DAN PROBST

WILL THE RECESSION KILL THE MARKET FOR GREEN ARCHITECTURE? QUITE THE OPPOSITE, SAYS THE CHAIRMAN OF ENERGY AND SUSTAINABILITY SERVICES AT CHICAGO-BASED REAL ESTATE GIANT JONES LANG LASALLE. IN TODAY’S DOWN ECONOMY, ENVIRONMENTAL DESIGN IS A MUST-HAVE.

Is the slump slowing developers’ investment in green architecture?
Our clients fall into two basic categories: investors and corporate owner/occupiers. When you are an owner/occupier, there is a pretty clear return on investment. If you are saving energy, it is going right to the corporate bottom line. And a lot of corporations have social responsibility programs and public goals for reducing their carbon footprint. They recognize that a large portion of their environmental footprint is tied up in real estate. So, they have been pretty progressive.

On the investor side, investors in multitenant office buildings have been a bit slower to pick up on this. But that has begun to change quite dramatically in the last six months or so.

Why the sudden change among investors?
Talking primarily about existing buildings, there are a number of drivers. Investors want to lower operating expenses, so energy retrofits start to make sense. They are starting to see what is going on in the regulatory environment and want to be out ahead of it. And in down cycles, investors want to find every angle, to be more competitive in the marketplace. Their tenants are starting to ask questions. Sustainability is not number one on the list of a prospective tenant picking a location, but it is on the list. It is getting incorporated into RFPs. Then developers are saying, “Well, gee, how does my building compare? How do I stack up? Are there things I can or should be doing?” Which comes back to our acquisition of the Green Globes tool from ECG for assessment and helping someone improve their building [ARCHITECT, August 2008, “Real Estate Investor Acquires Green Globes Developer,” page 21].

What about new construction? Are you seeing enthusiasm on the part of real estate investors in sustainability?
We are continuing to see increasing enthusiasm. It is a matter of degree. There had been some cost premium in the past to building buildings that meet certain green standards. That is quickly evaporating as new materials become available—the market for recyclable materials that was not there a couple years ago to the extent it is now—and as architects and engineers better understand green building criteria and are able to incorporate those concepts into their design.

Not every new building is going to be built to meet LEED platinum, for instance, but you are going to see good environmental design built into all new buildings. On the energy side alone, with the escalating prices, the numbers show that buildings built to LEED standards have operating expenses as much as 30 percent less than conventionally designed buildings. Those are pretty hard numbers to ignore.

You are also starting to see the impact of sustainability on location strategies. Companies are getting more focused on location strategies that enable them to be close to where their employees live or close to public transportation. Everybody’s commute is part of the company’s carbon footprint.

Is there an appreciable swing away from suburban properties?
I think it is too soon to see the impact of that thinking in the market, but it may be coming. Locating way out in some greenfield development in a remote suburb has its own implications in terms of the environment, but looking at urban infill and public transportation and transit-oriented development is going to become much more popular.

Are we at a watershed moment? It seems like the stars are aligning.
You know, it has really shifted to a business imperative. It is about the fact that energy costs continue to escalate, are extremely volatile. Buildings that are designed to these standards just perform better and have lower operating expenses. Corporations are feeling pressure from their shareholders about the environmental performance of the building, and they want to understand if there is some future risk because of legislation. Customers are asking companies about their environmental performance before they do business with them. Prospective employees are considering the environmental performance of a company before they go work for them. And then you do have the regulatory environment, which just increases every day. And the popular thinking is, no matter which candidate wins the presidential election, they are both advocating a more progressive legislative agenda in this area. So, there are all these forces coming at companies. The smart investors see that, and if their building is not meeting some level of environmental standards, they may become less competitive.
How green buildings are smarter

By Deborah Snoonlan, P.E.

Architects have always aimed to make buildings comfortable and safe, but various forces in effect today make these goals more pressing than ever. Over the past decade, the continued dwindling of natural resources, coupled with studies that demonstrate the adverse consequences of poor indoor air quality, have given rise to an increasing demand for building products whose manufacture, transport, use, and disposal safeguards both environmental and human health. Yet, though using green products is a critical step toward making buildings sustainable (see "What Makes a Product Green?" on page 173), in the long haul, slashing the power consumption of the built environment is what reaps the most benefits environmentally.

