



## Durability: A Key Component of Green Building

**T**HE HOUSE I LIVE IN IS 220 YEARS old, having survived storms, fires, and droughts and having experienced the emergence of petroleum, electricity, automobiles, plastics, and nuclear power. It has been repaired, enlarged (around 1800), plumbed, wired, gutted, remodeled, insulated, and restored by generations of inhabitants—adapting to meet changing technologies, needs, and fashions. Most recently, this house, which began life without electricity, central heat, or plumbing, was outfitted with wireless Internet access. Through its adaptation, the hewn beech frame, spruce rafters, wide sheathing boards, two chimneys, and dry-stone foundation have all survived, attesting to the durability of these systems and the house they collectively form. It is reasonable to expect that the house will last another hundred years—surviving past the end of the petroleum age.

What is it about this house that has enabled it to last so long? How have the monasteries in France and the ancient temples in Japan survived as long as 1,000 years, and how have some buildings in other parts of the world survived millennia longer? And conversely, why are many of the tract homes and shopping malls going up today unlikely to make it to 50 years?

This article examines building durability—what it means, why it's important, and some strategies for achieving it. While the article relates to all building types, many of the examples are drawn from light-frame construction, where durability is a particularly vexing issue. We take a look at durability issues relating both to building systems and to their component products and materials.

### Why Durability is Important

The environmental (and economic) benefits of durability would seem fairly obvious. A durable building—one that lasts a long time—provides a long period of time to amortize the environmental and economic costs that were incurred in building it. Notes Peter Yost, a building science expert with 3D Building Solutions, LLC, "if you double the life of a building, you halve the environmental impacts [of its construction]." The same argument goes for

*(continued on p. 11)*



Photo: Nadav Malin

Durable and carefully detailed roofing materials and very large overhangs contribute to the longevity of traditional Japanese temples, such as this 950-year-old Phoenix Hall at Byodoin, near Kyoto.

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### Quote of the month:

**"Durability and energy efficiency are the cornerstones of sustainability."**

Joe Lstiburek, Ph.D.,  
EBN Advisory Board member  
and president of Building  
Science Corporation

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### Editorial & Subscription Office

122 Birge St., Suite 30, Brattleboro, VT 05301

802-257-7300 · 802-257-7304 (fax)

ebn@BuildingGreen.com · www.BuildingGreen.com



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## What's Happening

### Second Solar Decathlon Held on National Mall

Students from 18 schools in the U.S., Canada, and Spain converged on the National Mall in Washington, D.C., in September 2005 to reconstruct the solar-powered homes that they had been designing and building on their own campuses over the past two years. The homes opened to visitors on October 7, and the final phase of the U.S. Department of Energy's second Solar Decathlon began.

Up to 200 points were awarded for the "architecture" of each home, or its attractiveness and the degree to which the team integrated energy efficiency into the design. Up to 100 points were awarded in each of the remaining nine categories:

- Dwelling: the home's livability and buildability;
- Documentation: how well the team analyzed its design for energy performance and the quality of "as-built" drawings;
- Communications: how well the team explained its experiences and

design strategies through a website and public tours (BuildingGreen's webmaster, Ethan Goldman, helped judge this component);

- Comfort Zone: the home's ability to retain a steady, uniform, and comfortable temperature and humidity;
- Appliances: the home's ability to maintain set temperature ranges in the refrigerator and freezer and its ability to wash and dry laundry, cook and serve meals, and operate a dishwasher, TV, video player, and computer for set lengths of time;
- Hot Water: the home's ability to deliver 15 gallons (57 l) of hot water in ten minutes or less;
- Lighting: the home's ability to meet specific light levels in each room;
- Energy Balance: the photovoltaic systems' ability to provide the necessary energy for the duration of the contest; and
- Getting Around: the distance each home's street-legal, commercially available electric vehicle could



The "solar village," made up of 18 homes and educational exhibits from event sponsors, was open to the public October 7-16, 2005.

Photo: Stephano Paltera/Solar Decathlon

be driven, supplied only by the home's excess power.

Earning a grand total of 853.716 points, the University of Colorado won the 2005 overall competition for the second time running (see *EBN* Vol. 11, No. 10). "It was so exciting," says Julee Herdt, faculty advisor and principal investigator for the Colorado team. "You have to pull out your best work; you're on the world's stage." Designed "to integrate natural materials and innovative technologies in an environmentally conscious, publicly accessible, modular, solar home design," the team's BioS(h)IP went far beyond energy efficiency. The home was designed around the BioSIP, a biobased structural insulated panel developed by Herdt in collaboration with the U.S. Department of Agriculture's Forest Products Laboratory in Wisconsin. Herdt hopes the patent-pending panel will be commercialized within a few years.

Weather during the Decathlon was abysmal for solar power generation. "It was a dark and gloomy week, constantly raining," says Herdt. "It meant that we had to be much wiser in how we used the energy in our batteries, and we had to ration our stored energy to help us in points where we needed them." Given the forecast, several teams, including Colorado, sacrificed performance in Energy Balance to use their limited power for other categories. "We said, 'Let's go for it,'" Herdt told *EBN*, "knowing that if the sun popped out we were out of the game."

Second and third places went to Cornell University and California Polytechnic State University, respectively, both of which also earned more than 800 points. Proposals for participation in the 2007 Solar Decathlon are due December 2. For more information on the contest itself, the performance of individual homes, or preparations for the 2007 competition, visit [www.solardecathlon.org](http://www.solardecathlon.org). —JB

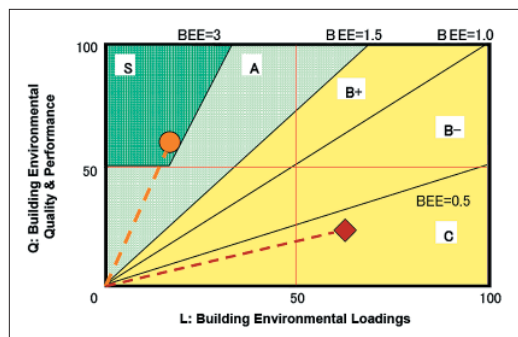
## SB05 Tokyo Conference Highlights

Tokyo, Japan, was the latest venue for the World Sustainable Building Conference (SB05), which began in 1998 in Vancouver, Washington, and took place in between in the Netherlands and Norway. As at past events, a wide range of technical sessions and poster presentations featured research and experiences from around the world.

A prominent theme throughout these events has been the development and implementation of green building rating systems. The Vancouver conference was organized in part as a meeting about the GBTool assessment system (see *EBN* Vol. 7, No. 10), and that system has continued to evolve through the subsequent conferences while also spawning variants. Among the most intriguing of these is the Japanese Comprehensive Assessment System for Building Environmental Efficiency (CASBEE), which is now being used in Japan in both self-assessment and third-party verified modes, and is being exported to China as well.

Two particularly interesting aspects of CASBEE are its overall framework and its graphic presentation of the results. CASBEE has two components: the first quantifies the quality of comfort and services provided by the building and its immediate site (building performance); the second quantifies negative impacts of the project on the local, regional, and global environment. A project is rated based on the ratio between these two scores, so that high performance with low environmental burdens provides the best result. The resulting rating is then displayed on a graph that shows how the project scored in each aspect (see figure) and is given a letter grade (S—sustainable, A, B+, B-, etc.) depending on where in the graph the rating falls. Not surprisingly, given

### Building Environmental Efficiency Ratings



Source: Japan Sustainable Building Consortium

*Buildings are rated in CASBEE based on the ratio between the Building Environmental Quality (Q) and the Building Environmental Loading (L), so projects with high quality and low impacts (upper left quadrant) achieve the best ratings.*

that it is modeled on the GBTool, CASBEE is quite data-intensive—its users estimate that at least a week is needed to collect and input the data for a project. There is now a "family" of CASBEE rating systems to address the various phases in a building's life-cycle.

Overall, the scope of material presented at SB05 was mind-numbing: Just in the core conference 204 papers were presented in 26 three-hour sessions, which were organized into 7 parallel tracks. At the same time, two additional tracks were devoted exclusively to building assessment case studies, and several special sessions were offered on related topics. Topping that off was a two-hour session each day (during lunch) devoted to poster presentations. Paper topics ranged from useful but predictable (such as the documentation of measured energy use in a housing complex in Sweden) to surprising (such as experimental results showing that wood harvested during the waning moon is naturally rot-resistant).

In addition to building assessment tools, other recurring themes were the role of developing countries and the global impact of China's rapid economic growth (four-tenths of all cement used in the world today is used in China). Strengthening ties to developing countries was an explicit goal from past conferences, and

was implemented through a series of regional conferences leading up to SB05. One special session at SB05 was devoted to reporting the results from those conferences, and at the closing press conference several Japanese officials cited exporting their know-how to developing countries as a top priority for sustainability.

Also noticeable was a shift in attitudes about global warming, with a sense that it is too late to prevent the problem (it's already happening) and necessary instead to work on mitigation and adaptation. In this context, Robert Lowe, Ph.D., of Leeds Metropolitan University in the U.K. presented a matrix identifying the impact of various actions on climate change mitigation on one axis and adaptation on the other and proposed that those actions that are beneficial on both fronts, such as increasing the energy efficiency of buildings, be given top priority.

The Japanese Ministry of Land, Infrastructure, and Transport hosted the event in conjunction with three international organizations: the International Council for Research and Innovation in Building and Construction (CIB), the International Initiative for a Sustainable Built Environment (iiSBE), and the United Nations Environment Programme (UNEP).



Her Imperial Highness Princess Takamado graced the SB05 conference with a substantive opening address and then sat through the opening keynote and toured the exhibit hall before departing. Photo: SB05 Secretariat

Technical sessions were conducted in English, and plenary sessions featured simultaneous translation into or from Japanese. Melbourne, Australia, was announced as the site of the next conference in this series, SB08, to be held in November 2008. – NM

**For more information:**

SB05 Tokyo conference proceedings on CD-ROM can be ordered for 5,000 Yen (about \$45) for a limited time only by e-mailing a request to the conference secretariat: [info@sb05.com](mailto:info@sb05.com).

