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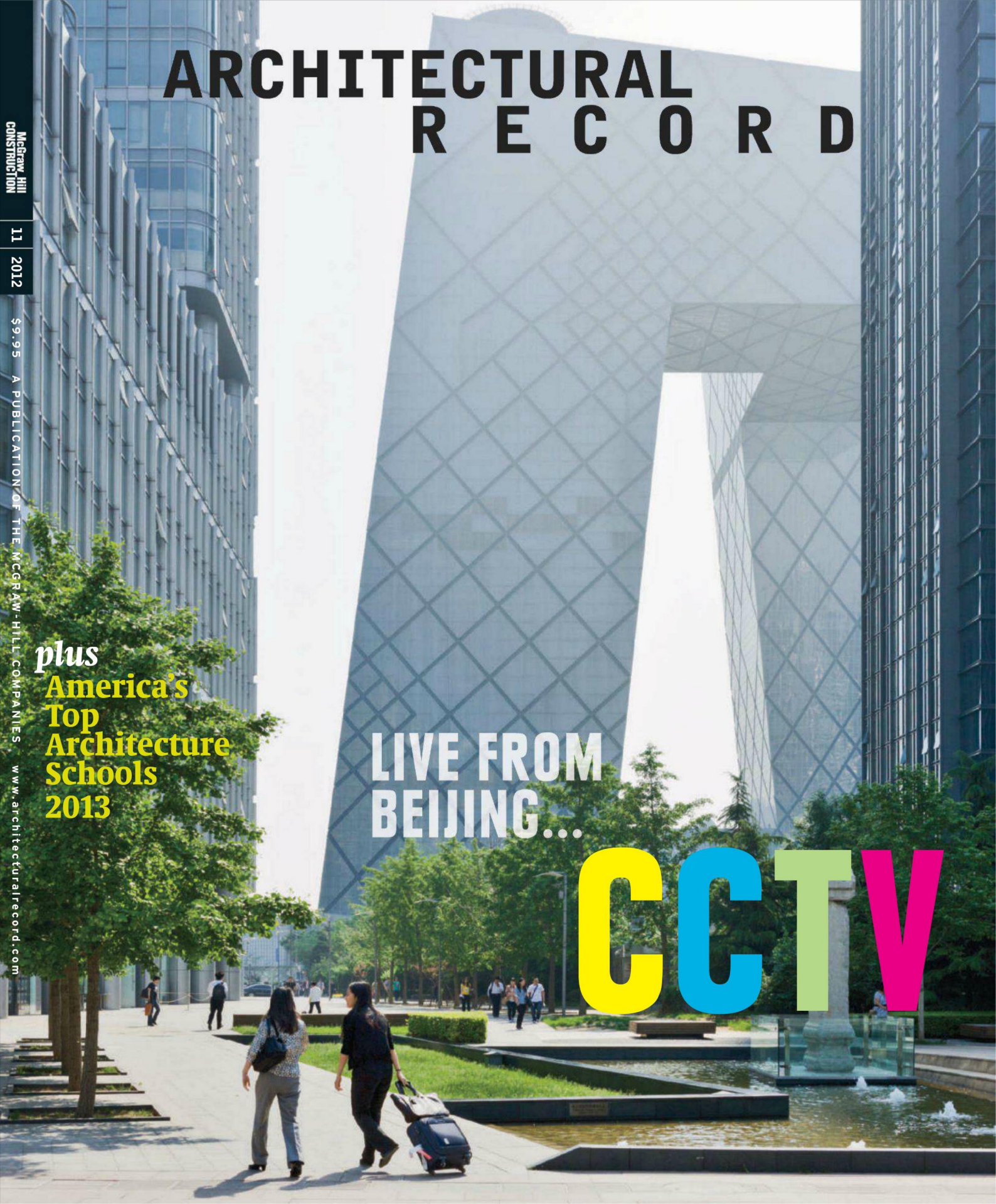
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The image shows a large, modern auditorium with a curved wooden ceiling. The ceiling is composed of various sized panels of light-colored wood, with integrated linear lighting fixtures. Two large, dark, cube-shaped speakers are suspended from the ceiling. The walls are also finished with wood, and there are large windows or glass panels on the side. The overall atmosphere is warm and contemporary.

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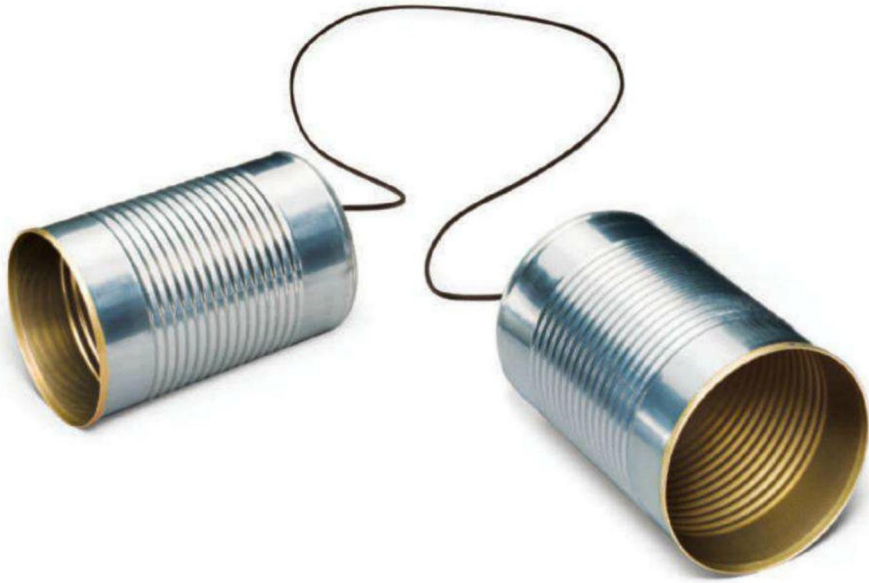
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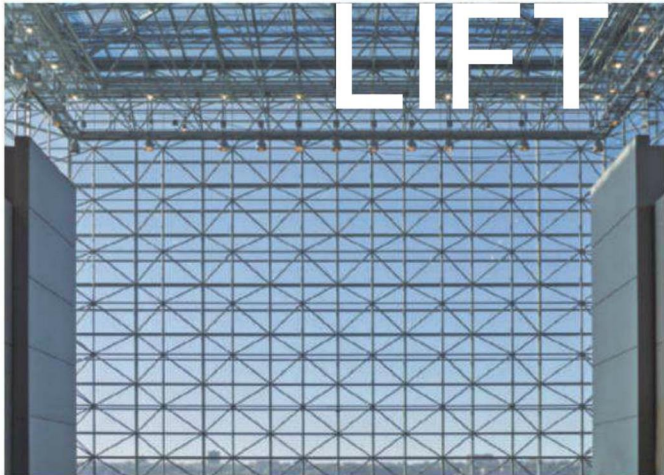
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## Transforming design into reality

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Architect: Epstein Global, FXFowle Architects  
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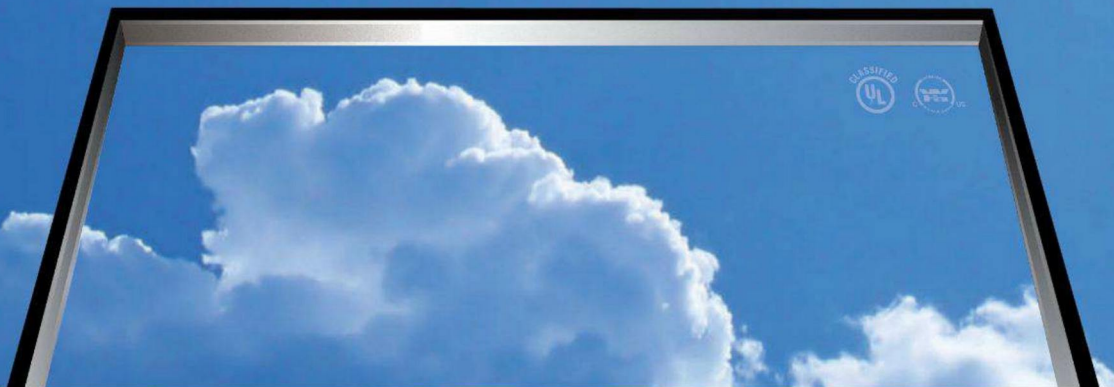
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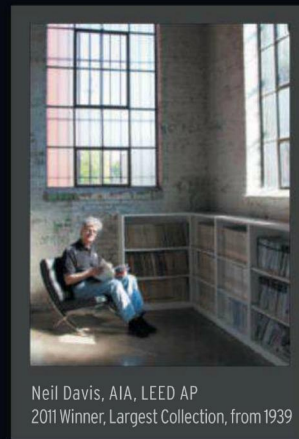
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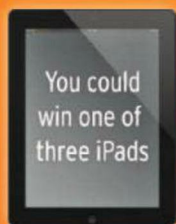


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ON THE COVER: CCTV HEADQUARTERS, BY OFFICE FOR METROPOLITAN ARCHITECTURE. PHOTO BY IWAN BAAN.

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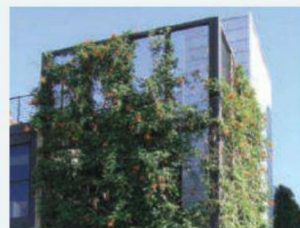


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## Innovation at Every Scale

Using high technology and low, architects are pushing new ideas in design and construction.

**EVERY YEAR** at this time, a new crop of students is busy assembling applications and portfolios for architecture school. In this issue of *RECORD*, we're publishing our annual rankings of the best graduate and undergraduate programs in the United States, from research conducted and analyzed by the *DesignIntelligence* group. Despite the costs of higher education—and the hammering the profession has taken in this economy—becoming an architect is still a powerful aspiration. In 2011, enrollment in architecture schools was down only 1.1 percent from the previous academic year, and the student survey included in our report (page 67) indicates that 82 percent of the respondents plan to become registered architects.

Anyone who can't understand why architecture remains such an alluring profession should have dropped in on *RECORD*'s 10th annual Innovation conference in New York last month, titled "Design Leaders Envision the Next Decade" (page 30). The stellar lineup of speakers exemplified the best in innovative thinking and practice, not only in the use of rapidly changing digital technology but in research, sustainability, and explorations in materials, engineering, and construction. The day belonged to newer leaders as well as more senior professionals: One of the panels celebrated the successes of four architects under 50 who had previously been chosen as significant emerging talents in *RECORD*'s Design Vanguard program. Two of the keynote speakers—Jeanne Gang and David Adjaye—were also former Vanguard winners.

Throughout the conference, the audience saw striking displays of innovation at every scale, from a small vaulted laminated-wood pavilion at Lincoln Park Zoo in Chicago by Studio Gang Architects to details for the tapering Kingdom Tower in Saudi Arabia by Adrian Smith + Gordon Gill Architecture, which will be the world's tallest skyscraper when it opens in 2017. Also shifting scales was William Pedersen, founding partner of Kohn Pedersen Fox, who joked that he'd spent more time perfecting the design of his "loop" chair than he has on some of his supertall structures—but the ideas behind both were connected. "A chair can inform a building, and a building, a chair," he said.

Material experimentation provided a common thread, too. Sheila Kennedy and her team at Kennedy & Violich like to subvert traditional materials, such as the marble they sliced to form thin plates for the entrance to Golkin Hall at the University of Pennsylvania Law School (page 109) or the cloth "walls" that harness solar energy in a housing project in Germany. Even commonplace applications of materials can lead to innovative solutions, as the Berlin-based architect Francis Kéré explained in his inspiring presentation about the schools and library he's designed of brick, stone, wood, and corrugated iron in his native village in Burkina Faso, constructed with the labor of the local community.



We heard, of course, about digital technology. "Computing performance doubles every 18 months," said Dennis Sheldon, chief technology officer at Gehry Technologies, and that enables increasingly ambitious architecture and improved integration of design and construction. Yet even with technological advances occurring at warp speed, the source of innovation is human and often messy, as many architects get their hands dirty, testing materials, making prototypes, and soaking up ideas from everywhere, including old-fashioned books. ("There are many volumes in our office library," said Jennifer Luce, "and very few are about architecture.") In this age of media complexity, as Gang put it, "most of the attention is on digital tools. But at our office we find that the newest technologies work best when supplemented by other forms of thinking and making, including hand-drawing, model-making, material experiments, and other forms of low-tech creativity."

Sometime in the future, people may look back at this moment—when we enthusiastically engage both high tech and low—and see it as just a blip in history. But now it seems an exciting time for the next generation of architects to explore a vast landscape of creative possibility. ■

*Cathleen McGuigan*

Cathleen McGuigan, Editor in Chief



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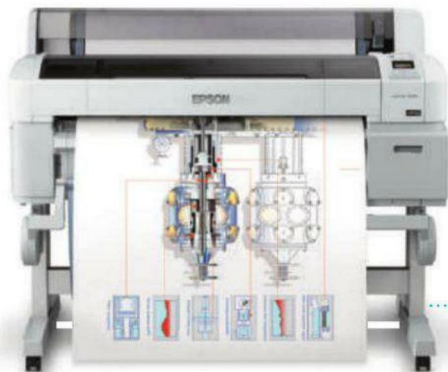
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# perspective

**“The office building is a dinosaur. No more should get built. Cafés are the office of the future.”**

—**Kent Larson**, principal research scientist at Massachusetts Institute of Technology’s Media Laboratory, speaking at RECORD’s Innovation conference on October 4

## Brits Declare War on School Curves

BY CHRISTOPHER TURNER



Foster + Partners' Langley Academy, with its curved facade, would not be sanctioned under new rules.

