous amount of energy, greenhouse gas emissions, and money. +

2 See "Building Commissioning: A Golden Opportunity for Reducing Energy Costs and Greenhouse-Gas Emissions," at: http://cx.lbl.gov/cost-benefit.html.

3 For examples of the kinds of errors commissioning uncovers, see "Hall of shame–Visible evidence of problems addressed by commissioning," in "Building Commissioning," pp. 4-5, at: http://cx.lbl.gov/2009-assessment.html.

10. Action Plan: 18 Recommendations for Advancing Sustainability in Reconstructed Buildings

We offer the following recommendations in the hope that they will help step up the pace of high-performance building reconstruction in the U.S. and Canada. We consulted many experts for advice, but these recommendations are solely the responsibility of the editors of *Building Design+Construction*. We welcome your comments. Please send them to Robert Cassidy, Editorial Director: rcassidy@sgcmail.com.

FEDERAL EXECUTIVE DEPARTMENTS + AGENCIES

1. The Energy Information Administration should update *and refine* the CBECS data file.

CBECS—the Commercial Buildings Energy Consumption Survey— is a national survey by the Energy Information Administration that collects data on the stock of U.S. commercial buildings, their energy-related building characteristics, and their energy consumption and expenditures. It is the basis on which Energy Star rates buildings, and it hasn't been updated since 2003. That data hole needs to be filled.

After a budget delay in 2011, CBECS will now be conducted beginning with data collection in April 2013, with the first data releases expected in spring 2014. That work needs to be completed as quickly as possible. Following data collection, the documentation and presentation of the data must be improved so that Building Teams can utilize the data in referencing their own work against CBECS metrics.

2. Energy Star should create a new program to encourage energy efficiency in tenant spaces and reconstructed buildings.

The activities of tenants—their use of lighting, heating and cooling, plug load for electronics, etc.—impact at least half of all energy use in a typical office building. Yet there are few incentives for tenants to be more conscientious in their use of energy.

Energy Star should investigate ways to recognize conscientious energy use by tenants.[1] Since 2001, Energy Star has given "Industrial Awards" to manufacturers who excel in energy management. Why not extend this concept to building owners who improve their energy efficiency? Similarly, LEED should consider a system to reward building owners whose renovations result in significant energy reduction, even if they don't achieve LEED certification.

1 See Anthony E. Malkin (President of Malkin Holdings LLC), "Lessons Learned at the Empire State Building: From Innovation, to Implementation, to the Future," in "Lessons Learned: High Performance Buildings," available for purchase at: http://www.earthdayny.org/education/lessons-learned/465-lessons-learned-7.html.

3. Congress needs to straighten out the mess with the PACE program for energy improvements.

PACE (Property Assessed Clean Energy) allows states to grant local governments—cities, counties, special districts—the authority to issue bonds to fund nonpublic energy improvements for homes and commercial buildings. Property owners repay the loans over time (as long as 20 years, in some states), and the obligation to repay the loan stays with the property upon sale. Twenty-seven states have adopted PACE.[2]

On 6 July 2010, the Federal Housing Finance Agency directed Fannie Mae and Freddie Mac to stop underwriting mortgages for properties with PACE assessments. Since then, the validity of existing PACE programs throughout the country has been thrown into doubt, and the order has had a chilling effect on the creation of new PACE programs.

PACE has had a solid record of providing voluntary financing for energy improvements without a burden to taxpayers. Congress needs to step in and clean up the mess FHFA has created. Although as a matter of principle we do not comment on pending legislation, HR 2599 (http://www.opencongress.org/bill/112-h2599/show) makes the case for the rescision of the FHFA order.

2 PACENOW is advocacy blog that covers PACE-related events: http://pacenow.org/blog/.

STATE AND LOCAL GOVERNMENTS

4. States and local jurisdictions should devise ways to provide incentives for improving energy efficiency in buildings, such as reducing vehicle miles traveled (VMT) through reconstruction and retrofitting of existing buildings in urban areas.

As a gross simplification, cities use more energy for buildings than their surrounding suburbs, while suburbs use more energy for transportation than for buildings, according to the Center for Neighborhood Technology. State and local land-use planning should be directed at providing incentives for energy savings to owners of existing buildings in cities to encourage walkable neighborhoods and the use of public transit, thereby reducing vehicle miles traveled.

Further, as "The Greenest Building" notes, policy makers should also consider "the significant role that older buildings play in creating more character-rich and human-scale communities."