Information about SB08 is online at [www.sb08melbourne.org](http://www.sb08melbourne.org).

Results of the regional conferences are featured in Vol. 33, No. 5, of *Building Research and Information*.

Information on CASBEE is available from the Japan Sustainable Building Consortium at [www.ibec.or.jp/CASBEE/english/](http://www.ibec.or.jp/CASBEE/english/).

## ICC Officials Vote Down Efficiency Improvements

The International Code Council (ICC), an organization focused on building safety and fire prevention, disappointed the green building community when it voted in late September 2005 not to adopt member-ratified changes to the 2004 International Energy Conservation Code (IECC) that would have strengthened standards for wall insulation. The changes would have saved more than \$7 billion and 500 trillion Btus (530 million GJ) of energy over 30 years, according to an assessment conducted by Bion Howard, president of Building Environmental Science and Technology, and William Prindle, deputy director of the American Council for an Energy-Efficient Economy (ACEEE).

The changes were proposed in response to a format change in the 2004 IECC that decouples wall insulation requirements from window area, introducing the potential for homes to be less efficient than they would have been under the 2003 IECC, according to the ACEEE report. "The wall improvements in question—from R-13 to R-15 in zones 3 and 4 and from

R-19 to R-21 in zones 5, 4 Marine, and 6—were included in the major overhaul of the IECC that was approved by the IECC Committee in 2003 and overwhelmingly ratified by the membership in 2004." The vote to reject the upgraded insulation standards came as a surprise to most observers.

The National Association of Home Builders (NAHB) campaigned to block the changes. Calling the vote a "victory for housing affordability," NAHB claimed that the proposed changes "do not provide a significant energy savings, nor are they cost-effective." NAHB also argued that the changes would have unfairly benefited the fiberglass insulation industry: "The higher insulation requirements potentially excluded from the marketplace many types of insulation, such as sprayed cellulose and expanding foams, which could not have achieved the new ratings using standard 2x4 wall construction." The U.S. Department of Energy (DOE) also opposed the changes, citing a "lack of analytical basis." "The Department believes that more data is needed to fully address the potential cost impacts of various insulation options," wrote Ronald Majette on behalf of DOE.

Organizations working to increase insulation rates, however, including ACEEE and the North American Insulation Manufacturers Association, supported the changes. "This is a shocking slap in the face for consumers, many of whom are going into debt to pay their energy bills," says Prindle. "We find it incomprehensible that the ICC would roll back energy codes when U.S. home heating prices, let alone housing prices, are at record levels." – JB

**For more information:**

International Code Council  
[www.iccsafe.org](http://www.iccsafe.org)

The ACEEE analysis, *Impact Assessment of 2004 IECC Wall Criteria Changes*, is online at [www.aceee.org/buildings/policy\\_legis/bldgcodes/iecc.pdf](http://www.aceee.org/buildings/policy_legis/bldgcodes/iecc.pdf).

The DOE statement is online at [www.energycodes.gov/2004\\_2005\\_iecc\\_irc.stm](http://www.energycodes.gov/2004_2005_iecc_irc.stm).

## Newsbriefs

**California Commits \$2 Billion to Efficiency**—In what it describes as the most ambitious energy conservation campaign in U.S. history, the California Public Utilities Commission in September 2005 authorized \$2 billion in funding over the next three years for energy efficiency and conservation. The program's provisions include financing strategies, online energy audits, and consumer rebates for ENERGY STAR® appliances. The program also provides \$230 million each year (a 36% increase) for the Governor's Green Building Initiative, with the goal of reducing the energy use of government buildings by 20%. "What this plan does is help us meet our growing needs, first and foremost, with the cleanest, most cost-effective energy of all—greater efficiency," says Susan Kennedy, the commissioner leading the efficiency proceeding. Details are at [www.cpuc.ca.gov](http://www.cpuc.ca.gov).



**California Enacts New Building Efficiency Standards**—California's updated Title 24 building efficiency standards, approved by the California Energy Commission in late 2003 (see *EBN* Vol. 13, No. 1), took effect on October 1, 2005. The strengthened standards include a range of changes for both residential and nonresidential buildings. Mandatory changes involve indoor and outdoor lighting and, for residences, checks for leaky ducts when new central furnaces or air conditioners are installed. It also mandates "time-dependent valuation" of energy for all buildings, favoring peak energy-saving measures over off-peak measures. A complete description of the changes is online at [www.energy.ca.gov/title24/2005standards/](http://www.energy.ca.gov/title24/2005standards/).



**New York City Passes Green Building Bill**—New York City Mayor Michael Bloomberg has signed into law a bill establishing green building standards for certain capital projects.

The law, Int. 324-A, requires most new and renovated City buildings that cost more than \$2 million to "be built according to green building standards that are as stringent as LEED," according to an Office of Communications press release. Schools and hospitals must meet LEED Certified or equivalent, and all other city projects must meet LEED Silver or equivalent. "Our hope is that our investment in green buildings will be returned many times over through energy savings and environmental, community, and health benefits," said Bloomberg upon signing the bill. The law takes effect January 1, 2007.



**LEED-NC 2.2 Approved**—In balloting that closed on October 28, 2005, the membership of the U.S. Green Building Council (USGBC) voted overwhelmingly to approve version 2.2 of USGBC's flagship LEED® for New Construction (LEED-NC) rating system. While other versions of LEED have been released in the interim, this vote endorses the first substantive update of the NC rating system since version 2.0 was released in May of 2000. (LEED 2.1, containing only administrative changes, was released without member ballot.) LEED-NC 2.2 will be formally released on November 11 at Greenbuild in Atlanta. Projects can be registered under LEED-NC 2.0/2.1 until December 31, after which registrations will be accepted only for 2.2. (Previously registered projects will still be able to apply for certification under the older systems.) A new exam based on LEED-NC 2.2 is expected in July of 2006.



**Artists for Humanity Achieves Platinum**—EpiCenter, the Artists for Humanity, Inc., 23,500 ft<sup>2</sup> (2,180 m<sup>2</sup>) headquarters in South Boston, Massachusetts, has achieved 53 points in the U.S. Green Building Council's LEED® Rating System, earning the project a Platinum rating. Dedicated



Photo: Arrowstreet, ©Richard Mandelkorn

Located on a brownfield site in South Boston, the EpiCenter opens onto a grassy area irrigated with collected rainwater. Protected from street noise, the area is shaded in the summer and shielded from wind in the winter.

to "providing programs for youth empowerment through art and entrepreneurship," the building includes fine art and commercial art studios, a learning laboratory, and 5,000 ft<sup>2</sup> (465 m<sup>2</sup>) of gallery space for student work. With no mechanical cooling, the EpiCenter is expected to use very little energy, and it sports a 49-kilowatt PV array (currently the largest in Boston). A detailed profile of EpiCenter, designed by Arrowstreet, Inc., with green building consultant Mark Kelley from Building Science Engineering, is available in BuildingGreen's Case Studies Database.



**Blakely Hall Earns First U.S. Green Globes Certification**—Blakely Hall, a community center and town hall for Issaquah Highlands, a planned community near Seattle, Washington, earned two Globes (out of four possible) in the Green Building Initiative's Green Globes™ green building performance tool in September 2005, making it the first U.S. building to receive Green Globes certification. The 7,000 ft<sup>2</sup> (650 m<sup>2</sup>) building, which includes offices and public space, also earned a LEED® Silver rating from the U.S. Green Building Council in



Blakely Hall, which has earned both Green Globes and LEED certification, features low-flow toilets and fixtures, waterless urinals, locally sourced materials, recycled-content materials, and extensive daylighting, among other green features.

Photo: Courtney Rosenstein

September. Port Blakely Communities served as developer, and Weber + Thompson served as architect and interior designer. For more information about Green Globes, see *EBN* Vol. 14, No. 3.



#### **GBI Earns ANSI Accreditation**

The American National Standards Institute (ANSI) recognized the nonprofit Green Building Initiative™ (GBI) as an accredited national standards developer in September 2005. Following its accreditation, GBI submitted an application to establish its Green Globes™ commercial buildings rating system as an American National Standard. For more on GBI and Green Globes, visit [www.thebgi.com](http://www.thebgi.com) or [www.greenglobes.com](http://www.greenglobes.com), or see *EBN* Vol. 14, No. 3.



#### **DuPont and Tate & Lyle Invest in Corn-Based Polymers**

DuPont and Tate & Lyle have begun construction on a \$100 million plant in Loudon, Tennessee, that will convert corn into 1,3 propanediol (PDO). The product, also known as Bio-PDO™, will replace petroleum-based PDO in the production of Sonora®, DuPont's newest polymer, used in clothing, carpeting, plastics, and other products. The production of Bio-PDO requires 30 to 40% less energy than the production of petroleum-derived PDO, according to the companies. More information is online at [www.dupont.com/sorona/](http://www.dupont.com/sorona/) and at

[www.tateandlyle.co.uk](http://www.tateandlyle.co.uk) (click on "media centre" and then "latest news").



#### **Greenguard Introduces Standard for Schools**

The Greenguard™ Environmental Institute, a nonprofit certifier of products with low emissions of volatile organic compounds (VOCs), has created the Greenguard Standard for Children & Schools™, which sets

emissions criteria for building materials, furnishings, finishes, and cleaning products to be used in schools and daycare facilities. Recognizing that children have higher inhalation rates per pound of body weight than adults and are more susceptible to chemicals in other ways, the new standard applies a "body burden correction factor of 0.43" to current allowable emission levels and introduces a limit on phthalate emissions, among other adjustments. More information on the new standard is online at [www.greenguard.org](http://www.greenguard.org). For more information on Greenguard, see *EBN* Vol. 12, No. 10.