**MICHAEL GOVE**, Tory member of Parliament and the U.K.'s secretary of state for education since 2010, has declared a controversial war on “curves or ‘faceted’ curves” in school buildings—as well as “minimal indents, ‘dog legs,’ and notches in the plan shapes.” Folding partitions, glazed walls, roof terraces, and ETFE roofing are also banned.

In a series of new Design Templates for prototype schools published at the beginning of October—a document intended to steer architects bidding for \$4 billion in contracts for 261 state schools to be rebuilt over the next five years—the British government called for “simple rectilinear forms” and no-frills designs. Buildings such as Foster + Partners’ approximately \$34 million Langley Academy (2009), which has a cylindrical wooden facade with vertical louvers, would not be sanctioned.

Gove wants schools to be architect-free and, according to the critic Rowan Moore, churned out “the way Tesco builds its supermarket or McDonald’s its outlets,” with little consideration

of the realities of a particular site. With his prescriptions, which sit at odds with his party’s continual attack on the “nanny state,” Gove hopes to save over \$9 million on each secondary and primary school, which will be 5 to 15 percent smaller than previous designs. In response, the Royal Institute of British Architects warned that these prescriptions herald the “flat-pack” school.

Peter Clegg, partner at Feilden Clegg Bradley Studios, which won Building Design’s Schools Architect of the Year in 2009 and has built a dozen schools, complained that the guidelines were “extraordinarily overprescriptive and [show] an extreme lack of trust in the architectural and construction professions to deliver schools to budget. Why are they not just telling us how much they want to pay per square meter? I can understand them wanting to turn the screw on the budget, but why do they not give architects who understand these things the ability to decide?”

Gove’s suspicion of architects has a (*continued*)

## WAF Festival Turns Five

Over 2,000 architects and designers attended the fifth World Architecture Festival, held October 3–5 in Singapore at the Moshe Safdie–designed Marina Bay Sands resort. During the festival, a jury (which included Safdie) chose 37 award winners from over 500 entries. Cooled Conservatories at Gardens by the Bay, designed by London’s Wilkinson Eyre Architects and connected to the Marina Bay Sands development, was named World Building of the Year. The 250-acre project consists of three waterfront gardens, one of which includes the planted “mountain” (below). *Laura Raskin*



Visitors can experience the planted “mountain”—part of Wilkinson Eyre’s Cooled Conservatories project—from various platforms. The interior contains exhibition spaces.

(Brits continued)

long history. Soon after coming to power, he axed the previous Labour government's \$88 billion Building Schools for the Future program, which had the ambitious aim of rebuilding or renovating most secondary schools in the country. (Six local school authorities took him to court, claiming that he had unlawfully failed to consult them before imposing cuts, and a judge agreed that in five cases this failure was "so unfair as to amount to an abuse of power.") While many agreed that the Labour government's scheme had been poor value for the money, with construction companies, lawyers, and project managers getting rich at the taxpayers' expense, Gove singled out architects for particular blame. He accused them of "creaming off" money that would have been

better spent on teachers.

In January 2011, at the government's first conference for "free" schools, Gove went so far as to declare: "We won't be getting Richard Rogers to design your school, we won't be getting any award-winning architects to design it, because no one in this room is here to make architects richer." Rogers, a Labour peer, reminded him that Gove had been praising Hackney's Mossbourne Community Academy, designed by Rogers Stirk Harbour + Partners, only the day before. Later that year, architects awarded the Stirling Prize to Zaha Hadid's sinuous Evelyn Grace Academy (RECORD, January 2012, page 100). The \$56 million London secondary school, which zigzags over and makes the most of its tight site, was the first and only school that has

been awarded the prize, a move that many considered a political statement in the light of Gove's demonization of the profession.

At this year's Venice Biennale, Aberrant Architecture, whose very name seems designed to offend Gove, created an installation in the British Pavilion inspired by Oscar Niemeyer's experimental 1980s school-building program in Brazil. In and around Rio de Janeiro, Niemeyer and his collaborators built 508 precast concrete schools of standardized design. The architects proposed this radical scheme as a model for austerity in Britain, but Niemeyer's Modernist designs would have failed Gove's test. The undercrofts of these buildings are surrounded by arched loggias, and the facades are punctuated by lozenge-shaped windows. Even the Bauhaus had curves. ■

## Architecture Heals

BY DAVID HILL

**WHAT DO** you do with a building that's been the site of a mass shooting? Tear it down? Remodel it? Turn it into a memorial for the victims? How do you make a decision?

Nearly three months after the horrific shooting at an Aurora, Colorado, movie theater, which left 12 people dead and dozens injured, the theater remained closed. A chain-link fence covered with green privacy fabric surrounded the Century 16 theater, located next to a shopping mall. In August the theater owner, Texas-based Cinemark Theatres, asked the city of Aurora to conduct an online survey asking the community what should be done with the multiplex.

### Architect advises: Get input from survivors and victims' families before redesigning.

"We had well over 6,000 responses," says Aurora communications director Kim Stuart, "and the majority, over 70 percent, supported reopening the theater." In September, Aurora Mayor Steve Hogan forwarded the survey results to Cinemark's president and CEO, Tim Warner, urging him to refurbish and reopen the theater with a "possible facade modification." Hogan also asked that survivors and victims' families be able to visit the theater. In reply, Warner promised to "reconfigure the space and make it better than ever," and he said he hoped the theater would be ready "by



Columbine High School's library was redesigned after the 1999 shootings.

the beginning of the New Year." What happens next is unclear. Stuart says, "The design and planning will be Cinemark's." A Cinemark spokeswoman said the company had no comment.

While at least one shooting survivor has called for the movie theater to be demolished, others have countered that the actions of one person—accused shooter James Holmes—should not have the power to close a popular community-gathering space.

If architect J.D. Nelson has one piece of advice for Cinemark officials, it's this: Don't do anything without getting input from the survivors and victims' families. "Allow them to work through their anger by being involved in the redesign," he says. "It's part of the healing process."

In 2000, Nelson, now in private practice, was working for the Denver architecture firm Davis Partnership when he was asked to take the lead in redesigning the library at Columbine High School, where the previous year two

teens murdered 12 students and one teacher before shooting themselves. Ten of the victims were killed in the second-floor library, which was sealed off after the massacre.

Initially, Nelson says, school officials asked Davis to reconfigure the library to "make it look very different from the original library space." But as they began working on the project, a coalition made up of families of victims and survivors convinced the district to tear down the library. The group, Healing of People Everywhere, or HOPE, raised \$3.1 million to build a new

library and convert the old one into a two-story atrium by tearing out the concrete floor.

"The parents felt very strongly that the actual space where their children had died had to go away," Nelson recalls. "They wanted to completely erase the memory of the library. It was something I struggled to understand at the time. Why would the library space have to go away? But as we worked through the design process, I realized that the parents were dealing with their anger and their grief. Architecture became a kind of therapy." The atrium, complete with a ceiling mural showing an "ant's eye" view of aspen and evergreen trees, opened in August 2000.

Is a similar redesign possible at the Century 16 multiplex? Some have urged Cinemark to convert Theater 9, where the shooting took place, into a memorial to the victims. At the very least, Cinemark, with its promise to "reconfigure the space," seems to grasp the power of design in moving beyond a tragedy. ■

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## Gang's All Here

BY LEE BEY

**THOUGH IT** focuses on the work of Chicago architect Jeanne Gang, *Building: Inside Studio Gang Architects* at the Art Institute of Chicago is not a retrospective. Rather than chronicling the evolution of the MacArthur Fellow's talent, it focuses instead on the visionary and collaborative thinking of her studio.

Organized by the Art Institute's architecture and design curator, Zoë Ryan, and assistant curator Karen Kice, and on view through February 24, 2013, the show highlights 13 projects by the firm. They range from built work such as Chicago's Aqua Tower to conceptual projects and competition entries including stunning models and renderings for the Kaohsiung Maritime Cultural & Pop Music Center in Taiwan.

Navigating the show's two adjoining gallery spaces in the museum's Modern Wing, visitors first encounter a variety of models, renderings, and video projections of Studio Gang's projects. There is plenty to see here, including a graceful, gossamer-like model of Aqua. A copied photograph of it has handwritten notes indicating which parts of the building's undulating balconies are "flares," "clefts," or "waves." The show also gives space and attention to a community center Gang designed for SOS Children's Villages on the

city's South Side. The center is a playful piece of architecture on a lesser-traveled street in a working-class neighborhood. It is good to see it highlighted here.

The second gallery space is set up like a workshop, with everything from tools to mock-ups on display. The development of the firm's three-sided Arcus Center for Social Justice Leadership—a small upcoming project in Kalamazoo, Michigan, that will feature exterior walls constructed with white-cedar masonry, a technique once common in the region—is told in 168 renderings and working drawings pinned to a gallery wall. A round table for reading and discussion sits in the middle of the space, along with a curved, laminated Douglas fir mock-up for Gang's well-received pavilion at Chicago's Lincoln Park.

There are some things to quibble about in the exhibition. The four "Rope Rooms" in the main gallery—they look like a cross between a tepee and a giant basketball net—add nothing to the accompanying video and projects. And although Gang is worthy of a show at a major museum, one can't help but wonder if this one

is a few years too soon, given that many of the large-scale projects featured in the exhibition are stalled or unbuilt. Even the Kaohsiung center, impressive as it is, took third place in the design competition for which it was sub-



Art Institute of Chicago architecture and design curator Zoë Ryan (left) and Jeanne Gang at an institute exhibition focusing on the architect's studio.

mitted. The show could feel more robust in three to five years, when, if the economy improves, the firm could have more large-scale work to demonstrate the fruits of its process. Still, *Building* is an attractive, informative, and well-executed show that conveys the talents and abilities of Gang and her team—and it demonstrates why she's become such a force. ■

## Leaving a Trace with an iPad

BY MICHAEL LEIGHTON BEAMAN

**MOBILE DEVICES** have seen unprecedented growth recently. Apple alone has sold over 84 million iPads in the last two years. It is clear these devices have changed the culture of digital-media consumption, but have they changed the way designers work?

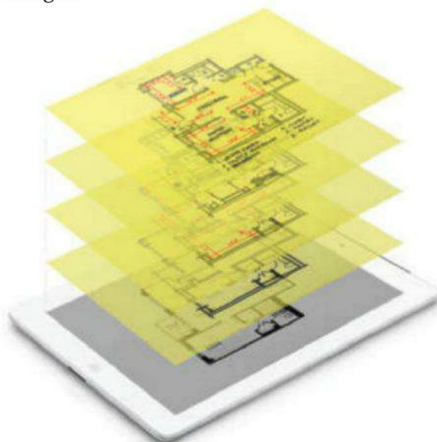
The Morpholio Project, a digital-media company started by practitioners and academics in the design professions, enters the currently limited field of design-oriented mobile-device apps with the goal of expanding productivity beyond the studio and desktop computer. In October the Morpholio Project released Morpholio Trace for iPad, a supplement to its core Morpholio portfolio app.

Launched in late 2011, Morpholio allows members to store, share, and critique design work with other members. Trace, along with Morpholio, is available free from iTunes.

The new Morpholio offering is a "sketch-

ing" app that performs much like tracing paper, transforming a mobile device into a palette for quick iterative design. The app works by overlaying a blank page, images (JPEGs only), or one of many grids, storyboards, or figure templates (99 cents per set) to start a sketch.

To create a drawing or annotate one, layers of successive sheets of trace can be added to build up dense, although somewhat limited, images.



For this purpose, Morpholio Trace works quite well. The app is responsive and lines are rendered smoothly, but using a stylus improves consistency and accuracy. Morpholio Trace is what Mark Collins, one of the app's creators, called "productively constrained"—offering only three options for pen thicknesses and either red or black pens. In just a few minutes of use, one becomes accustomed to the location of different line weights and colors, so the drawing process feels intuitive. Erase, undo, save, and e-mail functions are all accessed from the single toolbar, making the app easy to learn.

For more complex, nuanced drawings, there are apps with more functionality, such as Autodesk Sketchbook—one of the more popular drawing tools for mobile devices among designers. In contrast, what Trace offers beyond sketching is its connectivity to Morpholio. Although the apps are separate, there are plans to combine the two in the coming year and allow Morpholio members to share visual, not just textual, feedback. ■

The Morpholio Trace app allows users to sketch on layers of tracing "paper."