Many states and cities lavish huge tax breaks on corporations to locate in their jurisdictions. A more economical and environmentally beneficial incentive would be to create financing mechanisms for existing businesses to stay in place and improve their energy efficiency. Landing a Fortune 500 corporation may grab headlines for a community in the short term, but achieving long-term energy and environmental improvements could prove to be more beneficial for that jurisdiction.

5. States and localities that do not have disclosure requirements on energy use in existing buildings should consider requiring such disclosure—and, where feasible, provide incentives for energy improvements.

More and more states and cities are requiring owners of commercial buildings to reveal the energy use of their properties at the time of a sale, lease, or financing. In New York City, the Greener, Greater Buildings Plan requires yearly Energy Star benchmarking and public disclosure for large commercial and multifamily buildings. California requires commercial buildings to disclose their Energy Star ratings to the California Energy Commission at the time of a sale, lease, or financing for the entire building. The state of Washington requires commercial buildings to disclose Energy Star ratings at the time of a sale, lease or financing. The city of Austin, Texas, requires similar disclosure for commercial buildings. (For a helpful listing of all such requirements, see: http://www.buildingrating.org/ammap.)

These disclosure regulations give the buyer or lessee of commercial properties valuable information to weigh in the sale or lease transaction. But they also provide useful information to those seeking to expand the base of knowledge about existing buildings.[3]

3 As Rachel Scheu, LEED AP, of Chicago's Center for Neighborhood Technology, has noted, "Understanding how our building stock uses energy is critical, and local context is important. Building stock characteristics, utility regulatory structures, and energy costs and use vary widely by geography. National datasets (e.g., CBECS) are valuable but too small. Large datasets such as New York's provide tremendous benefits for policymakers and owners to set realistic and measurable energy-reduction goals and channel resources most cost-effectively."

6. States, counties, and cities should rev up efforts to adopt green building codes that encourage high-performance reconstruction, including water-conservation measures.

It is estimated that there are still 70 million 3.5 gallons/flush toilets in the U.S., not to mention inefficient urinals, showers, and sinks. Two years ago, the International Association of Plumbing and Mechanical Officials issued the IAPMO Green Plumbing and Mechanical Supplement (available for purchase at: http://iapmomembership.org/index.php?option=com_virtuemart&vmcchk=1&Itemid=3), which provides excellent guidance for jurisdictions to adopt water-conservation regulations.

The recently released International Green Construction Code (http://www.iccsafe.org/cs/IGCC/Pages/default.aspx) also offers a path for states and localities to implement energy- and water-saving measures. It is estimated that implementing either of these measures could reduce water use in buildings by 20% compared to current plumbing codes, saving millions of gallons of fresh water at one end and eliminating the need for treating the waste water at the other end.[4]

4 For more on water efficiency, see our 2009 White Paper, "Green Buildings + Water Performance," at: http://www.bdcnetwork.com/2009-white-paper-green-buildings-water-performance.

7. State historic preservation offices and building code officials need to be more flexible in their interpretation of codes and standards, to enable "outcome-based" energy efficiency and whole-building design in reconstruction projects.

SHPOs are notorious for going by the book, especially regarding historic authenticity and aesthetics, but if more historic buildings are to be preserved, economic, environmental, and technological considerations have to be factored into the equation. SHPOs will have to be more open to compromises that improve energy and water efficiency in historic properties, especially as new, more economical technologies come on line.

Similarly, means have to be found, perhaps through performance- or outcome-based codes, for code officials to have more flexibility in borderline situations, such as scope of work questions. For example, how much renovation work should trigger a code-required energy upgrade? Fifty-one percent of gsf? Seventy-five percent? Or should code officials have greater discretion to determine if the renovation provides sufficient energy upgrading that no further work is required? These are tough calls, but if we are to create a climate that leads toward "the 99% solution," these may be the kinds of judgments that code officials will have to make in the future.

At the same time, property owners and Building Teams will have to up the ante on their own skills in finding clever ways to introduce advanced technologies into historic projects without incurring the wrath of SHPOs or code enforcers.

8. Cities and counties should look to implement "aggregation initiatives," such as Seattle's 2030 District, for energy and water conservation in existing and renovated buildings.

The Seattle 2030 District (http://www.2030district.org/seattle) is a public-private collaborative working to create a high-performance building district in downtown Seattle, based on the Architecture 2030 Challenge for Planning (http://architecture2030.org/2030_challenge/2030_challenge_planning). The partnership is on its way to enrolling 88 million sf of existing buildings to provide innovative strategies that will assist property owners, managers, and tenants in meeting aggressive energy, water, and carbon reduction goals related to reconstruction and ongoing building operations.