#### **Al-Pac Achieves World's Largest FSC Certification**

A 13.6 million acre (5.5 million ha) forest in Alberta, Canada, managed by Alberta-Pacific Forest Industries, Inc. (Al-Pac), has earned certification according to Forest Stewardship Council (FSC) standards, making it the largest FSC-certified forest in the world. The announcement also makes Canada the leading country in the world for FSC-certified forestland, with 35.3 million acres (14.3 million ha), or 23% of the global total. Al-Pac is online at [www.alpac.ca](http://www.alpac.ca). FSC is online at [www.fsc.org](http://www.fsc.org). For more on FSC and forest certification, see *EBN* Vol. 12, No. 4.



#### **Rainforest Alliance Publishes Guide to FSC Wood Sources**

The Rainforest Alliance, an accred-

ited certifier of compliance with Forest Stewardship Council (FSC) standards, has published the *SmartGuide to Green Building Wood Sources*, a comprehensive listing of all FSC-certified suppliers in North America, including those certified by organizations other than the Rainforest Alliance's SmartWood program. The guide is organized by product type, including everything from engineered wood to office furniture, and each listing includes basic information about the product and the supplier, along with contact information. The document, which will be updated periodically, is online at [www.rainforest-alliance.org/greenbuilding/](http://www.rainforest-alliance.org/greenbuilding/).



#### **CRI Adds Adhesives to its Green Label Plus Program**

The Carpet and Rug Institute (CRI) has expanded its Green Label Plus program, released in 2004 to recognize carpets with low emissions of indoor pollutants, to include adhesives. Green Label Plus supersedes the organization's older "Green Label" program, which addressed carpets, carpet pads, and adhesives. Before receiving Green Label Plus certification, adhesives are tested over a two-week period for emissions of 15 compounds, ten of which are identified by California's Section 01350 protocols. Subsequent annual and semi-annual tests check for specific compounds and total levels of volatile organic compounds (TVOCs). CRI is online at [www.carpet-rug.org](http://www.carpet-rug.org). For more about Green Label Plus, see *EBN* Vol. 13, No. 7.



#### **University of Calgary Introduces Haworth Chair in Integrated Design**

The Faculty of Environmental Design at the University of Calgary in Alberta, Canada, has announced the establishment of the Haworth Chair in Integrated Design, funded by Haworth, Inc., under the "Project evolve" partnership with Direct Energy Business Services. The announcement did not specify whether the Haworth Chair holder will be given

a chair by Haworth. The Faculty of Environmental Design is online at [www.ucalgary.ca/evds/](http://www.ucalgary.ca/evds/). Haworth is online at [www.haworth.com](http://www.haworth.com).



**IFMA Study Finds Green Building Growing**—Among U.S. and Canadian members of the International Facility Management Association (IFMA), 70% are implementing green concepts within their organization's facility, according to a May 2005 online survey performed by IFMA. Full results are online at [www.ifma.org/tools/research/survey\\_results.cfm](http://www.ifma.org/tools/research/survey_results.cfm).



**Report Shows Benefits of Green Affordable Housing**—A September 2005 report from New Ecology, Inc., and Tellus Institute demonstrates that green affordable housing is more cost-effective than conventional affordable housing. The report, *Costs and Benefits of Green Affordable Housing*, features case studies of 16 green affordable housing projects around the country and lays out the long-term financial implications and net present value projections for each project. "The findings in this report provide strong validation for community-based developers of affordable housing who have recognized the value of greening their projects but, until now, have not had the data to back it up," says Joe Kriesberg, president of the Massachusetts Association of Community Development Corporations. The report also outlines the barriers to greening affordable housing and provides recommendations to researchers, developers, and policymakers. To download a PDF of the 200-page report (\$20.00), visit [www.newecology.org](http://www.newecology.org); to order a paper copy (\$49.00), e-mail [info@newecology.org](mailto:info@newecology.org) or call 617-354-4099 x25. For more on greening affordable housing, see *EBN* Vol. 14, No. 3.



**Green Builder Media Launches Green Builder Magazine**—Green Builder® Media, LLC, plans to publish the first issue of *Green Builder*

*Magazine* in January 2006. With 90,000 copies mailed to builders, contractors, and remodelers, and an additional 20,000 distributed at the International Builders Show, *Green Builder* will launch as the third largest magazine in the homebuilding industry, according to the company. Through an agreement with the National Association of Home Builders (NAHB), Green Builder Media will distribute the magazine to interested NAHB members, and NAHB will contribute editorial content to each issue. *EBN* Advisory Board members Peter Pfeiffer and David Eisenberg, along with former *EBN* senior editor Peter Yost and current *EBN* executive editor Alex Wilson, are all slated to serve as contributing editors. Details are online at [www.greenbuildermag.com](http://www.greenbuildermag.com).



**USGBC to Address Hurricane Rebuilding at Greenbuild**—The U.S. Green Building Council, along with the Enterprise Foundation, Habitat for Humanity, the Trust for Public Land, and others, is planning a series of charrettes focused on rebuilding the Gulf Coast. The meetings will be held during the Greenbuild Conference, to take place in Atlanta November 9-11, 2005. Scholarships will allow 30 Gulf Coast community leaders to participate. "The Greenbuild panel sessions will focus on embedding sustainable strategies in the rebuilding effort," according to USGBC. For more on rebuilding the Gulf Coast, see *EBN* Vol. 14, No. 10.



**USGBC Names Hicks Vice President of LEED**—The U.S. Green Building Council has named Tom Hicks vice president of the LEED® Rating System. Hicks has served as director of LEED for Existing Buildings since November 2004 and before that spent nine years as principal architect and program manager of the U.S. Environmental Protection Agency's ENERGY STAR® commercial building rating system. Hicks replaces Nigel Howard, who was

named USGBC chief technical officer in July 2005. USGBC is online at [www.usgbc.org](http://www.usgbc.org).



**GeoPraxis Becomes Green Building Studio**—GeoPraxis®, Inc., a company that provides architectural, engineering, and construction software and services, has become Green Building Studio, Inc., taking on the name of the company's online energy-analysis service. The firm's utility and real-estate consulting business, including the online EnergyCheckup™ tool, meanwhile, has spun off but remains under the GeoPraxis brand. For more information, visit [www.geopraxis.com](http://www.geopraxis.com) or [www.greenbuildingstudio.com](http://www.greenbuildingstudio.com).



**MTS Progressing with Standards Development**—The Institute for Market Transformation to Sustainability (MTS) is preparing to release its Sustainable/EPP Flooring Standard® for all hard-surface flooring, following a public meeting in Dallas, Texas, on November 1. MTS is also holding organizational meetings for two new standards it is seeking to develop: the Integrated Design Process Standard Guide for Sustainable Buildings and Communities and the Sustainable/EPP Products Performance Standard. Both meetings will be held in Chicago on November 29. For details, see <http://mts.sustainableproducts.com>.



**Russell Perry Joins SmithGroup**—*EBN* Advisory Board member Russell Perry, AIA, is now at SmithGroup's Washington, D.C., office, after 11 years with William McDonough+Partners (WM+P). While at WM+P, Perry was project leader for several high-profile, aggressively green projects, including Ford's River Rouge complex in Dearborn, Michigan, and the National Collections Centre at the National Museum of Science & Industry in Wroughton, England. SmithGroup is online at [www.smithgroup.com](http://www.smithgroup.com).

## Awards & Competitions

### Lighting for Tomorrow Announces 2005 Winners

Lighting for Tomorrow, a national lighting fixture design competition held by the American Lighting Association, the Consortium for Energy Efficiency, and the U.S. Department of Energy, has announced the winners in its second annual competition (see *EBN* Vol. 13, No. 8 for winners of the first competition). All prototypes had to meet ENERGY STAR® criteria to be eligible for the competition. Each of the three grand prize winners was awarded \$15,000, and the second place winner took away \$7,500.

David Lizzi led the design of the grand-prize-winning fixture in the

whose design was led by Stephen Blackman of American Fluorescent Corporation. "We developed the size and shape of the fixture specifically around the sizing of the CFL lamp and the new self-contained 'socket ballast,'" says Blackman of the line, which will be released in January 2006.

Blackman and American Fluorescent Corporation also led the winning team in the technical innovation category, for using an on-board dimmer in the pendant fixture Chablis-Soleil, which will be available in January 2006. "This ballast and lamp combination shows that it is now possible to bring to the market a well-designed, cost-effective fixture with fluorescent dimming," says Blackman.

A second place award was given in the indoor-fixture-family category for the Windows Collection™ from Justice Design Group, which borrows the traditional look of craftsman-style windows. This line will be available in May 2006.

Honorable mention for functionality was awarded to Good Earth Lighting, Inc.,

led by Alex Kowalenko, for its line of lighted mirrors. Honorable mention for use of sustainable materials was awarded to David Bergman Architect and Fire & Water Lighting + Furniture for Lulu, a line of fixtures incorporating shades made of 50% post-consumer recycled plastic and for Flipster, a line with low-VOC panels made of a resin incorporating up to 40% post-industrial recycled content.



Photo: American Fluorescent Corporation

*The Chablis-Soleil, designed by Stephen Blackman, conceals a dimmer in the lower decorative finial.*

indoor-fixture-family category. The Ferros line, including several fixture types, all of which will become available from Lithonia Lighting in December 2005, combines brushed nickel and opal white glass or bronze and tea-stained glass in a contemporary style.

The outdoor-fixture-family grand prize went to the Eureka line,

All honorable mention products are currently available.

#### For more information:

Lighting for Tomorrow  
[www.lightingfortomorrow.com](http://www.lightingfortomorrow.com)

### ED+C Announces 2005 Excellence in Design Winners

*Environmental Design and Construction* magazine (ED+C) has announced the winners of its third annual Excellence in Design Awards. More information about the winners, including finalists and honorable mentions, is online at [www.edcmag.com](http://www.edcmag.com).