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# RECORD Innovation Conference: Shaping the Future

BY FRED A. BERNSTEIN

IN A TIME of 24/7 connectivity and cloud computing, it is essential for architects to make room for “forms of low-tech creativity,” said Jeanne Gang, principal of Chicago-based Studio Gang Architects, describing both the way she designs (by hand as well as by computer) and the materials she uses in her buildings. For the Arcus Center for Social Justice Leadership at Kalamazoo College in Michigan, she is working with “wood masonry”—slices of logs that, in their diversity, remind her of the people who will benefit from the center.



The need to balance technology and the human touch was a note sounded often during the 10th annual ARCHITECTURAL RECORD Innovation conference. Gang was the first of more than a dozen speakers in this year's program, titled “Design Leaders Envision the Next Decade.” The event drew some 400 attendees to the auditorium of the McGraw-Hill Building in Manhattan. Many presenters rejected the idea that architects should take their cues from algorithms; as Francis Aish of Foster + Partners put it, “Sometimes the computer can be too objective.” Dennis Shelden, Gehry Technologies chief technology officer, sees his goal as more, not less, personalization. “Lurking in there,” Shelden said of the advances



Left, Diébédo Francis Kéré presenting; above, Carol Willis, director of the Skyscraper Museum, with (from left) William F. Baker, William Pedersen, and Gordon Gill.

in building information modeling, “is the possibility of connection to identity and individuality.”

Gang, who spoke in the morning, remained to hear the afternoon presenters, including Diébédo Francis Kéré. The principal of Berlin-based Francis Kéré Architecture showed photos of schools he has designed for his native Burkina Faso, where villagers help to erect the compressed-earth structures. He described one scene of a partially completed building covered in plastic to protect it from a heavy rainfall: “It looks like Christo and Jeanne-Claude,” he said, eliciting a laugh. Otherwise, his talk was heart-rending. With extraordinary modesty he told the crowd, “I don’t know what to call my work, but when you call it architecture, you make me proud.” He is now building a library in his hometown, Gando, a place where access to books—and education—is still, he said, “an unreachable dream for many.”

Kéré was followed by another African-born architect, London-based David Adjaye, whose own Francis Gregory Library in Washington, D.C., serves as a gathering place and beacon. A few miles away, on the National Mall, work has begun on the Smithsonian National Museum of African American History and Culture, which Adjaye designed as part of a team (Freelon Adjaye Bond/Smithgroup). Adjaye described some of the technological challenges posed by the project—numerous sensors are being used to ensure that construction doesn’t destabilize the Washington Monument—but also its human elements, with both African and African-American art forms influencing the design. The plan for the museum’s main hall calls for a ceiling of half a million wooden planks, lit from above.

Positioned under any one of them, Adjaye says, “you become the figure in the story.”

Much of the day was devoted to discussion of technological advances. Kent Larson, principal research scientist at the MIT Media Lab, showed a project for a car that folds, parks, and charges itself (currently being tested in Spain). Sheila Kennedy, of Kennedy & Violich Architecture, presented a group of rowhouses, now under construction in Germany, in which curtains rearrange themselves to create microclimates. “It’s an old idea about curtains and tapestries,” Kennedy said, “but in a new, specialized way.”

During a panel discussion on supertall buildings, the masters Gordon Gill (of Adrian Smith + Gordon Gill Architecture), William Pedersen (of Kohn Pedersen Fox), and William F. Baker (of Skidmore, Owings & Merrill) described their towers as cultural, as much as technological, achievements. And Stephen Selkowitz of the Lawrence Berkeley National Laboratory talked about the work he and his colleagues do to test building performance, but he urged that architects not let themselves be slaves to data. “Studying things is fine,” he said, “but getting things going is better.”

At another panel discussion, four alums of RECORD’s Design Vanguard (Sebastian Schmaling, Jennifer Luce, Eric Bunge, and Marc Tsurumaki) described the challenges of advancing their practices during a down economy. They got good advice from Stephen Kieran, principal of KieranTimberlake, who was asked at the end of his presentation how architects can avoid giving their innovations away. At the beginning of every project, he said of his Philadelphia-based firm, “we articulate a research agenda” and build it into the contract price. That’s not always possible, he said. “But a client that isn’t interested in a research agenda probably isn’t a great match anyway.” ■



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## [ NEWSMAKER ]

**Roman Mars**

BY LAURA RASKIN

AS HOST OF the weekly radio show and podcast 99% *Invisible*, Roman Mars takes a democratic interest in the stories behind all kinds of design. With 4- to 10-minute segments, the show (a project of KALW in San Francisco) has explored the past and future of the Purple Hotel outside Chicago, designed by John

Roman Mars, host of the radio show 99% *Invisible*.

Macsai; the sound of the World Trade Center towers “breathing”; and depression induced by airport design, among many other topics. With richly layered music and sound effects and clever editing, Mars uses storytelling to find meaning in the mundane and idiosyncratic. This summer, he launched a \$42,000 Kickstarter campaign to fund the third season of 99% *Invisible*. He blew past his goal in less than 24 hours and raised over \$170,000.

**Your background is in plant genetics. I can see a link between that kind of study and the way your show dissects the DNA of the designed world. How do you connect these interests?**

The main thing is that a good education, regardless of the subject, teaches you to think critically. My time spent working on my PhD, even though I never got it, is not wasted. At least that’s what I tell myself. It makes you disciplined in a way of thinking. It also gives you a desire to study and read things, and to wade through things that are hard. Since I’m not trained in architecture, I have to get through the stuff that is really new to me.

**Why did you decide to create 99% *Invisible*?**

AIA San Francisco had a relationship with

KALW, the public-radio station. I had worked with KALW for years and years—it’s where I started in radio. They had an idea for an “architecture minute” on *Morning Edition*, and I was asked to help them conceptualize it. I got really intrigued by it as a project I would actually do, rather than as a project I would pass off. I thought, “I think I can make something someone really loves if I could have 4.5 minutes.”

**Were you surprised by the response?**

I thought it would be good from the beginning. It wasn’t until I was into it a bit that people would say, “I thought you were insane for doing it. I thought that would be the worst show ever!” But—from Apple products to Gary Hustwit’s documentary *Helvetica*—people are more aware of design. I sensed that the approach I was planning to take, this radio-phonetic way, would hit people nicely if you did it right.

**How did you come up with the name 99% *Invisible*?**

AIA San Francisco gathered a bunch of people for the first pitch meeting, including John Edson from the design firm Lunar, who was the first funder of the show, and Gary Strang, the landscape architect. Strang brought Bruce Mau’s book *Massive Change*. There’s a quote from Buckminster Fuller about the 99 percent invisible forces that shape the world. I just thought it worked, because it captured the spirit of what I wanted. I didn’t want to call it “design” or “architecture.” I wanted it to be about the story behind objects, not about glorifying objects. It’s not so much that the objects are not notable, it’s that the best part is the thought that goes into them. When he said that, I ran home and registered the domain. That’s when I was sold on the show.

**Why did you decide to try to raise money for the third season on Kickstarter?**

I needed to do it, and I don’t want to discount anyone who funded it before, but it was not a proper amount of pay for the work. It was getting more popular, and I was getting requests for more. I still can’t really turn it into a full-time job. I was looking for different sponsorships, but they were never at a self-sustaining level. Since I’d built up a pretty sizable audience, I thought Kickstarter would work. I was completely unaware that the Kickstarter story itself would be intriguing.

**Any spoilers for this season?**

We’re doing a story on the Alford Lake Bridge, one of the oldest reinforced-concrete bridges, in Golden Gate Park. I’m obsessed with it. We’re working with Andrea Seabrook, who used to be at NPR and now hosts the podcast *DecodeDC*, on something about the design of sets for political rallies. ■

**Foster + Partners Wins 425 Park Avenue Competition**

In October, Foster + Partners won the competition to design a 650,000-square-foot office tower at 425 Park Avenue in New York City, beating out Rogers Stirk Harbour + Partners, OMA, and Zaha Hadid Architects.

**Frank Lloyd Wright House in Phoenix Buys Some Time**

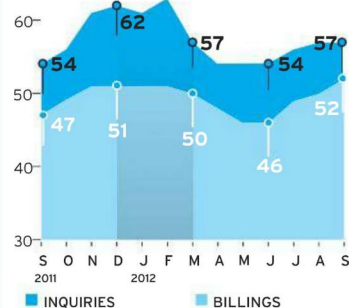
The developer who owns a 1952 Frank Lloyd Wright house in Phoenix agreed in early October to delay demolition of the structure for at least a month while the Chicago-based Frank Lloyd Wright Building Conservancy scrambles to find a buyer. Wright designed the house for his son David.

**Gehry Tapped for Bacardi Renovation in Miami**

Frank Gehry has been tapped to master-plan the interiors and a new park and performing-arts center for the 1963 Bacardi Tower and Museum campus in Miami, which was recently sold to the National YoungArts Foundation. The building was designed by Enrique Gutierrez.

**Ulrich Franzen Dies; Architect of the Gropius Generation**

Ulrich Joseph Franzen, a prominent New York architect in the latter part of the 20th century, died after a brief illness on October 6 in Santa Fe, New Mexico, at the age of 91. Franzen became part of a cohort that would disseminate the Modernist vocabulary of Bauhaus founder Walter Gropius in the U.S. during the boom period after World War II.

**ABI Climbs at Fast Pace**

The Architectural Billings Index (ABI) increased in September at its fastest pace since late 2010. The September ABI score was up 51.6. “Going back to the third quarter of 2011, the multi-family residential sector has been the best performing segment of the construction field,” said Kermit Baker, AIA chief economist, in a press release.

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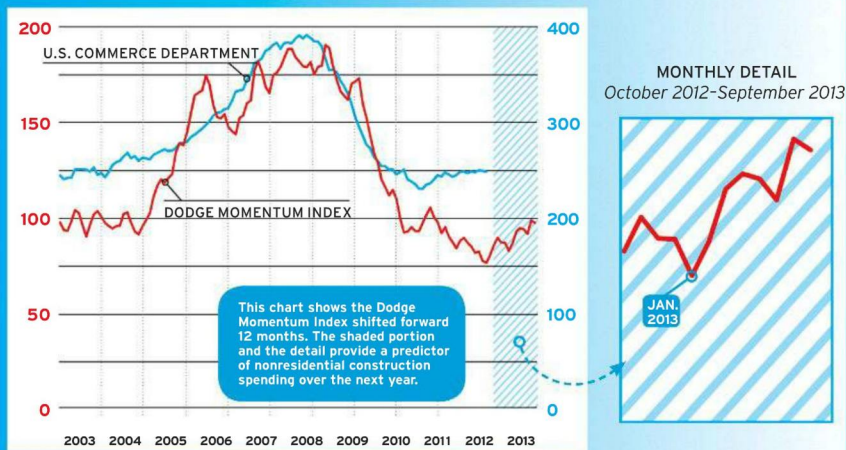


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## UNCERTAINTY PUTS INDEX ON PAUSE

The Dodge Momentum Index retreated 0.8% in September to 94.7, down from a revised level of 95.4 in August and 96.7 in July (100 is the index baseline and is derived from the total value of projects in the Dodge database in 2000). While analysts regard the long-term trend as positive, the index appears to be in a holding pattern. Uncertainty related to the impending presidential election, the scheduled expiration of the Bush-era tax cuts, and approaching federal-spending cuts are likely the main contributors to this pause.



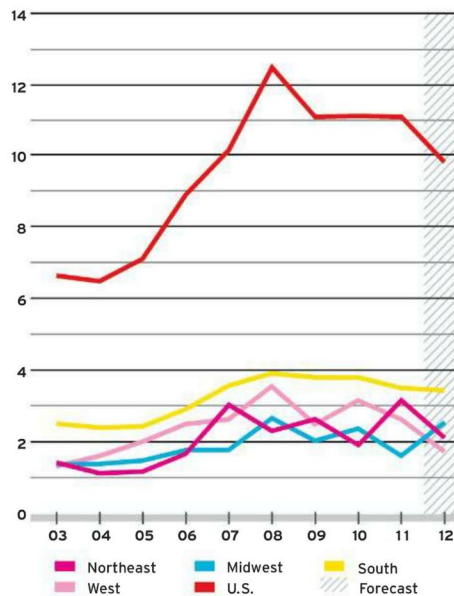
The Dodge Momentum Index is a 12-month leading indicator of construction spending. The information is derived from first-issued planning reports in the largest database of construction projects in the U.S., McGraw-Hill Construction's Dodge Reports. The data have been shown to lead the U.S. Commerce Department's nonresidential spending by a full year.

### COLLEGE AND UNIVERSITY BUILDINGS

Like most nonresidential construction, college and university starts peaked in 2008 and have not yet made a substantial comeback.