Taking environmental upgrades to the district-wide level, rather than focusing on new, existing, or reconstructed buildings one at a time, is the necessary next step in a more volumetric approach to "the 99% solution." Already, Cleveland has jumped on board and will be launching its own 2030 District this month (http://www.2030district.org/cleveland/). The city of Milwaukee's Milwaukee Energy Efficiency (http://www.smartenergypays.com/), or Me^2, is using $60 million in ARRA funds to link up building owners with energy service contractors and private lenders. Upfront costs of improving energy efficiency will be paid back from savings in energy use.

Denver's Living City Block (http://www.livingcityblock.org) is another district-wide effort to reduce energy use, in this case a block and a half of Denver's historic Lower Downtown district. The goal: cut energy use in "Lo Do" in half by 2013. The Living City Block has spread to the Gowanus neighborhood of Brooklyn, N.Y.

Other cities and counties should be investigating these neighborhood-based models for sustainable building renovation as well.

APPRAISERS AND VALUATORS

9. The Appraisal Institute should lead efforts to educate the building valuation community on green commercial buildings, especially for high-performance renovations.

In our 2011 White Paper, we called for the appraisal community to develop model real estate appraisal standards for net-zero and other low-energy buildings. So, too, should the Appraisal Institute set its sights on developing standards for green renovations.

To its credit, the Appraisal Institute has been presenting education programs on the value of green commercial buildings, and it has begun to consider improved valuations for green-certified single-family homes.[5] But the AI and the appraisal community in general need to give greater attention to the valuation of nonresidential green buildings—in particular, high-performance reconstructed commercial buildings—in order to create incentives for building owners to engage in renovations.

5 Information on these education programs is available at: http://appraisalinstitute.org/education/prof_dev_programs.aspx.

BUILDING OWNERS AND DEVELOPERS

10. Owners of small commercial buildings need to get on the renovation bandwagon.

More than 90% of commercial buildings in the U.S. are under 50,000 sf; 73% are under 10,000 sf. The owners of these buildings are notoriously risk averse, but they are the ones who hold the key to potentially large-scale energy and environmental improvements. BOMA (Building Owners and Managers Association International) is making some progress in this direction through its BOMA Energy Efficiency Program and BOMA 360 Performance Program, but more needs to be done.

It is important for owners of smaller buildings to realize that retrofits don't have to be completed or paid for all at once—that incremental improvements over time can be done in conjunction with major events, such as tenant turnover, code-required upgrades, market repositioning, or necessary improvements to the building envelope (roof or window replacement, overcladding, insulation upgrades, etc.)[6] Making small improvements over time will produce cumulatively greater energy and dollar savings than waiting to undertake the whole job much later.

Other organizations that can play a significant role in reconstructing nonresidential buildings include the Certified Commercial Investment Manager Institute, CoreNet Global, the Council of Education Facility Planners International, the Institute of Real Estate Management, the International Facility Management Association, NAIOP, the Society of Industrial and Office Realtors, and the Urban Land Institute.

6 "Financing Deep Energy Retrofits: Workshop Report," 17 May 2011, Northwest Energy Efficiency Alliance and the Rocky Mountain Institute, at: Whitepaper_Financing_Energy_Retrofits_RMI_05-17-2011.pdf.

11. Owners who engage in reconstruction projects should meter their buildings for both energy use *and* water use.

Reconstruction is a perfect time to meter an existing building. However, while forward-thinking owners may "get" the benefit of metering (and submetering) for energy use, many neglect to think about measuring water use.

Advice to owners and Building Teams from Rob Zimmerman, PE, of Kohler Co.: 1) If you are doing energy monitoring, pull the water use in via a smart meter so you know your water use in real time, and make the data available on a dashboard or via the Web—don't rely on utility bills; 2) submeter major water uses like landscape irrigation and cooling towers; 3) benchmark your building's water use against similar types of buildings; 4) replace old fixtures with high-efficiency toilets and urinals, and consider using piston-style flushometer valves for commercial toilets.

INSTITUTIONS OF HIGHER LEARNING

12. Community colleges and technical training institutions should create programs to educate and train skilled professionals for jobs in deep energy (and water) retrofits.

The nation's community colleges, along with private-sector training institutions like DeVry and ITT Educational Services, are uniquely positioned to train a generation of mid-level experts skilled in energy modeling, building commissioning, and energy- and water-conservation practices in existing buildings and retrofits. Such an effort could start with certificate programs and lead to two-year associate's degrees in energy, water, and building materials management for retrofits.[7] Certification programs that go beyond LEED-EB:O+M accreditation could also be developed for architects, engineers, and construction professionals who want to strengthen their expertise in reconstruction work.[8]

7 One model AAS program for energy management and renewable energy is offered by Lane Community College, Eugene, Ore. (http://www.lanecc.edu/science/energyMgmt/).