- **The Alberici Group Corporate Headquarters**, 8850 Page, designed by Mackey Mitchell Associates, won the category for commercial, office, industrial, multiuse, and corporate buildings. The \$20 million, 110,000 ft<sup>2</sup> (10,200 m<sup>2</sup>), Class-A office building in St. Louis, Missouri, earned a LEED® Platinum rating in July 2005.
- The 172,000 ft<sup>2</sup> (16,000 m<sup>2</sup>), \$32 million **Richard J. Lacks Sr. Cancer Center** at Saint Mary's Health Care in Grand Rapids, Michigan, designed by Trinity Design, won the category for institutional, non-profit organization, educational, and healthcare facilities.
- The 110,600 ft<sup>2</sup> (10,300 m<sup>2</sup>) **Pennsylvania Department of Environmental Protection** Southeast Regional Office Building in Norristown, Pennsylvania, designed by L. Robert Kimball & Associates, won the category for local, state, and federal government facilities.
- **Eastern Village Cohousing Condominium** in Silver Spring, Maryland, won the multiuse residential category. A full description of the LEED Silver, 93,000 ft<sup>2</sup> (8,600 m<sup>2</sup>) renovation, designed by EDG Architects and the Eco Housing



Living units in the Eastern Village Cohousing Condominium include bamboo flooring, linoleum flooring, low-VOC paint, sink aerators, and ENERGY STAR® appliances. Photo: Tom Kochel

Corporation, is in BuildingGreen's Case Studies Database.

- **Eastern Sierra House** in Gardnerville, Nevada, won the single-family residence category. A full description of this 3,450 ft<sup>2</sup> (321 m<sup>2</sup>) home, designed by Arkin Tilt Architects, is in BuildingGreen's Case Studies Database.

## Award Briefs

**COPT Wins First NAIOP Green Development Award**—The National Association of Industrial and Office Properties (NAIOP), the world's leading organization representing commercial real estate executives, has awarded its first Green Development Award to Corporate Office Properties Trust (COPT) for a 125,000 ft<sup>2</sup> (11,600 m<sup>2</sup>) office building in Annapolis Junction, Maryland. The award was developed in consultation with the U.S. Green Building Council, and COPT intends to certify its winning project to the Silver or Gold level in the LEED® for Core and Shell program. NAIOP is online at [www.naiop.org](http://www.naiop.org), and COPT is at [www.copt.com](http://www.copt.com).



**AFH Wins INDEX Design Award**—Architecture for Humanity (AFH) was one of five recipients of the 2005 INDEX Design Award, honoring the best examples of "design to improve life for vast numbers of people." AFH was recognized for its work with the Africa Centre for Health and Population Studies in Somkhele, KwaZulu-Natal, South Africa, to design and build a soccer club that will double as a health outreach center (see *EBN* Vol. 14, No. 6). Hundreds of designs were nominated, and 118 were recognized as finalists. "This is truly the little project that could," said Cameron Sinclair, executive director of AFH, who accepted the award at a Copenhagen, Denmark, ceremony in September 2005. Information about the award is online at [www.index2005.dk](http://www.index2005.dk). AFH is online at [www.architectureforhumanity.org](http://www.architectureforhumanity.org).



**Fanger Wins Pettenkofer Gold Medal**—P. Ole Fanger, D.Sc., director of the International Centre for Indoor Environment and Energy at the Technical University of Denmark and fellow of the American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc.

(ASHRAE), has won the Pettenkofer Gold Medal, the International Academy of Indoor Air Sciences' highest honor for research on how the indoor environment influences human health, comfort, and productivity. Among other achievements, Fanger's doctoral thesis was published as the influential book *Thermal Comfort* in 1970, and he developed the *olf* unit for air pollution (one *olf* denotes the emission rate of pollutants from a standard person). Fanger's work provides the basis for significant portions of ASHRAE's Standard 55 on thermal comfort. For more on thermal comfort, see *EBN* Vol. 13, No. 7. For more on productivity, see *EBN* Vol. 13, No. 10.



**NAHB Calls for Green Building Award Entries**—The National Association of Home Builders (NAHB) is inviting submissions for the 2006 National Green Building Awards, to be presented at the National Green Building Conference, March 12-14, 2006, in Albuquerque, New Mexico. Entries are due December 23, 2005. For details, visit [www.nahb.org/greenbuildingawards](http://www.nahb.org/greenbuildingawards).



**New York DEP and EPA Open Green Building Competition**—The New York City Department of Environmental Protection (DEP) and U.S. Environmental Protection Agency (EPA) Region 2 have announced a call for entries in the second annual New York City Green Building Competition. The competition is open to projects built in or designed for specific sites within the boroughs of New York City. Awards will be made in five categories: industrial buildings, single-family houses and low-rise multiple dwellings, mid-rise and high-rise apartment houses and hotels, commercial and office buildings, and public buildings. Entries are due January 17, 2006, and winners will be announced in March. Details are online at [www.nyc.gov/html/oec](http://www.nyc.gov/html/oec).

**Product News & Reviews**

**Aquia Dual-Flush Toilet from TOTO**

TOTO, a leading toilet manufacturer whose toilets have consistently been among the best in terms of flush performance, introduced to North America the Aquia™ Dual-Max™ dual-flush toilet in May 2005. While this toilet has been available elsewhere for five or six years and is the most popular toilet in Thailand, where it is manufactured, according to Gunnar Baldwin of TOTO, this marks the company's dual-flush entry in North America. The Aquia uses 1.6 gallons (6.0 liters) of water in the high-flush mode and 0.9 gallons (3.4 liters) in the low-flush mode. The low-volume flush is designed for use with liquid wastes (and paper), while the standard flush is for solid wastes.

Like most other TOTO toilets, the Aquia is a wash-down, gravity-flush toilet. The bowl has steep sides, and 100% of the flush water enters through the toilet bowl rim and exits through a larger-than-average, 2 5/8" (67 mm) trapway. By contrast, most U.S. toilets rely on a siphon-jet technology in which much of the flush water enters through the side of the bowl, creating a swirling, siphonic action that pulls—rather than pushes—water and wastes out of the bowl.

As with an increasing number of toilets, the Aquia is flapperless. Instead of a hinge-mounted flapper, which is prone to seal failure and leaking, the toilet has a flush tower. Flushing the toilet lifts the valve seal mechanism, releasing water from the tank. A full-volume flush fully raises the flush-valve seal; a low-volume flush doesn't raise the mechanism as far up the tower before it quickly reseals the tank.

Instead of a typical flush lever, the Aquia has a dual-button flush actuator integrated in the center of the toilet tank lid (see inset photo). Depressing the larger side of the button produces the full-volume flush; depressing the smaller side results in the water-conserving flush.

TOTO estimates that a typical family of four will save approximately 7,000 gallons (26,000 l) per year by installing this toilet in place of a standard 1.6 gallon-per-flush (gpf) toilet. (The savings will be far higher if it replaces an older toilet.) The elongated bowl complies with building codes for commercial building, allowing the toilet to be used in commercial settings where gravity-flush toilets are used. According to TOTO, the Aquia qualifies for Seattle, Washington's multifamily and commercial-building toilet rebate program as well as for Portland, Oregon's toilet rebate program.

The Aquia performed very well in the Veritec Consulting, Inc., MaP testing, which is becoming standard throughout the industry (see EBN Vol. 13, No. 1). At full flush, the toilet flushed 800 grams of test media. (Flushing 250 grams is considered the minimum satisfactory performance, and BuildingGreen maintains a minimum threshold of 400 grams for inclusion of a 1.6 gpf toilet in the GreenSpec product directory.)

The toilet seat is slightly taller than normal, but not high enough to qualify as an ADA (Americans with Disabilities Act) toilet. "We're working on that," says Baldwin.

The TOTO Aquia has a manufacturer's

suggested selling price of \$395 to just under \$600, depending on color and other options (such as TOTO's SoftClose® seat). The toilet is available in cotton white, colonial white, Sedona beige, bone, gray, and black. The skirted bowl design is touted by TOTO as both stylish and easy to maintain.

According to Baldwin, the toilet has been so popular that TOTO is having trouble keeping up with demand. When the Aquia was formally rolled out at the Kitchen



Photo: TOTO USA

The TOTO Aquia dual-flush toilet will reduce water consumption about 20% compared with a standard toilet. (Inset: users push the larger side of the split flush button for a full flush and the smaller side for a light flush.)

& Bath Show in May, more than 1,000 were ordered on the first day, says Baldwin, and the current wait for delivery is about two months.

As for user satisfaction, early reports are encouraging. Dave Broustis, who works for the Resource Conservation Division of Seattle Public Utilities, installed an Aquia toilet in his home

when it became available. He told *EBN* that he wasn't expecting to like it—he had installed a dual-flush toilet before that he didn't like—but he was pleasantly surprised. "It's actually great," he says. Though the *water spot* (the surface area of the standing water in the bowl) is smaller than that of a typical American toilet, "it does clean the bowl well," he says. Broustis, who is knowledgeable about toilets through his work for Seattle, explained that wash-down toilets typically do a very good job at flushing solids ("they're impossible to clog"), but they don't clean the bowl well because of the smaller water spot. TOTO seems to have found a good balance with this product. — AW

#### For more information:

TOTO USA, Inc.  
Morrow, Georgia  
770-282-8686  
www.totousa.com

Veritec Consulting, Inc.  
Mississauga, Ontario  
905-696-9391  
www.veritec.ca  
(click on "reports" to download latest MaP test results)

## Product Briefs

**GreenFiber Acquires Bonded Insulation**—Cellulose insulation manufacturer U.S. GreenFiber, LLC, based in Charlotte, North Carolina, acquired Bonded Insulation, located in Hagman, New York, in July 2005. The acquisition will allow GreenFiber to expand its manufacturing and distribution presence in the Northeast and in eastern Canada. "GreenFiber has the capacity to turn what has previously been an environmentally friendly 'specialty' product into a major competitor on the building products scene," according to the company. For more information about GreenFiber, see *EBN* Vol. 9, No. 9. The company is online at [www.us-gf.com](http://www.us-gf.com).