The current state of our built environment with respect to this last goal is a mixed bag. According to the Department of Energy, which surveys commercial buildings every four years (see map inset and graphs for more detail), the number of buildings in the U.S. has increased steadily since 1979 while total energy consumption has remained flat—suggesting we have found ways to make our structures more efficient. Yet buildings constructed after 1980 use more energy per square foot than older buildings, which contradicts this assertion. Suffice it to say that, on average, we’ve got a long road ahead of us—in the U.S., anyway.

But that road is being cleared of obstacles. The nationwide push to make buildings sustainable will hasten the efficiency of new buildings. In the past five years, cities such as Seattle, Chicago, New York, Arlington, Virginia, and many others have adopted green building guidelines and incentives for developers to build efficient structures using renewable power sources such as solar and wind energy. The U.S. Green Building Council has seen a four-fold increase in its membership since the mid-1990s and a growing list of projects undergoing certification. At the council’s first national conference, in November 2002, in Austin, Texas (which attracted nearly 4,000 people, more than double the number expected), the workshops and presentations emphasized the merging of the practices of architecture and engineering to fashion buildings more holistically from the design phase forward. This was true of both new construction and retrofits, in which owners have invested in energy-management technologies for systems such as HVAC and lighting to automate energy savings and cut operating costs.

Once in a great while making a structure more energy-efficient can even have spectacular unanticipated benefits. For example, on September 11, 2001, a high-tech energy-management system (EMS) played a role in saving many lives. It prevented millions of dollars in damage to a building whose continued operation was crucial for safeguarding national security. That building was the Pentagon.

Inside the Pentagon’s energy-management system

In the mid-1990s, Steve Carter, who holds the clunky title of real estate and facilities liaison to the $1.85 billion Pentgion Renovation program, was given a mandate: Reduce the energy bill of the Pentagon by 35 per-
Energy-saving technology can have unexpected side benefits for building safety and intelligence. One case study shows us how.

Midwestern buildings weigh in between other regions of the country in building size, age, and energy consumption. They are ranked second in total energy consumption, but third in per-building and per-square-foot use of energy.

The densely populated East has the highest number of buildings constructed before 1959. The average commercial building size is 18,000 square feet, larger than elsewhere in the country. Its structures use the most energy per square foot.

The states in the West have buildings that are newer, on average, than in other parts of the country. Its buildings also consume the least amount of energy on a per-occupant basis, and only slightly more energy than those in the South on a per-building basis.

As the largest region in the survey, the South has the highest number of buildings and the largest amount of square footage. On a per-building basis, its buildings are the most energy-efficient of the four regions of the country.
cent by the year 2010. Carter, an engineer, has worked at the 6.6-million-square-foot Pentagon for more than 17 years and knows its building systems as intimately as a chiropractor knows the spine. What Carter convinced his superiors to do was invest in a new energy-saving digital backbone for the Pentagon.

The primary feature of this backbone is an energy-management system that links together various direct digital control (DDC) technologies to automate the building’s HVAC system and make it easier to monitor and manage. Included in the EMS is equipment such as sensors for air flow and temperature, as well as actuators that control the actions of fans, pumps, and motors. DDCs were first developed in response to the energy crunch of the 1970s. Today, all modern HVAC equipment is digitally controlled, and EMSs are a common element of large-building construction because they offer efficiencies in operation that can pay for themselves within two to three years, according to industry groups.

As the Pentagon is renovated section by section, the HVAC equipment will be upgraded in sections as well, with new, DDC-equipped components replacing the old, manually operated ones. When Carter was given his energy-savings mandate, renovation staff were preparing to make over the first section of the Pentagon, Wedge 1. He proposed something radical—while replacing that wedge’s HVAC systems, why not retrofit new DDCs onto the existing 55-year-old HVAC system in the other four wedges? And while they were at it, why not centralize the building’s operations in a single location?

The price tag on his suggestions made them unpopular. “Nobody wanted to pay to put new controls on 55-year-old equipment, knowing it would all be replaced anyway during the renovation,” Carter recalls of the resistance he faced. Still, he persisted, demonstrating that the investment would pay itself back rapidly in dramatically lower energy bills and adding that consolidating the Pentagon’s operation in one location would streamline maintenance. In the end, his wishes were granted. That was in 1997.