8 The Northwest Energy Education Institute is one such exemplary program (http://www.nweei.org/)

AEC FIRMS AND BUILDING TEAMS

13. AEC firms should consider expanding their business models to add "service integration" to their portfolios.

Due to the disaggregation of building ownership in the U.S., with half of commercial floor space in buildings under 50,000 sf, there is a need—and a business opportunity—for "service integrators" to help owners overcome their reluctance to renovate their buildings. As the NEEA/RMI report, "Financing Deep Energy Retrofits," suggests, service integrators could provide "the full spectrum of support" to take the hassle out of doing deep retrofits. NEEA/RMI have proposed that service integrators could work through the U.S. Small Business Administration (504 Green Loan and 7a programs), utility companies, and community development banks. There is a huge need for such a "one-stop" service, but making it financially feasible, especially for owners of small properties, will not be easy, which is why some sort of sponsored experimentation is called for.

14. Building Teams must become more cognizant of the long-term economic and environmental impact of building products in renovation projects.

As the NTHP report, "The Greenest Building," notes, Building Teams should pay careful attention to the amount and performance of building materials used in renovation projects, or the environmental and financial benefits of reconstruction may be lost (as in the case of converting a warehouse to multifamily use).

Along similar lines, Building Teams involved in reconstruction must be clever enough to think ahead as to how future technologies might be applied to buildings currently undergoing renovation: for example, reconstructing a roof such that it could accommodate future photovoltaic arrays—cheaper, smaller, more powerful that today's—even if PVs don't make sense for the project right now.

BUILDING PRODUCT MANUFACTURERS

15. Building product manufacturers need to redouble their efforts on durability and end-of-life reuse in their products.

If it is true that the greenest building is the one that lasts the longest, then it follows that the greenest building product is the one that lasts the life of building—and can then be recycled or reused in some beneficial way. This is especially important for systems like roofing, cladding, windows, and other key components of the building envelope, as well as for interior components—flooring, furnishings, wood, ceiling tiles. Even old toilets and urinals have been known to have a second life, crushed into granules and mixed into flooring materials.

Product durability in particular needs to be emphasized, to avoid the kind of disaster that took place with some first-generation low-VOC paints and finishes that washed right off the wall (a problem that the paint industry has since rectified).

16. Public- and private-sector stakeholders need to find ways to work together on the next stage of technology innovation for sustainable reconstruction.

PRIVATE INDUSTRY, UNIVERSITIES, AND FEDERAL LABS

Technological innovation in building products and systems will require the synergies that might best be created through the collaboration of private industry, universities, and federal labs. The EnOcean Alliance (http://www.en-ocean-alliance.org/home/), which develops and promotes self-powered wireless monitoring and control systems for sustainable buildings by formalizing the interoperable wireless standard, is one such industry-based consortium.

A more wide-ranging collaboration is the Greater Philadelphia Innovation Cluster (gpichub.org/), a regional innovation center at the Philadelphia Navy Yard. One of three such federally funded clusters, it is unique in its focus on full-spectrum retrofits (50% or more energy reduction) of average-sized commercial, institutional, and multifamily residential buildings. The consortium consists of Pennsylvania State University, Philadelphia Industrial Development Corp., Ben Franklin Technology Partners of Southeastern Pennsylvania, Delaware Valley Industrial Resource Center, and Wharton Small Business Development Center, with additional membership from such high-tech companies as Bayer MaterialScience, IBM Research, Lutron Electronics, PPG Industries, and United Technologies.

Research-based universities and technology-enabled companies in other parts of the country need to establish similar innovation clusters to attack specific target technologies that would benefit the renovation and reconstruction of existing buildings.

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17. LEED-EB:O+M should recognize buildings that make significant improvements in reducing energy use, outside of Energy Star qualification.

U.S. GREEN BUILDING COUNCIL

Under current LEED-EB:O+M requirements, owners of the worst energy guzzlers who make substantial investments to reduce energy use in their buildings but who don't reach Energy Star top 25% level get left out of LEED-EB. This creates an obvious disincentive for owners of energy-hog buildings to participate in LEED-EB. The USGBC should appoint a committee to investigate a new form of recognition for these properties, which in some cases could be realizing greater energy-conservation gains than many certified LEED-EB:O+M properties.

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18. The U.S. Green Building Council should delete a proposed credit to LEED 2012 related to avoidance of chemicals of concern.