**Aquatherm Polypropylene Pipe Listed with ICC**—The Fusiotherm® and Faser® lines of polypropylene pipe and pipe fittings made by Aquatherm Piping Systems, LLC, were awarded ESR 1613 listing by the International Code Council (ICC) in September 2005. This listing, according to Aquatherm's Jim Brock, certifies that Aquatherm pipe and fittings meet all of the relevant plumbing codes. The products are also certified by NSF International to their standards 14, 15, and 61, and to ASTM 2389-4. For more information see *EBN* Vol. 13, No. 9 or contact Jim Brock at 248-830-7037 or [jim@aquatherm-usa.com](mailto:jim@aquatherm-usa.com). The company is online at [www.aquatherm-usa.com](http://www.aquatherm-usa.com).



**WatterSaver Water Heater Halted**—The WatterSaver heat-pump water heater from ECR International (sold under the Dunkirk brand) has been taken out of production due to tepid consumer response despite offering significant energy-savings potential. "We hate to see it go away, but it just didn't grab enough of the market," Karl Mayer, OEM sales manager for ECR International, told *EBN*. He expressed hope that the situation will be temporary: "We're looking to come up with a marketing and manufacturing partner." The WatterSaver was honored as a Top-10 product by *EBN* in 2002. See our product review in Vol. 11, No. 10.



**Waterless Offers Discounts to Hurricane Victims**—Waterless Co., LLC, manufacturer of No-Flush™ urinals (see *EBN* Vol. 7, No. 2), is offering \$500,000 in discounts on its urinals to building owners, schools, colleges, cities, counties, state agencies, the military, and other facilities in areas affected by Hurricanes Katrina and Rita. For more information, visit [www.waterless.com](http://www.waterless.com) or call 1-800-244-6364.

## Durability (from page 1)

the products and materials going into those buildings. Durable products and materials will not need to be replaced or repaired as frequently, so the raw materials, energy, and environmental impacts invested in them can be spread out over more time.

A house or commercial office building designed and built to last 100 years offers significant resource advantages over a comparable building that will last just 50 years (assuming similar energy performance and indoor environmental quality). From a life-cycle standpoint, the longer-lasting building's higher economic and environmental costs can usually be justified by its durability. Investing in increased durability shouldn't be carried too far however. Buildings are often modified or replaced for reasons that have nothing to do with their structural integrity, so part of good durability planning involves picking a reasonable service-life target for the building and its constituent assemblies.

Durability often goes hand-in-hand with low maintenance. Usually—but not always—a durable material is also a low-maintenance material. In the *GreenSpec® Directory*, durability and low maintenance are considered together as a criterion for product selection. Exterior siding that has to be painted every five years or vinyl composition tile (VCT) that has to be stripped and re-waxed regularly will not be durable unless it is maintained properly—and that maintenance becomes part of the material's life-cycle environmental and economic burdens (see "Floorcoverings: Including Maintenance in the Equation" in *EBN* Vol. 12, No. 5). By contrast, a pultruded fiberglass window frame and sash is considered highly durable, in part, because it will hold up well even with no maintenance.

## Focusing on Durability in Buildings

Given the significance of durability, it is remarkable that this hasn't long been a top consideration of buyers, sellers, lenders, insurers, and others in the supply chain of buildings. Until the recent upsurge in lawsuits over mold, remarkably little attention was paid to building durability outside of a relatively small cadre of building science experts.

The lack of interest in durability has frustrated many, including *EBN* Advisory Board member Joe Lstiburek, Ph.D., president of Building Science Corporation, based in Westford, Massachusetts. But things are looking brighter. Lstiburek sees the green building movement as a leading reason for the growing focus on durability. "I went from thinking the whole idea of green building was a boutique issue," he told *EBN*, "to seeing how it is the leading driver of change. Durability and energy efficiency are the cornerstones of sustainability."

Durability is integral to the new LEED® for Homes Rating System from the U.S. Green Building Council, which was released in a pilot version in August 2005 (see *EBN* Vol. 14, No. 9). The rating system requires the preparation of a detailed durability plan. Implementation of the plan with third-party inspection can earn the project up to five points, depending on the region—one point is available in regions with less than 20 inches (51 cm) of precipitation per year, three points in regions with 20–40 inches (51–102 cm), and five points in regions with more than 40 inches (102 cm). LEED for Homes also provides a point for humidity control in homes and mandates local exhaust of the most significant moisture sources (kitchens and bathrooms), with extra points for automated controls on exhaust fans and for performing third-party testing of the airflow rate from these systems.

While the LEED for New Construc-

tion (LEED-NC) Rating System, which applies to commercial buildings, does not address durability directly, the Canadian adaptation (LEED Canada-NC 1.0) addresses it explicitly as Credit 8 under Materials and Resources. One point is earned for developing and implementing a *building durability plan* in accordance with Canadian Standards Association (CSA) S478-95 (2001) – *Guideline on Durability in Building*.

The durability point in LEED Canada-NC is meeting some resistance, especially among insurance companies, according to Wayne Trusty, president of the Athena® Sustainable Materials Institute, which is heavily focused on durability issues. "Insurers are advising developers against going after the credit," says Trusty, "because there's an implied warranty." In addition, the cost of producing the required durability plan is not insignificant. "To fully comply with the CSA standard, you really have to do a lot of paperwork," Trusty told *EBN*. He has heard that the cost of creating that plan has run about CA\$6,000.

As for U.S. government programs addressing durability of buildings, the Department of Energy (DOE) has taken the lead, largely through its Building America program and applied research at several national laboratories. Lstiburek believes that the Department of Housing and Urban Development (HUD) really should be the leader with residential durability initiatives, but it has not played that role.

A number of home warranty programs in North America address durability, with the Environments for Living® program currently most active in this area (see *EBN* Vol. 12, No. 7). Environments for Living is a program of Masco Services Group, the largest insulation contractor in the world. Launched in 2000 and designed with the support of leading building science experts, including Building Science Corporation and Advanced Energy Corporation of

Raleigh, North Carolina, the program establishes requirements for tight construction, improved thermal systems, right-sized HVAC systems, fresh-air ventilation, balanced air pressure, internal moisture management, and combustion safety. Homes are tested for performance, and participating builders have the option of providing homeowners with a heating and cooling energy-use guarantee and—at the highest levels of certification—a comfort guarantee.

To date more than 70,000 homes have been constructed under the Environments for Living program, and six of the nation's ten largest builders currently participate. A new level of certification added in 2005, Diamond Class, adds green building elements, including water efficiency, to the program. By addressing moisture management, ventilation, and air pressure in new houses, Environments for Living helps ensure long building life with minimal problems.

Programs that seek to promote durability, whether in the form of LEED credits or homeowner warranties, use one of three approaches, according to Yost: The simplest approach is to prescribe specific measures, but those must be customized for the building type and region to be meaningful. The next level is to set performance-based goals, but these are notoriously hard to verify until the building has been around (or not) for decades. Finally, a program can focus on the process. A process-based approach offers the best leverage for improvements over a wide range of users but doesn't guarantee good results for any specific project. Both LEED for Homes and LEED Canada rely heavily on process requirements, while Environments for Living is more prescriptive and performance-based.

## Elements of Durability

The durability of buildings depends on relatively few specific factors that can be addressed through design and construction. These are described

below, followed by a checklist of actions for improving durability.

## Moisture

To a significant extent, durability is an issue of water management. Lstiburek estimates that fully 80% of durability problems in buildings have to do with moisture. Indeed, the publication “Durability by Design,” published by HUD’s Partnership for Advanced Technology in Housing (PATH), devotes more than three-quarters of its space to moisture issues.

Moisture damage comes from a number of sources: penetration of precipitation from outdoors; leaking plumbing lines, fixtures, and appliances; wicking (capillary movement) through floors and walls; internal sources, such as showering, cooking, clothes drying, firewood drying, and operation of unvented gas or kerosene heaters; infiltration of moist outdoor air into the building; and the drying of building materials such as concrete and wood framing members.

Several of these sources of moisture are heavily influenced by climate—which is why the LEED for Homes program has a graduated point system depending on expected annual precipitation. Several systems on the market warn building occupants of moisture problems in buildings (see sidebar).

A few moisture sources are influenced by occupant behavior. Moisture from drying firewood, for example, is an issue only if homeowners store firewood indoors. And even with a good bathroom ventilation system, homeowners can choose not to use it or—if the system is automated—deactivate the controls.

But the most significant factor with moisture problems is how a building was designed and built. Adequate roof overhangs, proper grading around the building, dampproofing on foundation walls, capillary breaks on concrete components, rainscreen details on walls, and proper flashing

are examples of measures for keeping moisture out of buildings; these and other strategies are described in greater detail in the checklist (see page 16).

Protection against moisture damage should be a key consideration with material selection. Certain materials resist moisture, repel water (these materials are called hydrophobic), retard water-vapor diffusion, block airflow (significant moisture transfer occurs via airflow), or block capillary flow. Such materials are an important part of moisture management in buildings, though the recommendations as to exactly where various air and vapor barriers belong have

been evolving as building scientists gain greater understanding of the moisture dynamics of buildings. In general, there has been a shift away from recommending vapor barriers, even on the warm side of building envelopes.

Water also corrodes certain materials, such as iron and steel. Rust can be a significant degradation problem in certain situations. The presence of salt, for example with coastal buildings exposed to saltwater spray, can accelerate corrosion.

## Heat

Thermal stress can reduce durability by causing materials to expand and

## Detecting Moisture Problems

If you can’t keep the water out, it’s good to at least know when it’s there. Two companies offer sensor-based systems designed to detect leaks, but they approach the problem very differently. The Floodstopper™ from FirstSmart Sensor Corporation is designed to stop plumbing overflows on the spot. It uses sensors placed at floor level near toilets, washing machines, and other potential flood sources. These sensors are connected (with wires or via a wireless link) to a central controller and an automatic shutoff valve. If a sensor detects a puddle forming, the valve shuts off the water supply. A manual reset button reopens the valve and reestablishes water flow. Floodstopper is available throughout North America through a network of distributors. Prices start at about \$400, not including installation. Details are at [www.thefloodstopper.com](http://www.thefloodstopper.com).