The ultimate result was the Building Operations and Command Center (BOCC), which opened in the newly renovated Wedge 1 of the Pentagon on June 8, 2001. The BOCC is like the Pentagon’s brain, the place where a network of thousands of DDCs that make up the EMS come together, and where information on the building’s condition is collected in real time. In the BOCC, maintenance staff can take the Pentagon’s pulse by watching five 90-inch display screens that show data such as room temperatures and pump statuses. They can spot trouble and fine-tune these systems from their workstations, or, if need be, they can also tap into the BOCC’s

Over 500 mechanical equipment rooms are controlled by the Pentagon’s EMS.
information system via laptop connections in the Pentagon's 500-plus mechanical rooms. This balance of centralized and distributed building information was both an innovation and a coup for a government-owned building of this size.

As Carter and his staff began working with the new system, they thought of more capabilities to add on top of the standard EMS technology. "We put in water sensors and leak detectors under all the air handlers, and gas detection where the natural gas system was, so that exhaust fans would be turned on if gas concentrations got too high in some areas, and we made sure the fire-detection system was linked to the HVAC system," he said. "We realized, too, that we could shift air patterns in the building—pressurizing some areas to keep out heat and smoke in case of fire, for instance." A laundry fire in one of the Pentagon's cafeterias in the summer of 2001 proved this was no small convenience: The smoke was tightly contained around its area of origin, and after the fire was doused, engineers were able to desmoke the building in 20 minutes. "The fire department was totally amazed. Everyone was really excited by what we were able to do," Carter said.

But the biggest test of all came on September 11, 2001. That morning, like most mornings, Carter was in his office in the BOCC. He and his colleagues were watching the twin towers burn on television when the plane struck Wedge 1. "All the control boards in the BOCC switched over and showed that the fire alarm system was going off," he said. "We immediately started shutting down some of the air handlers, but our first thought was, nothing could be this massive." But massive it was. Shortly after the crash, the BOCC lost power—and the operators lost their ability to watch or make adjustments to the building from there. Carter grabbed a two-way radio and headed to a mechanical room nearby that still had power. From his laptop, he tapped into the BOCC's information system (fortunately still intact) and sent out commands that closed dampers and turned off fans all around the Pentagon to contain smoke and starve the raging fire of oxygen. When he learned that a breached water main had caused the water pressure in the building to dip too low for firefighting, Carter dispatched a few of his engineers to the bowels of the building to remedy the problem. All in all, eight people stayed in the Pentagon on September 11, controlling the fire damage remotely via workstations from various mechanical rooms in the building, with Carter directing the effort by radio.

On September 12 the Pentagon reopened. One hundred eighty-nine people had been killed (125 on the ground), and the building suffered $501 million in damages. But the Secretary of Defense's office, the National Military Command Center, and other mission-critical areas such as data storage centers and wiring and switch rooms were spared, thanks to the energy-management system and eight people. Had the building's HVAC system not been automated and centralized—again, with the intent of saving energy, not lives—Carter and his maintenance staff would have faced a grave situation. To control the fire and smoke they would have had to close dampers and turn off fans manually in more than 500 mechanical rooms. Even if it were possible to reach these rooms in the midst of this conflagration, it would have taken many hours to do it.

While what happened at the Pentagon on September 11, 2001, was extraordinary, it speaks volumes about how sophisticated energy-management systems have become in enabling people to control building environments. Architects and engineers are only beginning to comprehend the benefits EMS technology holds for the future.
Critic Peter Buchanan argues that **green design** has too often been thought an add-on. A new exhibit asks viewers to think of environmental sustainability as a synthesis of technology, poetics, and place.

Green buildings are the inevitable future of architecture. Conventional buildings consume and contaminate vast amounts of water, and are responsible for much of the greenhouse-gas emissions that cause global warming—the most tangibly urgent environmental problem threatening our whole way of life.

Whether drawing on long-proven traditional strategies or innovative new techniques, green design everywhere, but especially in Europe, is moving to a new, more holistic scale. Buildings already exist that are sparing in their use of water and energy, and even export energy harvested from sun and wind. Such buildings can also be more profitable than conventional...

*James S. Russell adapted material supplied by Peter Buchanan, a London-based architect, writer, and critic, who curated the show.*

**WWW** Go to Green Architect at www.architecturalrecord.com for more
Project: Cotton Tree Housing, Maroochydore, Queensland, Australia
Architect: Clare Designs
buildings, largely because their occupants prefer them. Though such buildings may include unconventional elements, their acceptance by users accords with major changes sweeping through the culture.