### College and University Building Starts by Region

Including U.S. total and 2012 forecast figures, by billions of dollars



### Top Metro-Area Markets

Total college and university building starts 1/2011 - 8/2012

		\$ millions
1	New York	952
2	Washington, DC	588
3	Los Angeles	509
4	Philadelphia	499
5	San Diego	472

## Top 2012 College and University Building Projects

Ranked by construction-starts value through August 2012

**\$105M**

**PROJECT:**  
Bartlett Hall Science Building Renovation, Phase II, West Point Military Academy

**ARCHITECTS:**  
SIV Group  
URS

**LOCATION:**  
West Point, NY

**\$100M**

**PROJECT:**  
Andlinger Center for Energy and the Environment, Princeton University

**ARCHITECT:**  
Tod Williams Billie Tsien Architects

**LOCATION:**  
Princeton, NJ

**\$90M**

**PROJECT:**  
Science Building, Middle Tennessee State University

**ARCHITECTS:**  
Thomas Miller & Partners  
Hastings Architecture Associates  
Einhorn Yaffee Prescott

**LOCATION:**  
Murfreesboro, TN

**\$83M**

**PROJECT:**  
Physics and Nanotechnology Building, University of Minnesota Twin Cities

**ARCHITECTS:**  
Architectural Alliance  
ZGF Architects

**LOCATION:**  
Minneapolis

**\$81M**

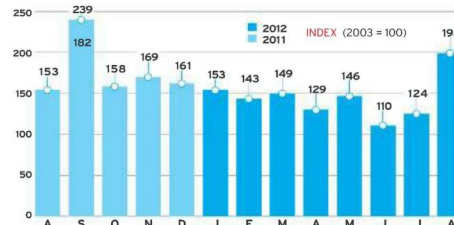
**PROJECT:**  
Center for Health Sciences South Tower Seismic Renovation, University of California, Los Angeles

**ARCHITECT:**  
ZGF Architects

**LOCATION:**  
Los Angeles

### THE DODGE INDEX FOR COLLEGE AND UNIVERSITY BUILDING CONSTRUCTION 8/2011-8/2012

This index is based on seasonally adjusted data for college and university building starts in the U.S. The average dollar value of projects in 2003 serves as the index baseline.





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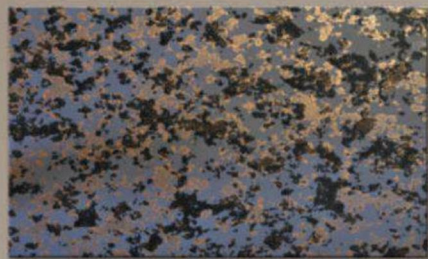
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## Plays Well with Others

Report card: Zaha Hadid's MAXXI turns out to be a good place to see art.

BY PETER PLAGENS

**THERE'S A** giant, white, habitable sculpture sitting in the midst of Rome's nondescript Flaminio district just north of the city center. Its exterior juxtaposes sinuous curves and sharply angled planes, and its interior flows in smooth, serpentine capaciousness. It's Zaha Hadid's National Museum of XXI Century Arts (better known as MAXXI), and doubtless it's a work of art itself. But museums aren't supposed to be stand-alone masterpieces. They're supposed to display and enhance other works of art to visual and contextual advantage.

Museums that call too much attention to themselves can be a problem, or at least take some getting used to. After a half-century of use, Frank Lloyd Wright's Guggenheim Museum in New York (1959) has finally achieved an uneasy peace with the sculpture, paintings, and works of installation art that find their way onto its premises. On the other hand, Daniel Libeskind's Denver Art Museum (which opened in 2006) is still getting mixed reviews—to put it charitably—about the way art struggles to hold its own against the building's radically triangular structure. But two years after its opening, MAXXI is treating art rather well.

When Hadid entered the competition to design MAXXI, one of the ideas floated for its programming was to concentrate on Arte Povera, the abject style that was Italy's main contribution to post-World War II art. (The mind boggles a bit at the thought of such a sophisticated, glamorous edifice as a thematic home for art like Piero Manzoni's infamous 1961 can of *Künstlerscheiss*.) Fortunately, the museum's purpose was expanded to explicate contemporary art and architecture across the board. MAXXI is also Italy's only national museum dedicated to contemporary art—the others are regional or local—which gives it an advantage in prestige.

To make MAXXI accommodating to art, Hadid designed a set of contiguous indoor terraces that turn out to be a graceful solution to manifesting “separate” galleries in an emphatically open interior. The absence of disruptive walls gives art room to breathe, while the discrete and nicely shaped balcony-esque galleries allow relevant works of art to be gathered together in conversational closeness. *Tridimensionale*, an exhibition that ran from March to September, clearly benefited from these spaces. In the show, very dissimilar



The 228,000-square-foot MAXXI opened in May 2010.

sculpture by Juan Muñoz (stylized bronze figures) and Franz West (faux-homely abstractions) enjoyed a kind of visual fellowship.

Moving among MAXXI's semi-separate staging areas is similarly amiable. Long, airy ramps, gently segmented stairways, and good lighting make traversing from one exhibition to another a pleasantly anticipatory experience. MAXXI does have a few white-cube spaces, and they work well, especially with one of the best photography exhibitions I've seen in years: *To Face*, Paola De Pietri's mesmerizing, large-format color images of World War I battlegrounds on the Italian front.

The most encouraging architectural aspect of MAXXI is its receptiveness to—indeed, crying out for—site-specific pieces that integrate themselves into the museum's own sculpture-like morphology. Finnish artist Kaarina Kaikkonen's installation this summer of children's garments hung on long, tapering rows of clotheslines—visible from both inside and outside the museum—humanized and softened the scale of the building. This is the institutional quality that prompted Carlos Basualdo, curator at the Philadelphia Museum of Art, to sign on as MAXXI's curator-at-large three years ago. “MAXXI is a building that, in many ways, dictates a program, and certainly calls for a

close collaboration with living artists,” he says.

MAXXI does have problems, to be sure, but they have less to do with quality than quantity—the small amount of art it owns and the large sum of money it needs to keep going. It is hamstrung by having had to start a collection from scratch, mostly with government funds, in a country with a patchy history of private collectors donating art to public museums. Still, the roster of artists in MAXXI's holdings is impressive: Gerhard Richter, Kara Walker, Ed Ruscha, Rose Marie Troeckel, Anselm Kiefer, Mario Merz, Alighiero e Boetti, and younger artists such as Giorgio Andreotta Calò and Rosella Biscotti. The museum is collecting renowned artists but also taking some chances.

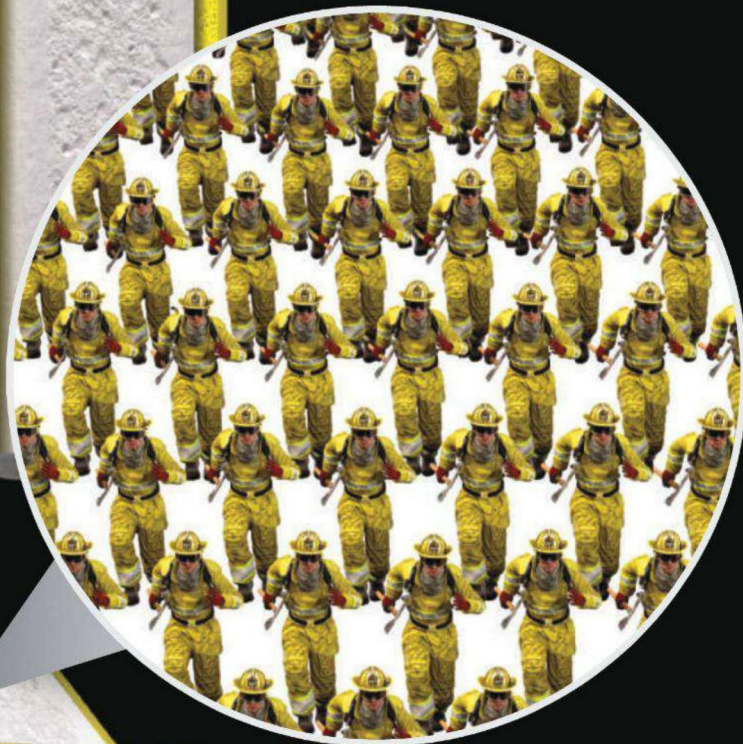
Alas, good things in the museum world don't come cheap. MAXXI requires about \$12 million a year to operate, which it has tried to cobble together from ticket sales (attendance is just OK), profits from the bookshop and restaurant, corporate sponsors, and some private donations. There has been a lot of infighting between the Fondazione MAXXI, which runs

**Contiguous terraces are Hadid's graceful solution to making “separate” galleries in an open interior.**

the museum, and the national Ministry of Cultural Heritage. The ministry said MAXXI will incur a \$13 million deficit between now and 2014, while the Fondazione's erstwhile president, Pio Baldi, claimed that the shortfall was illusory. Baldi resigned in May, and the museum was put into a “compulsory administration” (a.k.a. receivership) under a special commissioner. MAXXI is now scouring the country for new sponsors, and its officials say it will have some good news to announce.

Let's hope so. The museum itself is that rare work of art that's generous to other works of art. It would be a pity if MAXXI were to be substantially deprived of art or, worse, if contemporary art had no MAXXI to enjoy at all. ■

*Peter Plagens is a painter and art critic and was a senior writer at Newsweek from 1989 to 2003.*



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## Expanding Universities

Plans proceed apace at Harvard, Columbia, Penn, Yale, and Princeton.

BY ROBERT BARNETT

**DURING THE** last 10 years or so, five leading American universities have produced large-scale plans to guide their expansion, all of which are currently in various stages of implementation. The realization of these proposals will add millions of square feet of academic and related space to the campuses and cost billions of dollars. At the same time, higher education online is increasing in popularity, paradoxically offering the possibility of reduced demand for teaching space as well as lower education costs for students. Because of new online capabilities, could the expansion of the physical campus at these elite institutions soon be outdated?

To be sure, much of the physical expansion revolves around specialized research facilities—since research, in addition to teaching, forms such a vital component of the university mission. Even so, the 2008 economic crisis delayed fulfillment of some of these schemes; the recession caused Harvard University, for example, to revise its ambitious development for the Boston neighborhood of Allston, located across the Charles River from the Cambridge campus. The plan, prepared by Cooper, Robertson & Partners, Gehry Partners, and the Olin Partnership, called for the addition of up to 10 million square feet of academic and student-life space over 50 years. In 2009, construction of a \$1.4 billion science center designed by Behnisch Architekten was stopped after its foundations had been completed. The university is reprogramming the science building, now called the Health and Life Science Center, and has yet to say whether it is hiring a new architect. Harvard is also seeking partnerships with third-party developers for a biomedical-research campus along with residential and retail spaces on this site.

Columbia University's expansion into New York's Manhattanville neighborhood seems less affected by the recession. After years of assembling properties and obtaining regulatory approvals, the university is moving ahead with its plan, prepared by Renzo



Piano Building Workshop with Skidmore, Owings & Merrill. When completed, the 17-acre site, nine blocks north of Columbia's Morningside Heights campus in West Harlem, will total almost 7 million square feet. The first phase of the new campus, now under construction, includes the 450,000-square-foot Jerome L. Greene Science Center, designed by Piano, to be followed by two new buildings for the Columbia Business School by Diller Scofidio + Renfro.

Another plan going forward is for the University of Pennsylvania in Philadelphia. In 2006, Penn issued a vision plan prepared by Sasaki Associates calling for infill expansion on the main campus as well as the redevelopment of 24 acres of land acquired from the U.S. Postal Service. The land, contiguous with the main campus, affords the university the opportunity to add athletic fields and expand the medical school and other facilities. Penn partnered with a private developer to finance the project, which also includes mixed-use (commercial and academic) space. The first phase, Penn Park, designed by Michael Van Valkenburgh, opened in 2011 and, in



addition to athletic fields, offers green space accessible to the public. A center for nanotechnology research designed by Weiss/Manfredi, now under construction at 33rd and Walnut streets, will act as a new gateway to the university.

For its part, Yale University is engaging in a double-pronged expansion. In 2007, Yale bought a 136-acre site—formerly a corporate research-and-development park—along the Orange/West Haven border seven miles west of its New Haven campus. The existing plan and buildings are currently being kept and repurposed for biomedical and energy research, the School of Nursing, and museum storage and conservation. Yale is expanding not only in Connecticut

**PHILLY FILL-IN**  
As the first phase of the University of Pennsylvania's expansion on land acquired from the U.S. Postal Service, Penn Park, designed by Michael Van Valkenburgh, opened in 2011 (top). Nearby, a center for nanotechnology research, by Weiss/Manfredi, is under construction (above).

**COLUMBIA'S COLOSSUS**

The university's new campus, just north of its existing one (site plan, bottom), will be the home of the Jerome L. Greene Science Center by Renzo Piano (below).

but in Singapore as well. The only one of this group to build a campus abroad, the university is collaborating with the National University of Singapore to develop a 1,000-student undergraduate residential college. The new campus—for which KieranTimberlake and

Pfeiffer Partners in collaboration with Forum Architects prepared the master plan, and Pelli Clarke Pelli with Forum Architects are the design architects—is expected to open in early 2015.

Unlike Yale, Princeton University is staying close to home. After considering an expansion of its substantial landholdings in neighboring townships, the university decided to augment development on its main campus. Nevertheless, Princeton hopes to maintain its open space by making use of peripheral sites where town and gown overlap. One such site centers on the terminus of a spur train where the university is creating an Arts and Transit Neighborhood to enable the addition of theater, dance, and music

platform shared by Harvard and the University of California, Berkeley, called edX, which includes assessment, peer-to-peer learning, and live chats, among other networked features.