The Detec technology from Detec Systems, LLC., is designed with longer-term moisture problems in mind. Like the Floodstopper, it includes a system of sensors, but the Detec sensors can detect moisture buildup in addition to full-fledged leaks. Rather than instantaneously shutting off a water supply, Detec sends a warning to the mother ship via an internet connection. Technicians at the company’s Manitoba, Canada, manufacturing facility monitor these warnings around the clock and notify someone at the facility when they identify a situation that requires intervention.

This system is capable of identifying problems from condensation buildup in walls and other building cavities, but it is not typically configured to automatically shut off a water main. It can distinguish between leaks and gradual moisture buildup, however, and can be programmed to page someone immediately in the case of a leak, according to Gamal Mustapha, the company’s vice president of engineering. Detec’s system costs roughly one dollar per square foot (\$10/m<sup>2</sup>), depending on the number and type of sensors installed. Details are at [www.detecsystems.com](http://www.detecsystems.com). – NM



*The pair of copper strips on Detec’s moisture detection tape are connected to stainless steel probes so they can sense moisture buildup both on the surface and inside wood framing members. The system can also include temperature sensors to help interpret the moisture data.*

Photo: Detec Systems, LLC



Photo: 3-D Building Solutions, LLC

*A vented rainscreen helps keep walls dry by allowing for drainage behind the siding and providing for pressure-equalization, neutralizing the driving force of wind-driven rain at the siding plane. In this retrofit, the vertical spacers are made from leftover plywood, and black plastic mesh under the window protects the opening from insects while allowing airflow.*

contract. For example, this can affect long-term window performance; certain frame materials, including vinyl and aluminum, expand and contract at a higher rate than glass, making windows leakier over time (see *EBN* Vol. 5, No. 2). High roof temperatures contribute to the degradation of roofing materials (see also Sunlight, below), and this was an important factor in the highly publicized premature degradation of flame-retardant-treated plywood roof sheathing some years ago. With metal roofing, thermal expansion and contraction may loosen fasteners over time.

### Sunlight

Ultraviolet (UV) light degrades many materials, including most plastics, wood, fabric, and paint. Along with heat, this is a major cause of the degradation of roofing materials—and the reason vegetated (green) roofs can prolong the life of a roof membrane (see *EBN* Vol. 10, No. 11). Plastics that are used outdoors, including vinyl siding, are typically treated with UV stabilizers, but in some cases these stabilizers themselves carry environmental burdens. The toxic metals lead and cadmium were often added to PVC in the past to provide UV stability; today, less-toxic

stabilizers are generally used, though disposal of older vinyl products is still a significant source of lead and cadmium in municipal waste incinerators. UV light also degrades interior materials, though UV-blocking glazings can reduce damage and prolong the life of interior finishes and furnishings.

### Ozone and acid rain

Various atmospheric pollutants, especially ozone and acid rain, can degrade building materials. Ozone is formed at ground level through a chemical reaction between volatile organic compounds (VOCs) and nitrous oxides (NO<sub>x</sub>) in the presence of sunlight. While ozone is beneficial in the stratosphere because it blocks high-energy UV light, it is a pollutant at ground level. Along with causing a host of health problems, such as asthma and other respiratory illnesses, ozone also damages materials. Many synthetic materials, including rubber, polyester, nylon, dyes, and certain paints, are susceptible to ozone damage. It can also damage cotton textiles.

Acid rain, resulting primarily from sulfur dioxide pollutants in the atmosphere, corrodes various materials and is especially a problem with limestone building façades. Hundreds of cathedrals in Europe that had endured very well for many centuries began deteriorating with the dawn of the Industrial Age due to acid rain from coal and other hydrocarbon combustion. Acid rain also increases corrosion of copper and lead roofing, contributing to both shorter lifespans of those materials and the leaching of toxic materials into the environment. The low-emissivity coatings in most energy-

efficient windows block most of the UV radiation.

### Insects

A handful of insect families are responsible for more than \$2.5 billion in damages to U.S. buildings each year, according to the National Pest Management Association. Most costly of these insects are several dozen species of termites, mostly in the *subterranean* termite family. The Formosan termite, a species of subterranean termite that was accidentally introduced from China, is becoming the most damaging species in North America. Other insects that can damage wooden buildings include carpenter ants and powderpost beetles. A wide range of design practices, specialized barrier products, and insect-resistant materials, such as treated wood, are used to protect buildings from termites and other insects. For more on pest control strategies, refer to the table and see *EBN* Vol. 9, No. 9.

### Material failure

Some materials and building components simply wear out. It is reasonable to expect that some materials have shorter lifespans than others. The challenge is to understand this and plan accordingly. In some cases, it makes sense to spend more to buy materials and products that are more durable than standard products. In other situations, it makes more sense to accept that a particular material has a relatively short lifespan and design the building assembly so that the shorter-life material can easily be replaced. What is illogical, according to Lstiburek, is to spend more to install a long-life wall cladding material, such as brick (which should last more than 50 years), over a material like plastic housewrap that is designed to last only 25 years. "It makes no sense," says Lstiburek, yet this is common in many building assemblies.

### Building function

Some buildings, even as designed, function poorly. While popular in

the 1960s and '70s, geodesic domes and yurts lost favor in part because homeowners found it difficult to position furniture along rounded or segmented walls. A building that is highly functional will be durable by virtue of the value its occupants place on it; that building is more likely to be restored or renovated as components wear out, while a less functional building is more likely to be replaced.

The function of a building also changes over time, and an inability to adapt to those changes can reduce its useful life, even if it is structurally sound. The recent interest in so-called "open building" systems is an attempt to keep components that need frequent updates, like wiring, separate from assemblies that should last a long time, like walls. The article "Future-Proofing Your Building: Designing for Flexibility and Adaptive Reuse" (*EBN* Vol. 12, No. 2) provides background and recommendations on this issue.

Residential architect Peter Pfeiffer, FAIA, worries that certain increasingly popular building materials, such as insulated concrete forms (ICFs) and structural insulated panels (SIPs), will not do well when it comes to adapting these homes to changing needs. "How easy will it be to remodel these homes in 25 years, much less rewire them," asks Pfeiffer. "Durability means that you've got to be flexible," he argues. "If it's not flexible, it will become functionally obsolete."

A recent study completed in 2004 by the Athena Institute for Forintek Canada Corp. adds credence to concerns about building longevity having more to do with functionality than durability. The Institute examined 227 commercial and residential buildings in St. Paul, Minnesota, that were demolished from 2000 to mid-2003, examining the age of the buildings, the structural materials, and the reasons for demolition. Only 31% of the buildings were torn down because of physical condition,

while 57% were demolished because of area redevelopment or because the buildings weren't suitable for anticipated use. Even though steel and concrete are considered highly durable materials, 63% of the structural concrete buildings and 80% of the structural steel buildings that were demolished during this period were 50 years old or younger, while just 14% of the wood-frame buildings were in that age category. The full report can be downloaded from the Athena Institute website.

## Style

The idea of "timeless architecture" has important bearing on durability. Attractive, aesthetically pleasing buildings are more likely to be maintained and repaired as components fail than are ugly, unloved buildings. In *How Buildings Learn*, author Stewart Brand describes two types of buildings that tend to last: "high-road" buildings that have that timeless quality and "low-road" buildings that are readily adapted and modified to suit changing needs.

John Abrams, of South Mountain Company on Martha's Vineyard, Massachusetts, makes timelessness a key component of his company's house designs. "It's the buildings that are loved—and therefore cared for—that endure," says Abrams. "Make it beautiful and without trendy styling, and site it well, and you may ultimately be contributing to durability. In fact, that may be the most important thing you can do."

## Natural disasters

Finally, in many areas, design for durability must also address natural disasters, including hurricanes, tornados, floods, fires, and earthquakes.

(For certain building types, such as embassies and highrise towers, this category could be expanded to cover terrorism as well.) Design for survivability of natural disasters is highly dependent on the region. In the Gulf Coast region—as we know all too well today—as well as along much of the Atlantic coast, hurricanes and the resultant flooding are the prime concern. Along rivers and streams in virtually every state are areas where flooding is a risk during heavy rains—whether accompany-



Photo: 3-D Building Solutions, LLC

*Mold growth on paper-faced drywall, exposed when interior trim was removed, was the result of moisture wicking up the wall from the floor after a washing machine overflow.*

ing a hurricane or not. Tornados are possible almost anywhere, but a large swath of the Central U.S., referred to as the Tornado Belt, is especially susceptible to the intense storm systems that spawn tornados. Fires are a major concern in many western states, particularly as development creeps out into the chaparral country that becomes tinder-dry most years in the summer and fall. And earthquakes are a concern not only along the well-publicized fault lines in California but throughout North America.