Americans and Europeans alike have wondered why, to date, there has been so little of this kind of innovation in America—a nation that was once a fount of architectural progress. What seems to be missing from American work is the synthetic impulse one sees in the most insightful international projects: the poetics of architecture brought together with the most sophisticated engineering and technology. The Architectural League of New York has brought some of the best recent work to America in an exhibit. Ten Shades of Green, which opened in New York’s Urban Center in March, shows nine European buildings and four North American houses (grouped together as a 10th “shade”).

The title also refers to 10 themes that need to be considered to create a fully green or sustainable built environment. Some are familiar; others are too infrequently considered green in America. The show’s twin strands are intended to help professionals and the ordinary public engage with the designs and the ideas informing them, and also to better appreciate the rich way they have synthesized numerous tactics in even the most understated of structures. (The exhibit closes May 13, but is expected to travel to additional cities.)

These themes and buildings were chosen to dispel lingering misconceptions. They are not meant as prototypes suitable for universal deployment, nor must every green building subscribe to every item on the list—some of the projects do a few things very well. The Minnaert building uses just one element, rainwater, as a means to absorb heat generated by the building’s dense array of computers. The Götz headquarters cleverly exploits the thermally moderating qualities of a double curtain wall and a shaded atrium. Others, such as Nottingham University’s Jubilee Campus, unite an impressive number of strategies: A new lake and band of trees modulate climatic extremes; cowls atop

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Project: Jubilee Campus, University of Nottingham, Nottingham, England
Architect: Michael Hopkins & Partners
stair towers were shaped to create negative pressure to draw in prevailing winds for natural ventilation; atrium spaces serve as casual meeting places while thermally buffering classrooms.

Among the reasons the exhibited projects have been successful is that they do not look at green design purely as an exercise in diminished energy consumption and pollution. Nor do the solutions lie even primarily in the electrical or mechanical realms. These architects don’t see specifying low-emissivity windows, non-polluting paints, and low-flow toilets as the limit of their influence. Consider Commerzbank, which embodies numerous green technologies [January 1998, page 68]. The skygardens offer appealing casual meeting places. The vistas across its atriums subtly reinforce solidarity to co-workers on other floors in ways a conventional tower never could. In other words, the 10 themes represent a nexus of interrelated social, cultural, psychological, economic, and even poetic dimensions that transcend the product-oriented add-on approach.

Ten Green Themes

Buildings designed to use as little energy as possible and minimal or no fossil fuel are low energy/high performance. The biggest energy consumer is artificial lighting; next is air-conditioning, particularly the cooling cycle. Whatever energy is required is drawn as much as possible from ambient sources. Replenishable sources avoid overtaxing the earth’s resources by harvesting energy from sun and wind, waves and gravity, and using materials from renewable sources such as sustainably managed forests, or virtually inexhaustible ones such as mud, clay and sand. Recycling today means reusing entire buildings and assemblies, not just making use of reprocessed industrial waste. New buildings can be designed to facilitate recycling through easy disassembly of components. With fresh water among the world’s most threatened resources, capturing rainwater to irrigate plants or flush toilets will soon become a necessity everywhere, along with purifying “grey” water through reedbeds. Embodied energy takes into account the energy required to extract, manufacture, transport, and assemble materials and components. The greater use of wood in European architecture recognizes that its extraction, fabrication, transport, and assembly require the lowest energy output. (Aluminum requires 126 times the energy to produce.)

By designing buildings to be easily adaptable to new uses, architects conserve the energy embodied in their construction and increase the returns on initial investment, which is why long life, loose fit is an ecologically appropriate strategy. Architectural character can survive the vicissitudes of time. Total life cycle costing is an essential part of the
holistic thinking that makes sustainable buildings successful financially and evokes pride among owners and users alike. Of course, part of the life-cycle cost of a building is whether its useful life ends in 15 years or in 50. A building made of sturdy, appealing materials, with ample light and views, will find new uses. Even if a green building can’t adapt to future circumstances, its recyclable components will retain value even as the structure is demolished. A true life-cycle analysis will take into account such social costs and benefits, the ecological impact of the materials it uses, and the recyclability of its components, for example.