Coursera, another recently launched learning platform, offers online courses delivered by eminent faculty members from Princeton, Penn, Stanford University, and the University of Michigan, among others, and again, like edX, at no charge. Enrolled students, who do pay tuition and receive credit, take the course on campus, while many thousands of others registered with Coursera receive the same material online. At Princeton, faculty members are recording lectures in the Broadcast



## With the growth of online learning, could the expansion of the physical campus become outdated?

facilities while preserving commuter rail service. Beyer Blinder Belle has prepared the plan for the 22-acre site; Steven Holl Architects is designing the first phase of performing-arts buildings; and Rick Joy Architects is creating a new station building and renovating two early-20th-century station structures for a restaurant and café. The project is scheduled for completion in 2017.


As traditional universities expand their physical campuses, criticism is mounting that an undergraduate education at an elite college or university is accessible only to the “1 percent.” Yet it should be acknowledged that while costs continue to rise, only a small proportion of an undergraduate student’s tuition at a well-endowed private university is typically allocated to the operations and maintenance of the physical plant. Construction of new buildings—especially for research—is supported primarily by donors and long-term financing.

Nevertheless, increased costs of education have prompted many universities to step up financial aid, as well as to offer their course materials online at no charge. In 2000, MIT launched its OpenCourseWare initiative. There are no “admission” requirements, but neither are there course credits or even certificates of completion. This effort has since evolved into a learning

Center, a state-of-the-art facility originally built for connectivity with TV news stations. In the hybrid world of on- and off-campus learning, the video recording studio is emerging as a new type of teaching space, while the lecture hall may become obsolete.

While online learning on existing campuses is likely to require reconfiguration of academic space, most universities remain committed to the traditional emphasis on undergraduate residential life along with extracurricular activities, known since the 19th century as the “collegiate way.” This commitment to undergraduates, combined with university research—the primary impetus for creating new science, technology, engineering, and mathematics buildings—will most likely continue to promote expansion of the physical campus in the foreseeable future. So regarding the initial question about whether campus plans for these elite institutions may become outdated, the answer is probably not. Because of the traditional expectations about the academic community and the needs for research facilities, it looks as if virtual and physical worlds can successfully coexist. ■

*Robert Barnett, an architect, served as vice provost for university space planning and manager of capital projects at Princeton.*



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BUILDING VALUE SINCE 1906

## The Cost of Competing

Betting on a win can be a big risk for design firms.

BY FRED A. BERNSTEIN

**MARKUS DOCHANTSCHI** is ticking off the costs of entering a competition. “Say they want a model—that can be anywhere from 5 to 15 thousand dollars. If they want high-res renderings, that could be between 5 and 10 thousand. You’re up to \$20,000 fast.”

Winning a design competition can mean new work and prestige—and even making the short list can be great publicity—but as anyone who has ever entered one knows, the costs can be staggering. Small and medium-size studios in particular often find themselves conducting a tricky analysis: weighing the possibility of a payoff against significant up-front expenses.

For that reason, Dochantschi, principal of Manhattan’s studioMDA, can enter competitions only when his firm is flush. When he doesn’t have a lot of work and could be devoting time to competitions, he can’t afford to. In peak years his firm has entered as many as 10 competitions annually, but in lean times, as few as two. “You have to have money coming in to enter,” says Dochantschi, who has about a dozen employees. (To make the numbers work, he, like many architects, often values his own time at zero.)

Naturally, he tries to focus on competitions he has a chance of winning—ruining his decision to spend about \$25,000 to enter a 2010 competition for a Winter Olympics facility in Munich. It involved creating a detailed model and shipping it to Germany, he says, “and there were 50 firms competing, so it was pretty much a waste of time.” (Munich lost its bid for the 2018 Olympics to South Korea.) Better are competitions where the number of entries is controlled. In some German government-run competitions, Dochantschi says, six firms are invited, six are selected after presenting portfolios, and six more are chosen at random, keeping the number of competitors to 18. It was just such a competition that won studioMDA its biggest project to date—a building for the University of Applied Sciences in Aachen, Germany. The firm invested about \$25,000 in the

proposal, and the \$30 million facility is now under construction, which has given Dochantschi the wherewithal to enter other competitions.

“We have a love/hate relationship with competitions,” says Calvin Powei Chen of Bercy Chen Studio in Austin, Texas. “They’re risky and can drain the firm’s resources.” In 2009, Bercy Chen entered a competition called Re:Vision Dallas. The goal was to transform a block in that city’s downtown into a carbon-neutral development. Chen and his partner, Thomas Bercy, and half a dozen employees came up with an elegant proposal—a modern Alhambra, celebrating the flow of water. Their out-of-pocket costs were about \$16,000, he says, but he estimates the cost in time—and other opportunities sidelined during the seven weeks of work—at around \$50,000. A Portuguese firm won the competition. More recently, says Chen, “we came in second in an invited competition to design four city blocks in Shijiazhuang, near Beijing,” at a cost of about \$8,500. “The developer ended up going with a Spanish Colonial look.”

So was entering worth the time and expense? For all the setbacks, Chen says that even a losing entry can be good for the firm’s development. “Each competition entry is an important reminder of what we aspire to do with architecture beyond the constraints of our day-to-day practice,” he says.

Still, losing doesn’t pay the bills. And even winning may not land a firm on Easy Street. Lily Lim and Mateo Paiva, partners in a Brooklyn firm called Studio a+i, got a big boost last winter when they won the competition to design an AIDS memorial on a prominent site in Greenwich Village. Most of the time when a competition winner is announced, Lim notes, “only architects read about it.” But this time the winning entry, called Infinite Forest, received national attention.

The \$5,000 honorarium for winning the competition covered the firm’s direct costs, she says, but not anyone’s salary. Employees volunteered to work weekends and holidays on the entry,



**\$50K** Bercy Chen Studio

studioMDA **\$25K**



says Lim, who tried to make sure everyone was credited by name when the project was publicized. But then the political realities set in. In order to accommodate community groups, which wanted most of the memorial site turned into a park, the design had to be scrapped.

“We had a choice—to take the \$5,000 and the publicity and move on, or design a new memorial,” says Lim. She and Paiva chose the latter, sacrificing their initial concept but also demonstrating that, along with time and money, flexibility is an essential resource for firms hoping to find success with a competition win. ■

### EXPENSIVE PROPOSITIONS

After dedicating time and money (which the principals value at around \$50,000) to an entry, Bercy Chen Studio lost a competition for a Dallas development (top). StudioMDA principal Markus Dochantschi attributes winning a competition for a mobility-studies center at a university in Aachen, Germany (above), to considering the odds before investing about \$25,000 on the presentation.



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**CIRCLE 27**



perspective **house of the month**

JAMES GAUER, WITH BILDSTEN + SHERWIN DESIGN STUDIO, CREATES A SMALL HOUSE WITH AN EARLY MODERNIST FEEL IN SANTA BARBARA, WHERE SPANISH COLONIAL STILL REIGNS. BY LAURA RASKIN



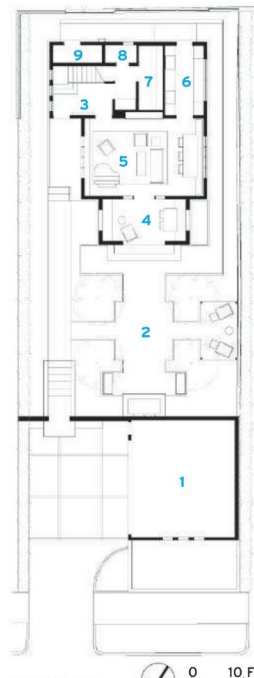
**SITUATED** ON a skinny lot at the edge of downtown Santa Barbara, California, architect James Gauer's 1,500-square-foot geometric house is an anomaly in a town known for its code-enforced adherence to the Spanish Colonial style. Gauer's clients, a couple who moved from New York City (Gauer had designed their Manhattan apartment), wanted to maintain the feeling of their contained, urban life in a California context.

Gauer, who lives in Victoria, British Columbia, worked with the Santa Barbara-based architect of record, Bildsten + Sherwin Design Studio, to devise a two-story wood-frame structure covered in crisp-edged stucco. The house is composed of three increasingly smaller, well-proportioned volumes based on a 4-foot grid: The first, a rectilinear bar at the north end of the lot, contains the entry and kitchen; the second, a 16-by-24-foot box, includes the living room and two bedrooms above; and the third and smallest volume provides a loggia that connects the living room to the garden. "I really love the way we managed to squeeze a rather elegant circulation of spaces into a very tight lot," says Gauer.

After parking in the garage or driveway adjacent to the street, a visitor must walk past the garden, loggia, and living room before reaching the entrance at the far north end of the site; the architect purposefully kept the garden intact with this procession. Gauer invoked Irving Gill's reduction of the Spanish Colonial vernacular to convince the local review board to approve his design. "They see this kind of harks back to Gill, but they don't understand that he was mimicking [Adolf] Loos, for whom I've always been a complete sucker," he says. "He stands at that juncture between Classicism and Modernism." ■

**SECRET GARDEN**

Architect James Gauer designed an elegant procession by separating the house from the street with a garage (above) and garden (right). The main entry is pushed to the side. Gauer raised the structure on a concrete plinth edged with brick. The concrete floors (below) contain a radiant-heating system.



- 1 GARAGE
- 2 GARDEN
- 3 ENTRY
- 4 LOGGIA
- 5 LIVING
- 6 KITCHEN
- 7 LAUNDRY
- 8 BATHROOM
- 9 STORAGE



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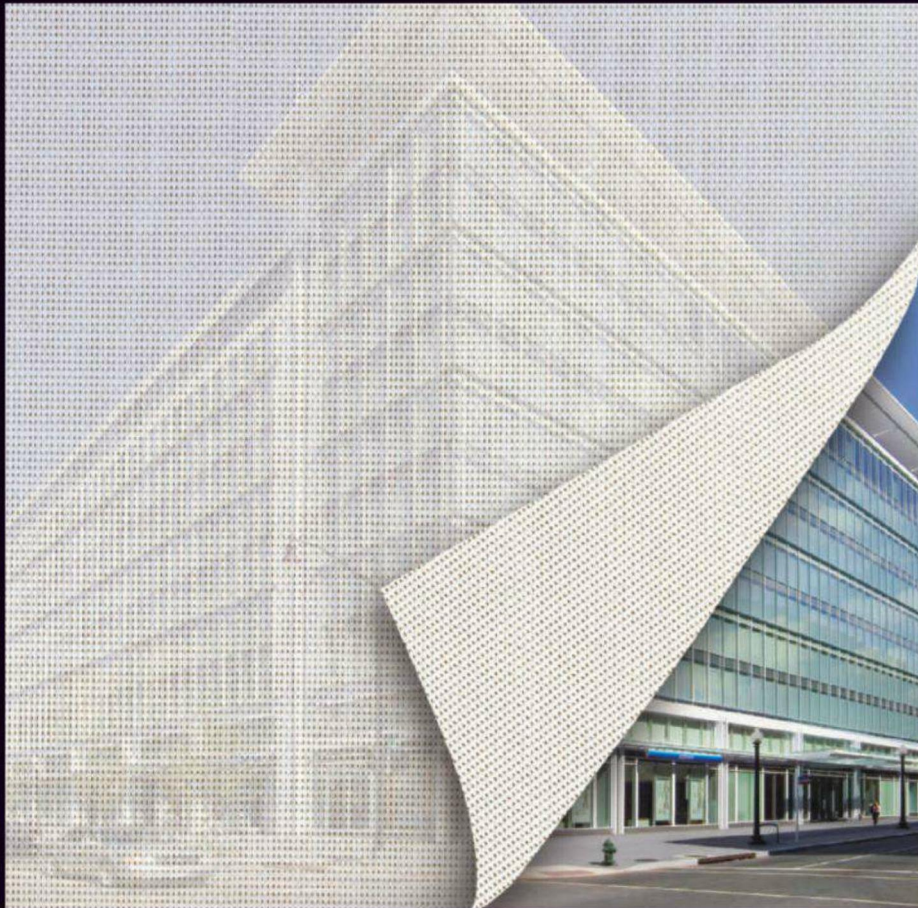
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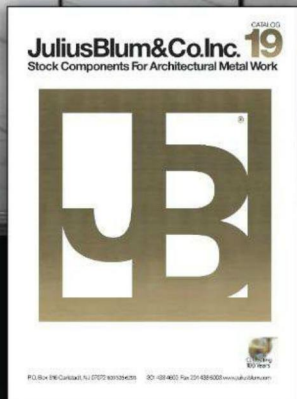
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BY RITA CATINELLA ORRELL

## The Mysterious Art of Color Forecasting

**WHILE THE** formulation of high-performance paint is a technical process, the craft of forecasting that paint's color is an unscientific one, say color experts. Color forecasters hope to give both consumers and professionals some direction in the seemingly endless choices they have when selecting interior paints and finishes.