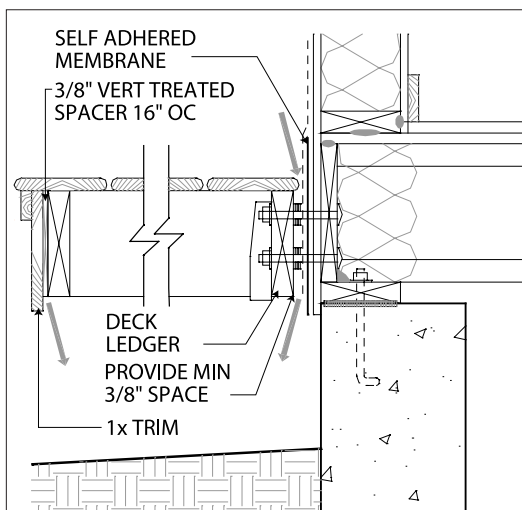
Some of our activities exacerbate natural disasters—and the damage from natural disasters. On a macro

*(continued on p. 18)*

## Achieving Durability in Buildings: A Checklist for Action

Strategy	Explanation
<b>MOISTURE</b>	
Survey site to assess moisture and drainage conditions.	Potential moisture problems on a site may be identified by examining soils, surface water flows, drainage conditions, and existing vegetation. An understanding of site conditions will inform drainage strategies and other design features.
Grade site to drain water away from building.	Grade the ground away from the building at a minimum of 4% (1/2" per 12" or 4 cm/m) for at least 6' (2 m) out from the foundation. With paved surfaces against the building (patios, sidewalks, driveways), grade at a minimum of 2%.
Provide gutters and downspouts.	Use gutters and downspouts to capture rainwater falling on the roof and carry it away from the building.
Provide foundation waterproofing or dampproofing and drainage.	Treat the outside of foundation walls with spray-on or trowel-on waterproofing in wet sites and dampproofing in drier sites. Provide a free-draining layer against the foundation and footing drains at the base of the wall that drain to daylight or sumps.
Protect foundation walls from frost heaving.	Insulate the exterior of the foundation or the ground outside the foundation (shallow frost-protected foundation) to prevent frost heaving and the development of cracks that can become pathways for moisture.
Provide capillary break on foundation components.	Apply a capillary break on top of the footing before pouring or laying the foundation walls, and on top of the foundation walls before framing the building.
Provide adequate roof overhangs.	Protect building walls from rain with roof overhangs on both eaves and rakes. A minimum 12" (30 cm) overhang is recommended in climates with more than 20" (50 cm) of rain annually, with the recommended overhang increasing to 18" (450 cm) with over 40" (100 cm) of rain per year.
Provide drainage plane (rain screen) in walls.	Provide a drainage plane or rainscreen detail in walls to reduce moisture problems and prolong the life of exterior finishes. With wood siding, provide an airspace on the outside of the sheathing and any housewrap using strapping perpendicular to the siding.
Follow recommended practice for vapor barriers, air barriers, and vapor retarders.	Recommendations on vapor barriers and vapor diffusion retarders have changed dramatically in recent decades. Most building scientists today recommend concentrating on air barriers and avoiding a separate vapor barrier in all but the coldest climates so that the wall cavity can dry to the interior or exterior.
Provide proper flashing.	Proper flashing details are critical in controlling moisture entry into buildings. Make sure that flashing is properly lapped to shed rain.
Rely on caulks and sealants only where repairs are possible.	Caulks and sealants generally have short lifespans and need to be reapplied periodically; rely on them only in locations where they can be reapplied fairly easily.
Ventilate roofs in most situations.	While hot roofs have been used very successfully, most building science experts still recommend vented roofs in most situations so that any accumulated moisture can be vented.
Do not ventilate crawl spaces.	Most building science experts today recommend against venting crawl spaces and unheated basements. Block moisture entry into the crawl space or basement with a capillary break, such as a layer of polyethylene on the ground or beneath the concrete slab.
Keep wood away from ground contact.	To prevent decay and obviate the need for treated wood, choose non-wood materials where ground contact or splash-back is possible.
Use treated wood where ground contact or splash is expected.	Where ground contact or splash-back is possible, use wood that has been treated to prevent decay. Use the least-toxic treated wood option that will serve the needs. See, for example, <i>EBN</i> Vol. 13, No. 10.
Specify high-performance windows or glazings.	Use windows and glazings with high R-value (low U-factor). These will reduce condensation problems, which can lead to rot and other durability problems.
Protect building materials from weather on the job site.	Fully protect all building materials from rain to avoid introducing mold or shortening the useful life of those materials.
Pressure-test plumbing for leaks.	After plumbing a building, pressure-test to ensure that there are no leaks. Leaking pipes are one of the leading causes of mold and decay in buildings.

<b>Protect against leaking clothes washers.</b>	Burst clothes-washer hoses are one of the leading causes of insurance claims in houses. Use only quality hoses, instruct homeowners to replace hoses periodically, and position the washer on a drainage basin large enough to capture at least the volume of water in the tub.
<b>Insulate cold-water pipes.</b>	Cold-water pipes in certain climates are a source of condensation and moisture damage. Insulate pipes to eliminate this problem.
<b>Ventilate all bathrooms and kitchens.</b>	Bathrooms and kitchens are the leading sources of moisture in most houses. Vent both to the exterior with quiet spot fans or a central ventilation system. Low noise is important so that occupants will use the fans.
<b>Install entryway track-off matting.</b>	Significant moisture is carried into buildings on occupants' feet. Install track-off entryway systems to capture this moisture. See <i>EBN</i> Vol. 10, No. 10.
<b>HEAT AND SUNLIGHT</b>	
<b>Specify reflective roofing.</b>	Use reflective roofing to keep the surface temperature down, which will prolong the life of both the roofing and the substrate. Reflective roofing is most widely available for low-slope roofs, but reflective pitched roof options are also available.
<b>Consider a green roof.</b>	With a low-slope roof, as on most commercial buildings, consider a green (vegetated) roof to extend the life of the roof membrane. See <i>EBN</i> Vol. 10, No. 11.
<b>Specify light-colored exterior wall finishes.</b>	Use light-colored wall surfaces (as with roofs) to keep surface temperatures lower and prolong the life of coatings and siding materials.
<b>Specify overhangs above south windows.</b>	Sunlight will degrade certain interior finishes and furniture. Use overhangs above windows to help block sunlight during the summer months. Note that the benefits of sunlight penetration (such as passive solar heating and daylighting) may outweigh the drawbacks.
<b>Specify UV-protective glazings as needed.</b>	To protect interior finish materials and furnishings, specify glazings that block the most destructive ultraviolet radiation.
<b>Specify UV-resistant materials.</b>	For outdoor exposure, use materials that are UV-resistant or protected from the sun. Plastics used outdoors, for example, should include UV inhibitors. Interior materials, such as fabrics, should be fade-resistant if used in rooms with significant solar gain.
<b>Provide vegetative shading.</b>	To protect buildings from excessive heat and sun, plant trees, vines, and other vegetation. See "Cooling Load Avoidance Strategies" in <i>EBN</i> Vol. 3, No. 3.
<b>OZONE AND ACID RAIN</b>	
<b>Avoid susceptible materials in high-pollution regions.</b>	In areas with significant smog or acid rain, avoid roofing and other exterior finishes that are susceptible to damage from these pollutants.
<b>INSECTS</b>	
<b>Provide physical termite barriers.</b>	In areas with risk of termites, install termite shields to block the entry of subterranean termites into buildings. Instruct building owners on inspection of termite shields. Other products, such as TermiMesh™ and termite-barrier sand, provide additional protection. See <i>EBN</i> Vol. 9, No. 9.
<b>Provide insect-resistant materials as needed.</b>	In areas where termite damage is common, provide wood treated with borates or sodium silicate (such as TimberSil™) for structural framing members, or consider use of steel framing.
<b>Provide termite bait treatment where needed.</b>	In areas with known termite problems, recommend the use of termite-bait systems (rather than blanket insecticide treatments) to protect wood materials.
<b>Prevent vegetation from contacting building.</b>	To minimize insect entry, provide at least some separation between the building and vegetation, such as shrubs and trees.
<b>MATERIAL SELECTION – GENERAL</b>	
<b>Keep shortest-life materials most accessible.</b>	Design building assemblies so that the least durable components are most accessible.
<b>Choose durable materials and products.</b>	When choosing between comparable-function materials, choose the more durable. Spending more on longer-lasting materials and products is often justified.
<b>Provide guidance on maintenance requirements.</b>	Provide building occupants with specific information on the maintenance of materials and products to ensure long life.



Connections between wood decks and house walls are a common source of rot. Proper detailing, shown here, provides a space between the ledger-plate and the wall and a water-barrier membrane penetrated by only lag bolts.

Photo: 3-D Building Solutions, LLC

scale, human contributions to global climate change are believed to be spawning more destructive hurricanes and rainfall events and contributing to droughts that are making western lands more susceptible to fire. On a more immediate level, population pressures and the desire to build close to scenic natural features are resulting in development along flood-prone rivers and streams and in places like the foothills of Southern California that are naturally managed by lightning-ignited fires.

Designing buildings to withstand natural disasters—and protect occupants in the event of these disasters—is a high priority but one that is fairly well addressed in our life-safety-based building codes. Other than moisture protection issues that relate to flood resistance, we do not address design for natural disaster resistance here.

### Dealing with Durability

Addressing durability in buildings is an important priority, especially in any building we want to call green. For a long time, complacency was the rule in the building industry when it came to durability. Lstiburek

believes that in the past we didn't address durability because we didn't need to. "The pain threshold for durability problems hasn't been great enough for long enough," he told *EBN*. But that's changing.

Lstiburek points to two reasons why we're beginning to address durability. First, we're experiencing more problems, according to Lstiburek, and we simply can't ignore it. "We're a reactive people," he says. The legal profession is helping focus attention on this, especially moisture-induced mold problems. He calls lawyers "the single most effective mechanism of change."

Notes Lstiburek: "There's nothing like a couple million dollars in liability settlements to focus attention on durability." The second major driver of this new focus on durability, according to Lstiburek, is the green building movement. "It's one of the great successes of green architecture," he says. "People are now asking these questions."

Creating durable buildings depends on the right knowledge and attention during design, specification, and installation, notes Yost. "If any one of these is lousy, the building fails," he adds. Lstiburek, who has devoted his career to understanding and preventing building failures, puts most of the blame on designers. "I think it's principally a design problem," he told *EBN*. More specifically, it's a problem with the way architecture is taught. "We teach architects to be artists," says Lstiburek, "we're not teaching basic skill sets." Lstiburek argues that the architect is supposed to be the generalist, yet the necessary training in technologies is not taught at architecture schools.

A checklist of the most important strategies for achieving durability in

buildings is provided on pages 16-17. While not comprehensive, the list is a good starting point for addressing the critical issue of achieving durability. Note that this checklist addresses only the factors relating to the building and its materials—not the issues of function and style, which can also be very important factors, as discussed above.