Achieving sustainability will also involve new ways of arranging human settlement. Energy-conservation virtue means little if a building is erected miles beyond the reach of public transport. Consideration of access and urban context is part of what makes a building green. Building owners too often fear that health and happiness will not be reflected in the bottom line. The best green buildings are pleasant and healthy places for people. A

Green design influences the whole form of a building and is one of its main generators from the first moments of design. As a corollary, green design is no constraint on creativity, but rather a stimulus to more novel and relevant designs. Green design is not incompatible with architectural excellence. Despite its all-glass roof and fully-glazed west elevation, the Beyeler Foundation Museum [May 1998, page 160] is exceptionally energy efficient. Europe’s leading architects, including Renzo Piano, Norman Foster, and Michael Hopkins, are also among its best exponents of green design. Soon no building will be considered first-rate if it is not also green.

As one of the 10 Shades themes asserts, green buildings cannot be designed in the abstract but are shaped by their reciprocal interactions with all aspects of a place, including its history and traditions as well as the microclimate and ambient energies that impact upon it. This is the strength of the Australian Cotton Tree Housing and the best North American work, whether it be by Lake/Flato in Cotulla, Texas; Fernau & Harman in coastal Marin County, California; Rick Joy, in arid Tucson; or Brian Mackay-Lyons in chilly Nova Scotia [April 2000, page 108]. For larger, less traditional building types, design tends to rely on meticulous surveys of all aspects of the setting (such as ecology, microclimate, and

Project: Minnaert Building, Utrecht, the Netherlands
Architect: Neutelings Riedijk

Project: Hall 26, Hannover Fairgrounds, Hannover, Germany
Architect: Herzog & Partner
hydrology) and state of the art engineering analysis. The design process is often far more intense than for standard construction, involving detailed computer studies and predictive modeling as well as constant collaboration with creative engineers. More sophisticated buildings need to be very precisely engineered: users cannot compensate for miscalculations by fiddling with the thermostat, because one of the benefits of the higher design effort is to reduce or eliminate dependence on mechanical air conditioning and ventilation.

“Clients won’t pay for it” is the usually cited obstacle to green design in America. It is true that Europe enforces aspects of green design through increasingly stringent laws. The European Union actively encourages sustainability by sponsoring research and experiment. (The Jubilee Campus and the Mont-Cenis Training Center [December 1999, page 199] both benefited from research paid for by the EU, which also subsidized their photovoltaic cells—a technology that such applications is making economically viable. But many green buildings are commissioned, often to standards exceeding Europe’s requirements, because clients (even speculative

building’s initial capital costs amount to only a small fraction of the total costs of ownership over time. More important, the salaries paid to occupants of a commercial building dwarf the operating costs. The advantages green buildings offer (fewer sick days, better employee retention) translate into enormous economic benefits quickly. Truly sustainable design transcends mere technical, ecological, and economic issues. By fostering community and connection, it brings the nurturing social linkages of the city and the inspiring aspects of the natural world into manmade realms. Today’s mechanized world puts us out of touch with the sensory pleasures of physical reality and the social ties that bind. Architecture can put people in contact with these precious aspects of life. ♦
developers) recognize their economic virtues.

Green buildings do not necessarily cost more than conventional ones. (Both the Jubilee Campus and the Minnaert Building are low-cost.) The reduction or elimination of mechanical systems tends to offset extra costs for more precise assemblies or for a more complex building shell. Diminished running and maintenance costs soon bring additional savings. But spectacular economic benefits arise from the impact on the occupants. Typically in green workplaces, absenteeism and staff turnover (and so retraining costs) drop considerably and productivity increases. Lockheed-Martin’s Building 157, built in the 1980s in Sunnyvale, California, is just one documented American example. With an American economy desperate for skilled labor, these are major incentives for American clients to build green.

Other common criticisms of green design are that it requires people to sacrifice comfort or convenience. Greater familiarity with such buildings will cause these concerns to evaporate. Improved quality of life explains the deep appeal of green buildings to their occupants. After the alienating isolation of sealed and artificially lit and ventilated buildings, people are overjoyed to re-establish contact with the outdoors, especially because well-designed green buildings embed themselves beautifully into their environment and enhance people’s contact with nature.

Green design also reinforces the social life within buildings. The rise and ebb of the rainwater-fed pool inside the Minnaert building...
puts its college community in touch with forces of nature otherwise taken for granted. The ponds and native reed beds built within the Slateford Green housing are arranged not only to filter grey water and shelter wildlife, they are arranged to create attractive places for residents to stroll or socialize. It is easy to underestimate (or simply to fail to value) design that is sensually satisfying and psychologically meaningful. But by allowing a building to resonate with people’s deep need to connect with nature and each other, we simply recognize forces that are increasingly coming to the surface in our culture. Instead of requiring any sort of regression, the green agenda asks us to step forward into a new culture that replaces the real-estate developer’s simplistic product or the marketer’s focus group-derived pastiche with buildings that allow us to become who we really can be.