LEED 2012, which is expected to be released in November, includes a Materials & Resources credit for "avoidance of chemicals of concern." Among the substances to be avoided is PVC/vinyl.

This latest attempt to get PVC blackballed by LEED should sound familiar to those who have followed the controversy in our White Papers over the past decade. (Note: The Vinyl Institute and Sika Sarnafil, a maker of PVC-based roofing products, are sponsors of this White Paper, but the views expressed here are entirely those of the editors.) Ten years ago, the USGBC asked its five-member Technical and Scientific Advisory Committee, chaired by Scot Horst (now Senior Vice President of LEED at the USGBC), to investigate.

The TSAC spent four years reviewing hundreds of scientific documents and studies related to PVC. Based on the TSAC report, the LEED Steering Committee concluded "that the evidence available at present is not conclusive, but it is suggestive that a credit specifically targeting PVC is not warranted." In essence, the USGBC's own blue-ribbon committee concluded that there was insufficient scientific evidence to prevent vinyl from being used in LEED-rated buildings.

The new MR credit came about as the result of a "pilot credit" experiment in which, after two years, only two projects gained credit for avoiding "chemicals of concern." Two data points do not a scientific conclusion make. Moreover, the list of chemicals to be avoided is based primarily on data from a private ecolabel that does not have an open, ANSI-type process. The proposed credit also makes reference to California Proposition 65, which calls for *labeling* of certain chemicals used in all sorts of products but *does not ban* them.

The MR Credit for Avoidance of Chemicals of Concern is another example of the USGBC overstepping its bounds, as it has in creating a de facto wood standard in LEED. The LEED credit development process is not fully open and transparent, unlike that of ANSI and other recognized standards-setting organizations. The USGBC argues that the use of LEED is voluntary, yet its website keeps a tally of all the government entities (442 localities, 34 states, 14 federal agencies) that treat LEED like a de facto standard—without a fully open, ANSI-based standards development process.

The USGBC should not be in the business of creating so-called "red lists." USGBC staff and members are not professional chemists, biologists, epidemiologists, or toxicologists, and they are not qualified to determine the health risks, if any, of specific building products. That's the job of Congressionally authorized federal agencies with the appropriate expertise and capability. +

Private Sector Could Benefit from Innovative GSA Programs

The General Services Administration, which leases or owns 9,600 buildings, has several programs in place that private-sector building owners and developers could learn from.

GSA Deep Retrofit Challenge will upgrade 30 federal buildings, totaling about 117 million sf, through energy service performance contracts. With ESPCs, the costs of retrofit buildings are paid out over time, through the energy savings. The Deep Retrofit Challenge is a complement to the Better Buildings Challenge, in which more than 60 hospitals, municipalities, states, colleges, and private companies have committed to investing a total $2 billion in energy-efficiency retrofits to 1.6 billion sf of property.

GSA Green Proving Ground (http://www.gsa.gov/portal/content/122139) is a program to evaluate 16 technologies from a pool of 140 projects across GSA's national portfolio. Many of the technologies, which include wireless temperature sensors, electrochromic windows, chilled beams, and nonchemical water treatment systems, are being installed in GSA building modernization projects, funded by the American Recovery and Reinvestment Act of 2009.

GSA Workplace Solutions (http://www.workplacesolutionslibrary.com/Pages/Introduction_Main.html) offers GSA clients (i.e., other federal agencies) expert advice on everything from how to survey staff about workplace needs, to furniture selection, to alternative workspaces, such as hoteling. The newest initiative: how to condense workspaces by 50% while improving employee productivity *and* saving energy—something private-sector companies are also exploring.[1] Pilot projects are under way in all 11 GSA regions.

GSA Urban Development Program (http://www.gsa.gov/portal/content/104461) looks at GSA properties from a neighborhood planning perspective: for example, how GSA site selection practices can be used to reduce "vehicle miles traveled"—through greater "walkability" and access to transit—for federal employees and users of government buildings. The program is also looking at how federal buildings can be used by community groups to securely add post-5 p.m. and weekend programming, such as community arts programs, to outdoor space. And, in a take on Jane Jacobs, the UDP is developing ways to securely add ground-floor commercial space to GSA properties, starting with its own headquarters in the District of Columbia.

Private-sector building owners and developers would do well to check with their regional GSA offices (http://www.gsa.gov/portal/category/22227) to learn how these programs might apply to their own reconstruction projects.

1 See "8 Must-know Trends in Office Fitouts," at: http://www.bdcnetwork.com/8-must-know-trends-office-fitouts.

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