To develop their annual lists, forecasting teams research trends they see across multiple industries throughout the year and then search for repeating themes that will be translated into palettes. "Trends continue to morph and evolve throughout the year," says Donna Schroeder, manager of color and design for Pratt & Lambert Paints. "Forecasting is an ongoing process that never really ends."

Depending on the company, forecasts are introduced at strategic times of the year, and sometimes up to 18 months in advance. Sherwin-Williams introduces its annual forecast at the NeoCon trade show in June. "We don't like to put our forecast out too far in advance," says Jackie Jordan, director of color marketing for the company. "We believe things change so quickly that if we forecast 18 months ahead, it might not be as relevant six or eight months down the road."

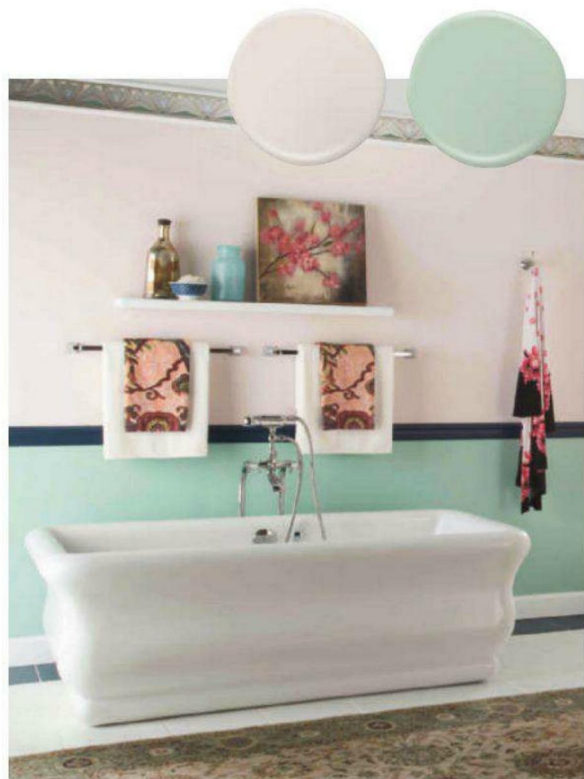
Color forecasters agree that almost anything can serve as inspiration, from politics and the economy to pop culture, the automotive industry, and the arts. According to Erika Woelfel, director of color at Behr Paints, "Even people talking about the decline of bees can influence the inclusion of honey-golden tones." Jordan says the Sherwin-Williams forecast was inspired by a range of sources, from the '60s style of pop icon Adele to the steam-punk aesthetic to bright neon and electroluminescent lighting. Fashion, of course, remains a major influence on interiors. "If a color remains popular

in fashion for at least two seasons, you see it filtering down into objects for the home," says Woelfel. The research needs to remain hands-on to be useful, however. "At the end of the day, we are a paint product, and we have to work with actual samples and actual products," she says.

Even though forecasts for the same year may vary from company to company, the process is far from subjective, says Benjamin Moore senior interior designer Sonu Mathew. "It's an observation of what's happening in the world," she says. It also extends beyond the consumer audience. Dee Schlotter, brand manager of PPG Pittsburgh Paints' program The Voice of Color, says 70 percent of PPG's business is professional, with much of that commercial. "Providing the trends and forecasting service for them is extremely helpful in their new projects," says Schlotter, adding that the company sees the most interest in its trends program in the hospitality, retail, and health-care sectors.

Pantone, known as the definitive color authority, issues several color forecasts a year. "All manufacturers and designers today are very aware of how important forecasting is and try to stay abreast by looking ahead," says Leatrice Eiseman, executive director of the Pantone Color Institute. This does not, however, "preclude them from using their knowledge and instincts," says Eiseman, "but can validate a direction or give new inspiration and direction."

So what's the hot color for 2013? It depends which forecast you check. But whether it's Lemon Sorbet, Awesome Violet, or Monaco Blue, one thing is for sure—the forecasters are already hard at work looking for what's next.



**COLORFUL FUTURE**  
Current forecasts from paint manufacturers include the Sweet Jazz palette from Behr Paints' 2013 forecast, shown above in a bathroom setting with Bee's Knees and Jazzy Jade dollops (top left and right). Influences of an election year could be seen in the Modern palette from PPG Pittsburgh Paints' 2013-2014 forecast (center), which includes a bright blue and a red. The neutral and earthy colors in the Yolo Colorhouse Fall 2012 palette (below) are intended to be nostalgic and current at the same time, like a photo from the popular Instagram app.





### New Zero-VOC Colorants, Paints, and App

**Sherwin-Williams** [sherwin-williams.com](http://sherwin-williams.com)  
Sherwin-Williams introduced several new products this year, including Emerald Interior and Exterior Acrylic Latex paint, the company's new top-of-the-line product, offering resistance to blistering, peeling, fading, and mildew. The paint was recently chosen to refurbish the landmark Hollywood sign in Los Angeles, which will celebrate its 90th birthday next year. Approximately 275 gallons of white Emerald Exterior paint will be used in the project, funded by Sherwin-Williams and the Hollywood Sign Trust. Emerald and all other Sherwin-Williams latex and water-based paints will be tinted with ColorCast Ecotoner colorants using a new tinting system that does not add VOCs or affect thickness and consistency. Finally, the ColorSnap Studio iPad app combines several existing smartphone and desktop tools from the company into one app offering the ease of use and high definition of a tablet. This includes a Color Visualizer tool and a paint estimate calculator. **CIRCLE 201**

### Molten Metallics

**Benjamin Moore** [benjaminmoore.com](http://benjaminmoore.com)  
The newest addition to Benjamin Moore's Studio Finishes portfolio is Molten Metallics, an alkyd high-gloss paint that creates a surface resembling hand-hammered metal. The coating, which can be applied to furniture, decorative pieces, trim, and walls, is recommended for exterior surfaces since it provides an effective rust-resistant treatment. Available in six standard ready-mixed colors. **CIRCLE 202**

### Zero-VOC Colorants

**Kelly-Moore Paints** [kellymoore.com](http://kellymoore.com)  
Kelly-Moore Paints has introduced new zero-VOC colorants to its line that will maintain excellent indoor air quality during application without the drawbacks commonly associated with zero-VOC additives, such as poor drying and increased water sensitivity. Kelly-Moore claims the new zero-VOC colorants not only eliminate these problems but offer higher strength, improved hiding, more fade resistance, and expanded color options. **CIRCLE 203**

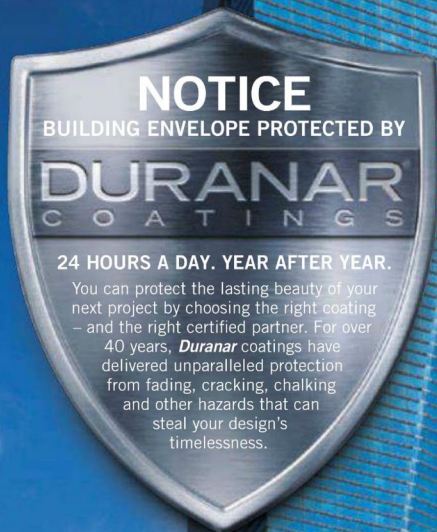
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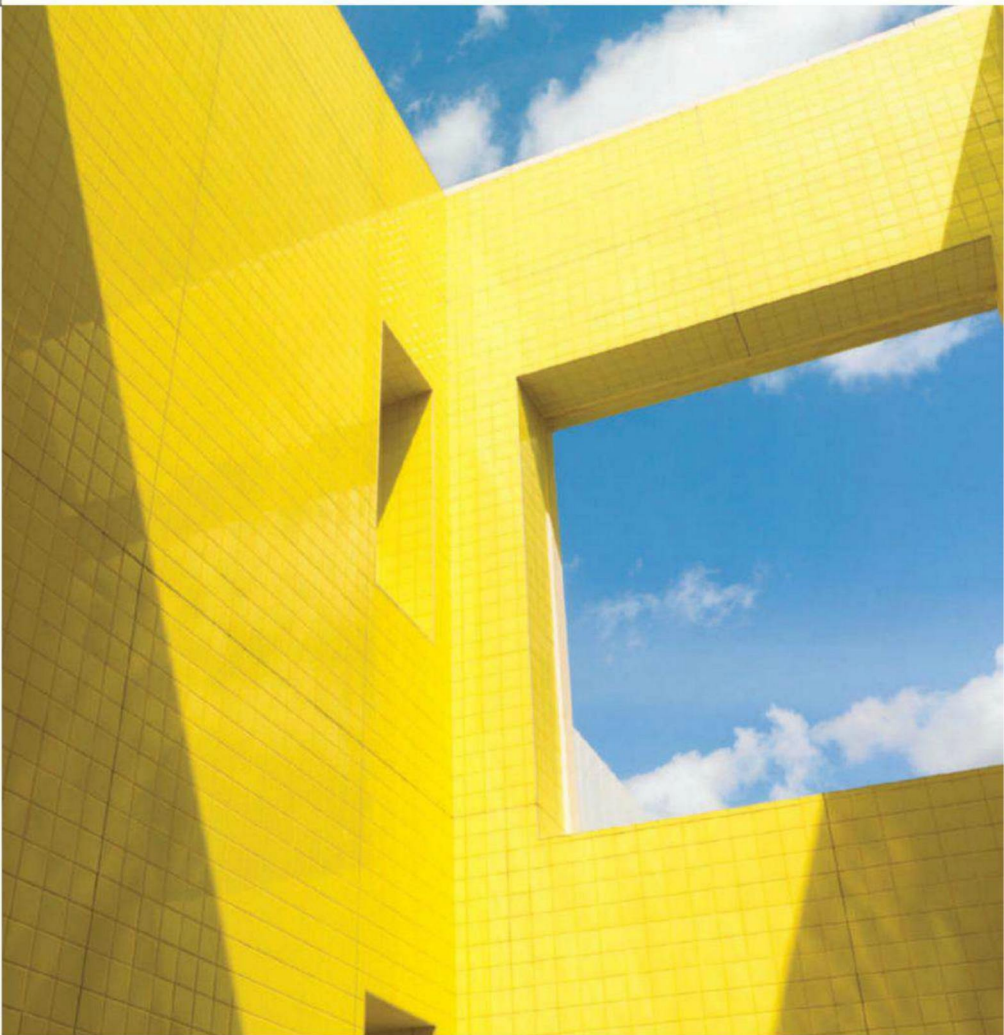
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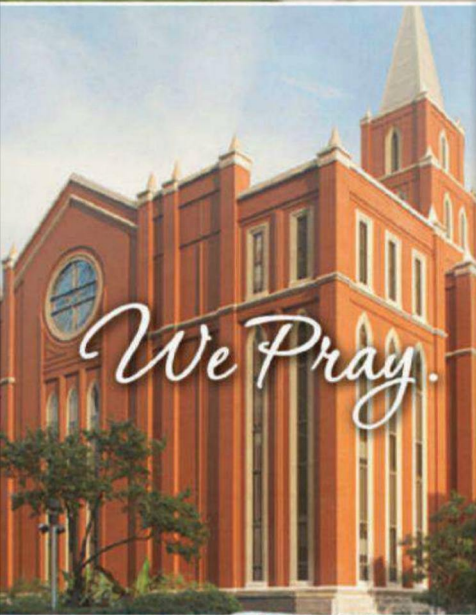
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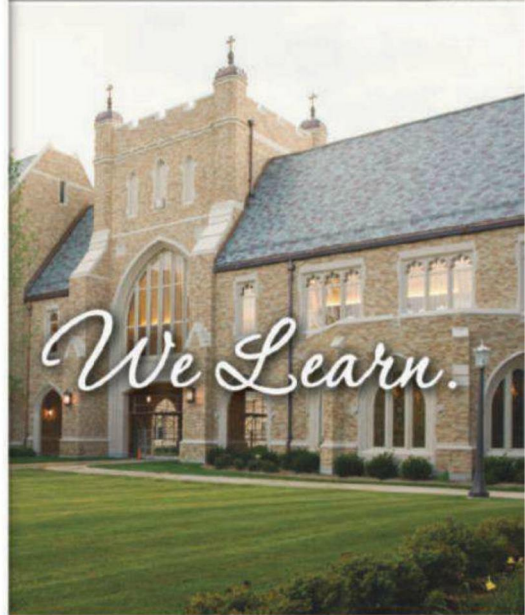
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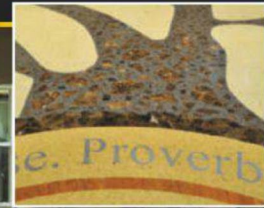