Yes, the environmental crisis makes green buildings an urgent priority. A deep-seated desire for more appropriate buildings may be asserting itself even without the crisis that is currently helping to precipitate the changes in our values. These buildings don’t deliver just low fuel bills and reduced emission of pollutants, they celebrate and symbolize human aspiration.
There are numerous ways to determine just how sustainable so-called green products are today

**INDIVIDUAL PROJECTS MAY BE FREE OF TOXIC EMISSIONS, BUT A PROJECT’S TRUE SUSTAINABILITY QUOTIENT DEPENDS ON A SCIENTIFIC ANALYSIS OF THE LIFE CYCLE OF ALL THE MATERIALS**

*By Nadav Malin*

A conversation with Ronald Dean of Farr Associates in Chicago illustrates how far some firms have come in their approach to green materials. Through their research and past projects, the designers at Farr Associates are very familiar with the considerations that go into choosing green materials, and factor those into their decisions as a matter of course. With that approach as a baseline, they are able to integrate green products into the broader quest for the right materials with which to construct a project. “It’s not just about whether the product is green, but how well it fits into the design and the stories we’re trying to tell with the building,” says Dean.

For some projects, an explicitly natural or ecological aesthetic is appropriate, suggesting a certain style of visibly green products. “We designed a clay-straw retirement home for a woman,” Dean explains, “and all materials going into that project tended to relate to that aesthetic or philosophy—a lot more wood, plaster, unpainted systems.” But any projects can use green products and materials, either by covering natural materials with more conventional finishes, or choosing from a palette of products that are environmentally sound even if it’s not obvious at first glance.

**What makes a product green?**

So, what constitutes an environmentally sound product? What should you look for, and how can one distinguish real green achievement from marketing hype? The tools and resources available to designers have, until recently, relied almost exclusively on a handful of attributes, such as recycled content or low indoor emissions, as indicators of environmental performance. For example, the U.S. Green Building Council’s LEED Rating System allocates points for the use of materials that are salvaged, recycled, rapidly renewable, locally produced, or harvested from well-managed forests.

But these attributes, considered in isolation, may be misleading indicators. Just because a product has one sustainable ingredient does not automatically make it the best environmental choice, as it may also have undesirable traits. Some recycled rubber flooring products, for example, offgas chemicals that make them inappropriate for indoor applications. And straw-panel products work great in some applications, but they are more sensitive to moisture than wood-fiber panels, making them less durable in damp climates.

To avoid these problems, researchers and environmental advocates are developing more holistic methods to determine which products are environmentally preferable. Most of these are based primarily on a system called life-cycle analysis (LCA)—not to be confused with the engineering practice of life-cycle costing. In LCA, researchers study a product from its origins as raw materials, through processing, manufacturing, and use to its ultimate disposal or reuse. For every process in this life cycle, they quantify the flows of resources and pollution, and then estimate the environmental impacts of those flows.

In theory, this comprehensive LCA approach allows us to know with more certainty which products are environmentally preferable. Indeed, the U.S. Environmental Protection Agency (EPA) recommends LCA as the basis of the Environmentally Preferable Purchasing programs that federal agencies are required to implement. The EPA has also helped develop some of the research and modeling...
New software packages allow designers to calculate the environmental burdens of materials

Most life-cycle analysis (LCA) software is complex and expensive and is best used by consultants who have the training to use it appropriately and interpret the results. Two software tools are now available, however, that can be easily used by any designer. New versions of both products have recently been released with significant new features, and they have very different emphases.

The Athena Environmental Impact Estimator version 2.0 (sample output shown below) is organized around building elements or whole buildings. It is a simple modeling tool, in which the user describes the primary building elements by inputting dimensions and choosing materials from a menu of options. Based on this model, the software computes a bill of materials, and then tabulates the environmental burdens of the project. The results can be displayed as tables or charts, either for a single project or as a comparison across multiple projects.

The software does not predict energy use from building operations, but it does include an option to input that information. The impacts of that energy use, reported as either annual energy use or energy use for the entire life of the building, can be included in the LCA results. The developers of Athena EIE hope that it will eventually be available as part of standard CAD software, making environmental-impact information available during the design process at the click of a button. Athena software is available for $390 from the Athena Sustainable Materials Institute: www.athenasm.org.