### Final Thoughts

Design for durability has finally come out of the closet. It is being addressed in dozens of workshops across the country and by organizations such as the U.S. Green Building Council and the Energy and Environmental Building Association. Clearly, progress has been made, but we have a long way to go. Lstiburek believes that if everything is done right in the design and construction of wood-frame buildings, they should last a thousand years! He says the Norwegians and Swedes are the closest to this goal. And while the U.S. lags far behind, we appear to be moving in the right direction.

A fundamental need in the pursuit of more durable buildings is funding for research. The building industry in North America, and especially in the U.S., devotes just a tiny percentage of its revenues to research—far less than in any other segment of industry. That needs to change. And it can change; there is growing awareness about the importance of understanding building and materials durability. This is one of the issues that the U.S. Green Building Council's soon-to-be-formalized research committee hopes to take up in the years ahead.

— Alex Wilson

#### For more information:

Building Science Corporation  
Westford, Massachusetts  
978-589-5100  
[www.buildingscience.com](http://www.buildingscience.com)

Peter Yost  
3-D Building Solutions, LLC  
Brattleboro, Vermont

802-254-3663  
 peter@3-d-buildingsolutions.com  
 www.3-d-buildingsolutions.com

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 www.effbuilder.com

Athena Sustainable Materials Institute  
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 866-520-6792, 613-269-3796 (fax)  
 www.athenasmi.ca

Canada Green Building Council  
 Ottawa, Ontario  
 613-241-1184  
 www.cagbc.org

Canadian Standards Association  
 Mississauga, Ontario  
 800-463-6727, 416-747-4000  
 www.csa.ca

U.S. Green Building Council  
 Washington, D.C.  
 202-828-7422  
 www.usgbc.org

## From the Library

### Two Titles for Future Green Builders

#### Green Dollhouse: Creating a Doll's Eye View of a Healthier World

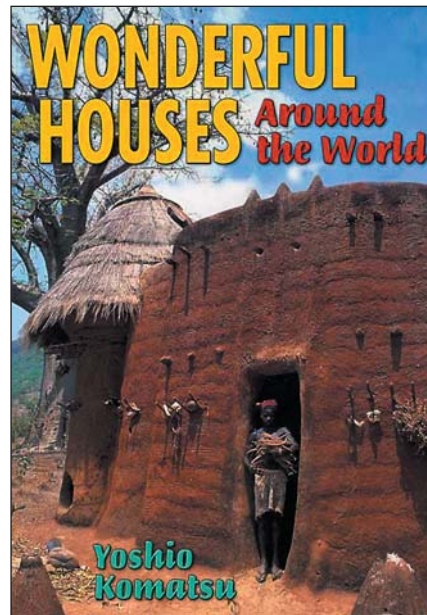
Ecotone Publishing Company, Kansas City, Missouri, 2005. Softcover, 72 pages, \$19.95.

#### Wonderful Houses Around the World

by Yoshio Komatsu, Shelter Publications, Bolinas, California, 2004. Flexcover or softcover, 48 pages, \$14.95/\$8.95.

*Green Dollhouse* documents the results of the Green Dollhouse Project, a design competition sponsored by San Mateo County in California in 2004 (see *EBN* Vol. 14, No. 5). That competition sought “dishy doll dwellings” that offered “great green guidance,” and it got them in the form of entries from as far away as Japan. The book features photos and descriptions of all the winning entries, accompanied by “fun facts” that put the dollhouse designs in a

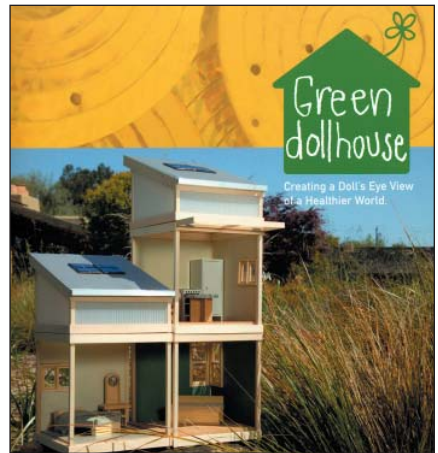
down until she had studied all the designs, and she hasn't stopped planning her own dollhouse since. The dollhouses featured represent a broad range of sustainable design solutions, making this a rich textbook for all ages.



*Wonderful Houses Around the World* is the children's version of Komatsu's amazing book *Built by Hand* (see sidebar “Finding Out More” in the article “The Natural Building Movement” in *EBN* Vol. 14, No. 5). *Wonderful Houses* features beautiful photographs and full-color, detailed illustrations of indigenous dwellings, and the people who live in them, from ten countries. The text is written for young children (ages four to eight, according to the publisher). It's hard to imagine a better introduction to the variety of traditional house styles, and the quality of the photos ensures that adults won't tire of looking through this book either. (If you're buying for an adult, however, spend a little more and get *Built by Hand*—you won't regret it.) – NM

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global context. It also has instructions and tips for building one's own doll dwelling.

My seven-year-old daughter loves dollhouses, and this book got her attention. She wouldn't put it

## Calendar

### NOVEMBER

**8-10 • 2005 Design-Build Expo**, Las Vegas, NV. *Organizer:* Design-Build Institute of America. *Information:* 202-454-7535; [pwilson@dbia.org](mailto:pwilson@dbia.org); [www.designbuildexpo.com](http://www.designbuildexpo.com).

**10-11 • Advanced Facilities Engineering Conference 2005 (AFEC)**, Denver, CO. *Organizer:* U.S. Green Building Council, Colorado Chapter. *Info:* 303-771-2000; fax: 303-843-6232; [lcramer@expomasters.com](mailto:lcramer@expomasters.com); [www.afec.biz](http://www.afec.biz).

**9-11 • Greenbuild International Conference & Expo 2005**, Atlanta, GA. *Organizer:* U.S. Green Building Council. *Info:* [info@usgbc.org](mailto:info@usgbc.org); [www.greenbuildexpo.org](http://www.greenbuildexpo.org).

**9-11 • 2005 Network Conference: Changing Communities in a Changing Landscape**, Washington, DC. *Organizer:* The Enterprise Foundation. *Information:* 410-964-1230; [www.enterprisefoundation.org](http://www.enterprisefoundation.org).

**14-18 • National Building and Renewable Energy**, Jessup, MD. *Organizer:* Solar Energy International. *Info:* 970-963-8855; [www.solarenergy.org](http://www.solarenergy.org).

### DECEMBER

**10 • The Business of Green Products**, Queens, NY. *Organizer:* NY Designs. *Info:* 718-482-5949; [www.NyDesigns.org](http://www.NyDesigns.org).

**13-16 • Ecobuild Federal**, Washington,

DC. *Organizer:* Sustainable Buildings Industry Council. *Info:* 800-996-3863; [www.ecobuildamerica.com](http://www.ecobuildamerica.com).

### JANUARY 2006

**12-14 • National Symposium: Indoor Air Quality Tools for Schools**, Washington, DC. *Organizer:* U.S. Environmental Protection Agency. *Info:* 703-247-6194; [www.iaqsymposium.com](http://www.iaqsymposium.com).

**21-25 • ASHRAE 2006 Winter Meeting/AHR International Expo**, Chicago, IL. *Organizer:* American Society of Heating, Refrigerating and Air-Conditioning Engineers. *Information:* [www.ashrae.org/chicago](http://www.ashrae.org/chicago).

### FEBRUARY

**6-7 • Cohousing Project Management**, Berkeley, CA. *Organizer:* The Cohousing Association of the United States. *Info:* 510-654-6346; [www.cohousing.org](http://www.cohousing.org).

**8-9 • Green Construction 2006**, San Jose, CA. *Organizer:* Construction Events. *Info:* 925-218-2225; [www.greenconstruction2006.com](http://www.greenconstruction2006.com).

### MARCH

**7-9 • Building Energy 2006 and Trade Show**, Boston, MA. *Organizer:* Northeast Sustainable Energy Association. *Info:* 413-774-6051; [buildingenergy@nesea.org](mailto:buildingenergy@nesea.org); [www.nesea.org](http://www.nesea.org).

**29-30 • GLOBALCON, Energy, Power & Facility Mgmt: Strategies & Technology**, Philadelphia, PA. *Organizer:* The Association of Energy Engineers. *Info:* [www.aeecenter.org/globalcon](http://www.aeecenter.org/globalcon).

### APRIL

**19-20 • CleanMed 2006**, Seattle, WA. *Organizer:* CleanMed. *Info:* 617-524-6018; [www.cleanmed.org](http://www.cleanmed.org).

### MAY

**10-12 • 4th Annual Greening Rooftops for Sustainable Communities Conference**, Boston, MA. *Organizer:* Green Roofs for Healthy Cities. *Information:* 416-971-4494; [www.greenroofs.net](http://www.greenroofs.net).

**22-26 • 2006 ACI Home Performance Conference**, Austin, TX. *Organizer:* Affordable Comfort, Inc. *Info:* 724-627-5200; [lindawig@affordablecomfort.org](mailto:lindawig@affordablecomfort.org); [www.affordablecomfort.org](http://www.affordablecomfort.org).

### JUNE

**14-16 • Eco-Architecture 2006: First International Conference on Harmonisation Between Architecture & Nature**, The New Forest, UK. *Organizer:* Wessex Institute of Technology, UK. *Information:* [www.wessex.ac.uk](http://www.wessex.ac.uk).

### JULY

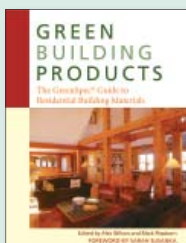
**7-9 • Eco Show 2006 and Greenbuild Australia**, Sydney, Australia. *Organizer:* WSB Media Group. *Information:* [www.ecoshow.com.au](http://www.ecoshow.com.au).

### SEPTEMBER

**19-22 • Rethinking Sustainable Construction '06**, Sarasota, FL. *Organizer:* University of Florida. *Information:* [www.treeo.ufl.edu](http://www.treeo.ufl.edu).

More complete information and additional listings are online at [www.BuildingGreen.com](http://www.BuildingGreen.com).

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