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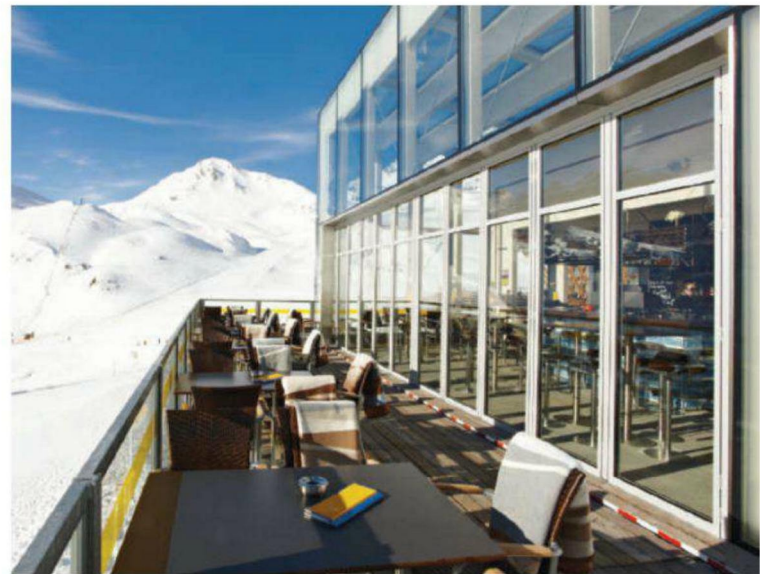
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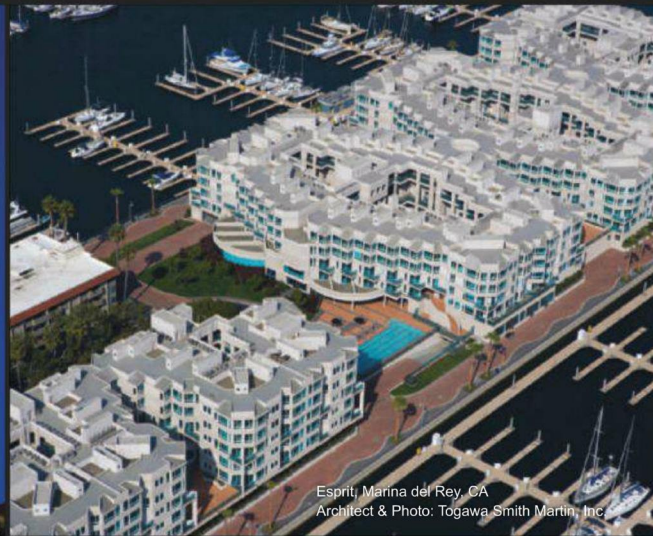
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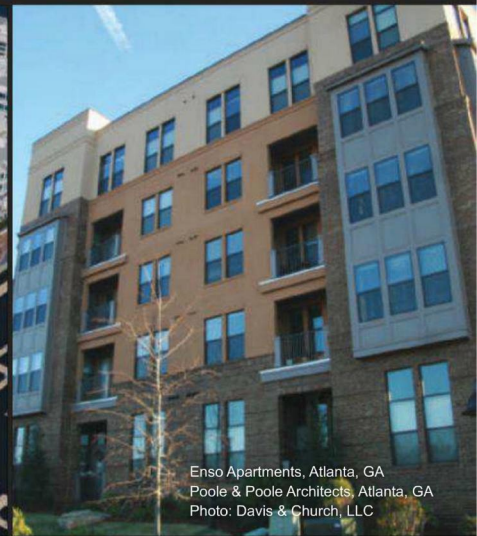
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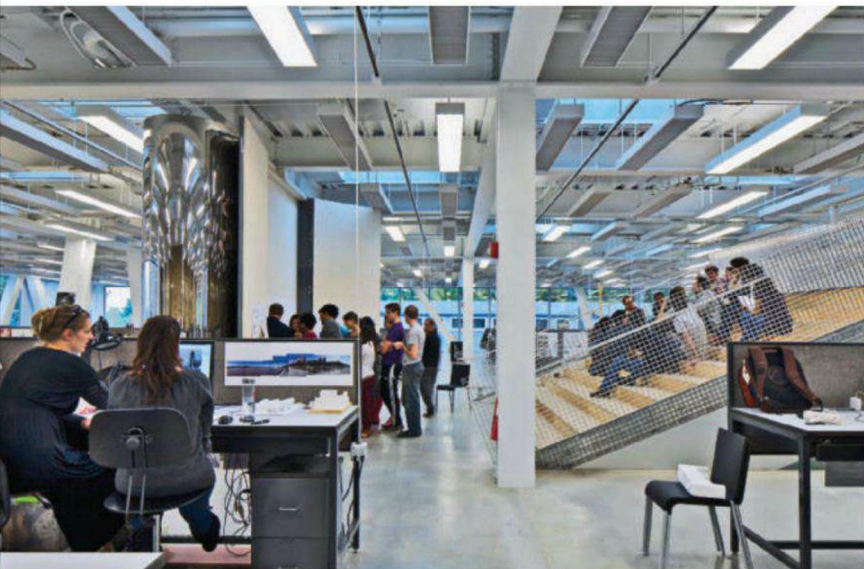
Architecture education has come a long way since the Massachusetts Institute of Technology launched the first program in the United States in 1865. Prospective students today have hard decisions to make, and their potential investment of time and money could hardly be greater. In this special section, RECORD presents the latest installment of its annual feature “America’s Top Architecture Schools,” ranking the top 10 programs, both undergraduate and graduate, along with an assessment of which colleges and universities are best at providing key skills. We also look at the architecture of half a dozen architecture schools—and how they function as places to learn and stay up all night sweating over that charrette. Finally, we examine why architecture remains one of the least ethnically diverse professions. This and other concerns need to be addressed more forcefully. Even so, architecture schools are still attracting great talent and devoted future practitioners.



**INSIDE OUT** SCI-Arc's Kappe Library (named for the school's founder Ray Kappe) occupies the north end of the second floor of a former freight depot in downtown Los Angeles.

# America's Top Architecture Schools 2013

by James P. Cramer



**NUMBER ONE** At the undergraduate level, Cornell University again scores in top place. Students now work in the new Milstein Hall (2011), designed by Rem Koolhaas/OMA.

## The Art of Ranking Architecture Education

Rankings rankle. Whether the rankings are for colleges and universities, law schools, or, in this case, architecture programs, they can irritate almost anybody involved in academia. Unless you are number one, of course. The Greenway Group, management consultant to the architecture, engineering, and construction industry, undertook the architecture-school rankings in 1998 as part of its strategic mission with the report *DesignIntelligence*, and for a very good cause. Much time and money are spent by students on architecture education, and rankings indicate to these “consumers” how well prepared they appear to be from the point of view of those hiring them.

For 2013 we collected surveys from 282 American architectural and architectural/engineering offices employing a total of 42,778 professionals. We asked leading practitioners which schools best prepared architects for professional practice. This is an increasingly difficult question in a changing architectural world. In many ways, the current economic climate resembles last year's (*RECORD*, November 2011, page 55). It is sluggish.

Yet we see positive signs: According to the Department of Labor's September 2012 figures, the unemployment rate is only 5.1 percent for the fields of architecture and building engineering. The National Architectural Accrediting Board (NAAB) reports that as of 2011, student enrollment in the 51 B.Arch. programs was 16,077, and in the 99 M.Arch. programs, 11,031—both down only 1.1 percent from the previous academic year.

Nevertheless, students and their parents may be concerned about their investment. More than ever, being a successful architect requires skills beyond design: business acumen, management know-how, digital savvy, and a facility in communication, to name a few. For that reason we asked practitioners to respond to questions about how well prepared graduate architects are in these areas, as well as their familiarity with such matters as building, equipment, and facility life cycles, not to mention sustainability.

All architecture education could stand improvement. Please see page 72 for additional thoughts.

## Methodology

In surveying architectural firms, we contacted CEOs, managing partners, and human-resources directors to learn about their hiring experience over the last five years. From a list of NAAB-certified undergraduate and graduate programs, firms could select up to 10 schools in each category. We also sent our survey to leaders in top levels of professional practices as defined and listed in the *Almanac of Architecture and Design* (also published by *DesignIntelligence*), based on such factors as awards, media recognition, and extent of international business. Separately, we surveyed students and deans. And, as we have done before, we conducted research on programs devoted to landscape architecture, interior design, and industrial design. For a comprehensive report on the results, see the November/December issue of *DesignIntelligence*, released Nov. 1 (see di.net).

## Graduate Rankings

For the M.Arch. degree, Harvard University's Graduate School of Design maintains its number-one position. In the 14 years that *DesignIntelligence* has been ranking architecture programs, only twice has Harvard missed the top spot—both times by a few points, when Yale University and the University of Michigan briefly unseated it.

Why Harvard? Not only does it have a strong reputation overall, but it scores very well in design, analysis, planning, and the communication skills that graduates need in professional practice. This year, for the first time in the history of *DesignIntelligence* research, Columbia University takes second place, followed by Yale University, Massachusetts Institute of Technology, Cornell University, and Southern California Institute of Architecture (SCI-Arc). Tying for seventh place are the University of Virginia (UVA) and the University of California, Berkeley. Always strong in our rankings, Washington University in St. Louis holds the ninth position, and the oft-cited school for innovation, the University of Cincinnati, rounds out the top 10.

The two programs that have shown the most upward movement in this year's top 10 are seventh-place UVA (which ranked 14th in 2011 and 11th in 2012) and sixth-place SCI-Arc (a leap from 13th last year). Why schools move up the rankings

## The Top 10 Graduate Programs

- 1** Harvard University
- 2** Columbia University
- 3** Yale University
- 4** Massachusetts Institute of Technology
- 5** Cornell University
- 6** Southern California Institute of Architecture
- 7** University of Virginia
- 7** University of California, Berkeley
- 9** Washington University in St. Louis
- 10** University of Cincinnati

## The Top 10 Undergraduate Programs

- 1** Cornell University
- 2** Southern California Institute of Architecture
- 3** Rice University
- 3** Syracuse University
- 5** California Polytechnic State University, San Luis Obispo
- 6** University of Texas at Austin
- 7** Virginia Polytechnic Institute and State University
- 7** Rhode Island School of Design
- 9** Iowa State University
- 9** Auburn University

### COMPARISON OF PREVIOUS RANKINGS: GRADUATE

	2013	2012	2011	2010	2009	2008	2007	2006
Harvard	1	1	2	1	1	1	1	1
Columbia	2	3	4	4	3	3	9	4
Yale	3	2	3	2	4	13	3	8
MIT	4	6	5	3	4	2	4	8
Cornell	5	6	6	7	6	3	6	-
SCI-Arc	6	13	13	-	-	-	17	-
UVA	7	11	14	9	11	13	5	3
UC Berkeley	7	14	10	9	17	8	-	13
Washington U in St. Louis	9	4	9	11	6	5	6	10
U of Cincinnati	10	10	6	6	2	7	2	2

### COMPARISON OF PREVIOUS RANKINGS: UNDERGRADUATE

	2013	2012	2011	2010	2009	2008	2007	2006
Cornell	1	1	1	1	1	2	1	1
SCI-Arc	2	7	6	-	19	-	-	-
Rice	3	5	3	9	8	11	2	3
Syracuse	3	7	2	2	4	3	3	7
Cal Poly San Luis Obispo	5	4	4	3	3	4	6	3
UT Austin	6	2	7	5	6	6	9	2
Virginia Tech	7	3	4	4	2	1	4	7
RISD	7	6	11	7	4	17	5	5
Iowa State	9	9	-	18	12	14	14	13
Auburn	9	14	18	13	12	18	6	15

Where more than one school receives the same number of votes, the schools are given the same numerical ranking, and the next rank is omitted.

obviously depends to an extent on the number of replies from a certain region. It also relies on growing reputations of practicing faculty members and—not to be overlooked—the effectiveness of the school in communicating its achievements to the architectural community. SCI-Arc excels at this sort of communication: Its students are reported by practitioners to be enthusiastic about their education and well prepared in their job interviews.

Included in the top 20 are the University of Michigan, the University of Texas at Austin, Kansas State University, the University of Kansas, the University of Pennsylvania, Rice University, Princeton University, Iowa State University, Virginia Polytechnic Institute and State University, Savannah College of Art and Design, and Clemson University.

## Undergraduate Rankings

Cornell University has taken the number-one spot this year in B.Arch. programs, as it has consistently for many years. However, the remaining undergraduate rankings do hold some surprises. SCI-Arc has come in at second (up from seventh last year) and Rice at third (up from fifth). Tying Rice for third place is Syracuse University. In the next four spots are California Polytechnic State University, San Luis Obispo; the University of Texas at Austin; Virginia Tech; Rhode Island School of Design; Iowa State University; and Auburn University. Perhaps the biggest story in this group is the movement of Auburn into ninth place (from 14th last year).

The next 10 rankings in undergraduate programs constitute a fascinating list, since so many programs have distinct identities in architecture education—some are known for an emphasis on art, some for sustainability, some for interdisciplinary studies, and some for a strong technical orientation or a particular architectural approach. Pratt Institute took 11th place, Carnegie Mellon University 12th, and the University of Notre Dame, the University of Oregon, and Boston Architectural College all tied at 13th. The Cooper Union for the Advancement of Science and Art and the University of Southern California tied at 16th; Pennsylvania State University moved into 18th. Tied at 19th place in the top 20 are the University of Arkansas and Rensselaer Polytechnic Institute. A complete listing of the rankings can be found at [di.net](http://di.net).