The second tool is Building for Environmental and Economic Sustainability (BEES). Unlike Athena, which is based on building elements, BEES focuses on individual products and materials. Version 3.0 makes it possible for the first time to compare brand-specific products. For example, the user can now compare the EcoWorx carpet tile from Shaw Industries with the PowerBond ER3 tile from Collins & Aikman or the Sabi tile from Interface Flooring. (The ER3 looks slightly better than the others, although the final result depends on how you choose to weight the relative importance of the various environmental-impact categories.) Eighty products from 34 manufacturers are included in the current version. It is also possible to compare generic products based on industry-average data for those product types.

The new release of BEES uses the latest EPA methods for analyzing the data. BEES 3.0 is free from the National Institute of Standards and Technology: www.nist.gov/oea/bees.html.

methods used to estimate the impacts of resource use and pollution associated with a product's life cycle.

In practice, however, LCA requires so many assumptions and approximations that any results it generates must be viewed with some skepticism. Even if the assumptions and underlying data are reasonably good, a margin of error of 30 percent or more is typical, so only very large differences in the scores of competing products are meaningful.

IN THE CASE OF INDOOR AIR EMISSIONS, MOST RELEASES OF VOLATILE ORGANIC COMPOUNDS (VOCs) DECREASE OVER TIME.

Before it became popular as a method for comparing and choosing products, LCA was developed to inform companies' internal product development. From this background came one of its strengths—the ability to tell us where in a product's life cycle the biggest environmental burdens are generated. In the case of building products, LCA results show that energy use or indoor air emissions during use are often the most important consideration.

For any product that affects the building's energy use, such as a variety of scales ranging from a chiller to a window or light fixture, selecting the model that saves the most energy almost always results in the lowest overall life-cycle burdens. Even ceiling tiles can make a difference—in a space that uses indirect lighting, the reflectivity of the ceiling is probably more important overall than the amount of recycled content in the tiles.

In the case of indoor air emissions, most releases of volatile organic compounds (VOCs) decrease over time. So the use of a very low-VOC paint may be important initially, but after a few months or years that benefit is negligible. Chemical emissions from ongoing maintenance, however, do not taper off in the same way. One study suggests that a single instance of stripping and waxing a floor releases as many unhealthy VOCs as are released by the installation of the flooring itself, including the adhesive, over its entire useful life.

A comprehensive look at materials highlights the fact that when we install and use a product in a building, we are engaging with that product at one point in its overall life cycle. Prior to reaching our job site, the product evolved through a series of resource extraction, manufacturing, and transportation activities. After it is no longer needed in our building,
more activities will be required to dispose of it or prepare it for reuse or recycling. Each of these processes had its own material and energy requirements and pollution emissions.

While the environmental burdens resulting from a product’s history and its future are important, they are rarely as important as the product’s performance in the building. Carpet got a bad reputation in the green building world in the early 1990s, due to concerns about its role in indoor air quality problems and due to the enormous waste caused by the tons of carpet replaced each year. Since then, carpet companies have been aggressively combating that image, and nearly every company claims that their products are green. Different companies are approaching that goal in very different ways, however. Noted below are features of products by some of the most progressive carpet companies.

Nearly all commercial carpet uses nylon face fibers. Nylon comes in two varieties: nylon 6, supplied primarily by Honeywell and BASF, and nylon 6.6, supplied by DuPont and Solutia (formerly Monsanto). Nylon 6 is easier to recycle, while nylon 6.6 may be more durable. A number of companies, including Interface Flooring, Lees, Shaw, J&J Industries, offer recycled-content fiber, though efforts to get large-scale recycling efforts going for turning old carpet fiber into new have not yet become commercially viable. Interface has also experimented with natural fibers, such as hemp, in commercial carpets, and plans to release carpet with fibers made from agriculturally derived plastics.

As conventional dyeing processes use a lot of water and generate significant waste, solution-dyed nylon is preferable. Many carpet fibers are treated with stain-resistance and mold-inhibiting chemicals, which can be beneficial (reducing the need for cleaning agents, reducing mold), yet the treatments themselves may also represent a health and environmental risk.

Nearly all companies use polypropylene fabric as the primary backing into which the face fiber is tufted. As petrochemical resins go, polypropylene is relatively simple and benign. Lees’ Metafloor product line takes a unique approach by beefing up and pigmenting the primary

This sample chart shows three cladding alternatives—brick and mortar, stucco, and aluminum siding—that have been examined across all 12 environmental-impact categories by using Building for Environmental and Economic Sustainability (BEES), a Windows-based, decision-support software. BEES is a powerful technique for selecting cost-effective, environmentally friendly building products. All stages in the life of a product are analyzed. (The difference between BEES and the Athena program is discussed in the sidebar on the previous page.)
New wood-certification projects have emerged to address concerns about logging practices

Wood has come under fire as a building material in the U.S., mostly by environmentalists concerned about logging in the old-growth forests of the Pacific Northwest and in tropical rain forests around the globe. From a manufacturing perspective, however, wood is a relatively low-impact building material, because trees do most of the manufacturing themselves, using photosynthesis. The amounts of energy and resources needed to mill and dry wood are small compared with those used to manufacture concrete or steel. To address concerns about logging practices and the associated loss of wildlife habitat and siltation of streams from runoff, a number of certification programs have emerged.

These programs monitor logging practices on the ground and certify forestry operations that meet their standards. The only such program that has widespread endorsement is that of the Oaxaca, Mexico–based Forest Stewardship Council (FSC). The FSC’s “Principles and Criteria” aim to ensure that forestry practices are environmentally responsible, socially beneficial, and economically viable. These global principles are translated into meaningful standards at a local level through a region-specific process of setting standards.

FSC also accredits and monitors certification organizations. These independent, third-party auditors annually evaluate compliance with FSC standards to award certifications. In addition to certification of forest-management practices, FSC-accredited organizations certify companies that process, manufacture, or sell products made of certified wood to ensure that a reliable chain of custody can be established. The majority of FSC certification audits performed in North America are conducted by SmartWood and Scientific Certification Systems (SCS).

Simply adding the FSC requirement to your standard specification is not enough. First, the quantities, species, and grades of wood that are available with FSC endorsement are limited, so you must find out what is available that will fit the needs of your project. Second, even if the material is available, it is best not to specify the highest grades of wood (at least not in large quantities), because only a small fraction of the lumber from any one logging operation can meet those grades. Specifying lower-grade wood greatly reduces the pressure to cut large, old-growth trees, and can save a lot of money. Often structural requirements can be met without using the highest grades.

To ensure that the wood used is actually certified, your specifications should require that project contractors and subcontractors submit vendor invoices containing their chain-of-custody certification numbers and identifying each certified product on a line-item basis. For more information, contact the Certified Wood and Paper Association: www.certifiedwood.org.

backing so that it can become part of the exposed surface of the floor covering, thus greatly reducing the amount of face fiber needed.

Most broadloom carpet is made with styrene-butadiene latex (SB latex) and a chalk filler, as the secondary backing. High-end products use a more dimensionally stable urethane backing. Many companies now offer a urethane backing option from Universal Textile Technologies that uses a soy-based polyol as one ingredient, comprising about 7 to 10 percent of the backing by weight. Lees Carpets’ two newest carpet lines use the Unibond RE backing, which contains 20 percent postconsumer recycled content.

Carpet tile products use either PVC (Interface, Collins & Aikman) or urethane (Milliken) backings. Collins & Aikman has led the recycling charge, with technology that shaves off most of the face fiber for recycling as nylon, and then recycles the rest of the carpet by mixing it into PowerBond E3 backing for new carpet. The residual nylon fibers in the recycled backing actually improve the product’s performance. Interface Flooring’s GlasBac RE backing system also uses a high percentage of recycled material.

Some companies have well-developed systems for taking back used carpet and utilizing it as a resource. Milliken Carpet, with its Earth Square process, extends the life of carpet tiles by taking back used tiles, retexturizing them, cleaning them, and overprinting them with a new pattern so they can be resold for about half the cost of new tiles. Interface Flooring’s Solenium product, introduced in 1999, was an effort to solve the future reuse problem by making it easy to separate the components.

Carpet innovations show that performance and sustainability aren’t mutually exclusive. If a product’s function affects the amount of energy or water used in the building, then how well it functions determines how good it is environmentally. More fundamentally, how a product or material works, functionally and aesthetically, is as critical in a green building as in any good design—if it doesn’t do its job, then it doesn’t matter how environmentally friendly it is. ■