## Additional Data

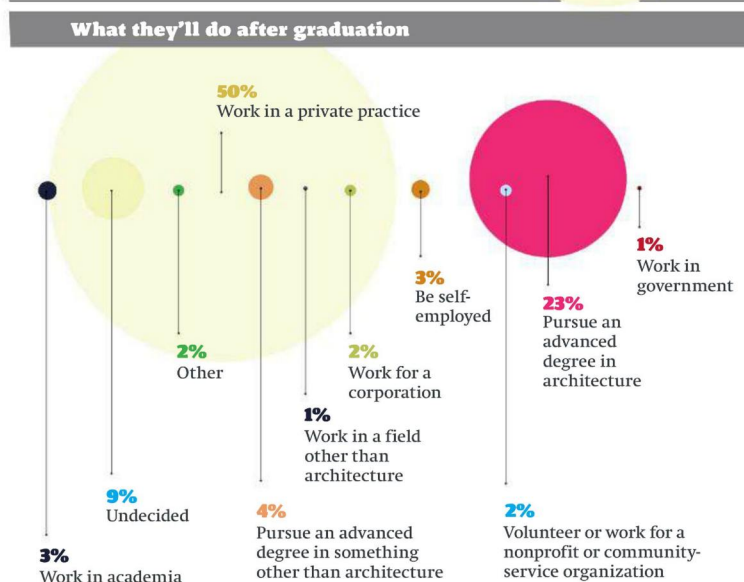
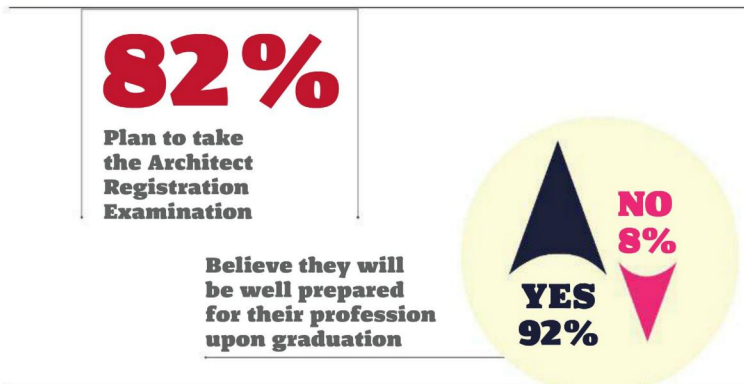
Our interviews with this year's decision makers in professional practice indicate that they are more positive about the state of architecture education than they were in the 1990s. It helps that many successful practitioners stay involved in teaching. It also makes a difference that professional groups, such as the American Institute of Architects' Large Firm Round Table, are including architecture-school deans in their meetings. Other factors account for the optimism: There is an effort to increase diversity in the makeup of students and educators, and architecture schools are said to be receiving more prominence within the larger university.

Even the students seem to be happy with the quality of education they receive, as shown by the graphics at right. ■

*James P. Cramer is founding editor of DesignIntelligence and cochair of the Design Futures Council. He is chairman of the Greenway Group, a management consultancy.*

# Architecture Student Survey

This year 2,151 students responded to *DesignIntelligence's* questions about their satisfaction with their education in 150 architecture programs. Of this group, 56 percent were undergraduates (B.Arch.) and 38 percent were graduate students (M.Arch.); 5 percent belonged to other categories. As the sample indicates, the students generally approve of the education they are receiving, and many consider it superlative.





## Skills Assessment

The collegiate programs that practitioners deem strongest for each skill area:

### ANALYSIS AND PLANNING

1	Harvard
2	Cornell
3	SCI-Arc
4	MIT
4	Columbia
6	Cal Poly San Luis Obispo
6	UC Berkeley
8	Princeton
9	Penn
9	Yale

### CONSTRUCTION METHODS & MATERIALS

1	SCI-Arc
2	Cal Poly San Luis Obispo
3	Harvard
4	Syracuse
5	Auburn
6	Kansas State
6	MIT
8	Rensselaer Polytech
8	U of Cincinnati
8	U of Michigan

### SUSTAINABLE-DESIGN PRACTICE & PRINCIPLES

1	U of Oregon
2	UC Berkeley
3	Harvard
4	SCI-Arc
5	U of Cincinnati
5	Auburn
7	UVA
8	Cornell
9	Cal Poly Pomona
10	Washington U in St. Louis
10	Virginia Tech

## Cost of Education

Architecture-school tuitions are high, especially considering the likely compensation upon graduation. Data from the "Architecture School Tuition & Fee Report 2011-2012" and the "2012 Compensation, Bonus & Benefits Survey" by *DesignIntelligence* offer interesting comparisons. For example, the average tuition and fees for B.Arch. programs, where public and private tuitions are combined, go from \$19,791 a year (in which in-state schools are included) to \$26,252 a year (where out-of-state tuition for public schools is counted). M.Arch. degree programs have very similar tuition and fee statistics. Private schools are somewhat more expensive as a group, averaging in the low \$30,000s.

Overall, costs have increased about 4.2 percent in the past year. While the average starting annual salaries for a B.Arch. (\$40,122) and an M.Arch. (\$43,645) seem low—depending on the region—the average debt of the architecture graduate is \$38,175, total. After three years of entry-level salaries, emerging architects start to see a noticeable increase, depending on the level of responsibility. Over the course of a career in architecture, the average base compensation will be \$108,859 annually, and the total compensation from internship to retirement will be approximately \$4,508,985.

An architecture education may be expensive, but the cost is well justified in the long run. *J.P.C.*

### TOP 10 GRADUATE TUITIONS COMPARED

RANK	GRADUATE	2012-13 Tuition		2011-12 Tuition	
		IN-STATE	OUT-OF-STATE	IN-STATE	OUT-OF-STATE
1	Harvard	\$41,510	\$41,510	\$40,166	\$40,166
2	Columbia	\$45,433	\$45,433	\$42,774	\$42,774
3	Yale	\$42,205	\$42,205	\$40,390	\$40,390
4	MIT	\$42,050	\$42,050	\$40,732	\$40,732
5	Cornell	\$43,185	\$43,185	\$41,325	\$41,325
6	SCI-Arc	\$33,976	\$33,976	\$30,650	\$30,650
7	UVA	\$15,728	\$25,734	\$12,828	\$22,152
7	UC Berkeley	\$19,034	\$31,279	\$18,835	\$31,080
9	Washington U in St. Louis	\$43,500	\$43,500	\$41,832	\$41,832
10	U of Cincinnati	\$17,144	\$32,632	\$16,392	\$31,356

### TOP 10 UNDERGRADUATE TUITIONS COMPARED

RANK	UNDERGRADUATE	2012-13 Tuition		2011-12 Tuition	
		IN-STATE	OUT-OF-STATE	IN-STATE	OUT-OF-STATE
1	Cornell	\$43,413	\$43,413	\$41,541	\$41,541
2	SCI-Arc	\$33,976	\$33,976	\$30,650	\$30,650
3	Rice	\$37,292	\$37,292	\$35,551	\$35,551
3	Syracuse	\$39,654	\$39,654	\$37,524	\$37,524
5	Cal Poly San Luis Obispo	\$9,021	\$20,181	\$7,791	\$18,951
6	UT Austin	\$9,876	\$33,990	\$9,876	\$33,290
7	Virginia Tech	\$11,573	\$26,565	\$11,159	\$25,130
7	RISD	\$41,332	\$41,332	\$39,777	\$39,777
9	Iowa State	\$8,126	\$20,238	\$9,166	\$21,038
9	Auburn	\$13,766	\$29,510	\$14,442	\$32,682

## James Cramer's Gentle Manifesto to Improve Architecture Education

*As we know, the nature of architectural practice is changing, and architecture education must keep up with the profession. Below are key points that I would suggest be considered by architecture schools, based on research undertaken by DesignIntelligence and the Design Futures Council.*

- 1.** Institute a program for faculty and staff that updates them continuously on the latest A/E/C industry information, including business metrics, technical research, materials breakthroughs, and professional compensation.
- 2.** Teach business leadership and communication skills in addition to design.
- 3.** Make metrics in finance, marketing, professional services, and operations part of studio projects.
- 4.** Incorporate into teaching on-site supervisory experience, cost analysis, fee adjustments, and other business practices, along with day-to-day project management.
- 5.** Create social and intellectual programs outside the classroom that will build bridges between the profession and education.
- 6.** Special lecture programs should involve not only the best talents in design but those in business as well. Lecturers should talk candidly about budgets, profits, strategic planning, and fees.
- 7.** The profession should bring educators into architectural practices as paid advisers on policy, technology, and related matters. There needs to be more interaction between professors and professional practitioners.
- 8.** Every firm should donate a percentage of its annual profit to a college program of its choice. The profession should make a financial commitment to educating the next generation.
- 9.** Architecture programs should provide older and tenured faculty members opportunities to reenergize themselves through a 12-to-24-month exchange program among schools.
- 10.** Since challenging the tenure system may be a losing battle, teaching quality can be bolstered by establishing a system of incentives. The profession should support this with endowments, chairs, and grants.
- 11.** Architecture-school facilities should be designed to inspire students, and be well maintained and provided with the latest tools and technology.
- 12.** Online learning must have a legitimate role as an option in architecture education. Educational institutions should enable nonaccredited degree graduates to gain the credits they need to qualify for licensure.

## Why the Lack of Black Students? by Jenna M. McKnight

**RECORD speaks to architecture students about the field's diversity problem.**

**GROWING UP** in Miami, Candace Hoskins was always drawn to the arts. Her interest deepened at Design and Architecture Senior High School, a premier magnet school with a diverse student body. But when Hoskins was admitted into the M.Arch. program at the University of South Florida (USF) in Tampa, she was the only African-American in her class of 40 students. "I definitely wish it was more integrated," Hoskins says.

The problem is not unique to USF. Only 1,444, or 5.3 percent, of the 27,478 students in programs certified by the National Architectural Accrediting Board identify themselves as black or African-American. The numbers get much smaller as these aspiring architects climb the professional ladder: Of

the 104,300 registered architects in the United States, roughly 1,860 of them—less than 2 percent—are black.

These numbers are similar to those in other professional degree programs, albeit somewhat lower. In 2010, 7.2 percent of first-year medical students were black, reports the Association of American Medical Colleges; numbers for black law students in 2008 were about the same, according to a study conducted by Conrad Johnson, a Columbia Law School professor.

When it comes to the dearth of black architecture students, there is no single culprit or simple solution. Various socioeconomic and historical factors contribute, ranging from high tuition costs to a scarcity of role models. Given the country's multicultural makeup, it's an issue that should concern everyone. "Because our work is in service to society, we should have professionals who reflect that diversity," says archi-

tect Toni Griffin, head of the J. Max Bond Center at the City College of New York. "The more we embrace this, the richer our buildings, communities, and cities can be."

A number of architecture schools offer scholarships for minority students and host programs, such as architecture summer camps, aimed at middle and high schoolers. "You have to reach them early on, so they're thinking about the right classes to take in high school," notes Kathy Dixon, president of the National Organization of Minority Architects, which is celebrating its 40th anniversary this year. Dixon, whose father is an architect, earned degrees from Howard University and UCLA. Today, she's one of only 290 or so black female architects in the country. "There are two strikes against you," she says of her gender and race. "You have to be more determined and more focused. You can't let anyone



**DEVANNE PENA,** 23, graduated with a B.Arch. from North Carolina State University in May 2012. She now teaches high school architecture and engineering-drafting classes, while completing an intern program for licensing.

deter you from your end goal. This is a difficult field.”

Indeed, black students often don't gain the encouragement needed to pursue architecture. Devanne Pena, who recently earned a B.Arch., grew up in a low- to middle-income neighborhood in Fayetteville, North Carolina, in a single-parent household. As a child, she dreamed of becoming an architect, and during high school she was one of only two girls in her drafting class. She recalls asking her teacher if he thought she could get into MIT. “‘Maybe as a maid,’” he reportedly told her.

Pena ended up studying at North Carolina State University, an experience she describes as rewarding yet grueling—and at times demeaning. For her first project, she was asked to design a 50-foot cubic volume. “The only architecture I could think of was a little church,” she says. Strapped for cash, she made her model out of cardboard. “All my classmates always used basswood,” Pena says, “and when I'd ask them how much they spent on their projects, they'd say \$100 to \$200.” For that initial assignment, Pena received the first of many harsh critiques. “I always felt like I was behind,” she says. “Everyone's projects always looked better than mine—my classmates came from a different place.” To add to her discomfort, none of her professors was black.

Historically, affluent white men have dominated the architecture profession. High educational costs and relatively low starting salaries have precluded many students of economically disadvantaged backgrounds from pursuing a design degree. “We're still recovering from generations of people who were disenfranchised, who didn't have the opportunity for an education,” says Namdi Alexander, an M.Arch. student at the University of Minnesota. To compound the problem, “being a nerdy architecture drafter guy doesn't fall into the spectrum of cool that most African-American kids grow up with,” he says. “The onus is on our culture and parents to alter the idea that hip-hop and basketball are the only viable career options.”

For those nerdy African-American drafters who do go on to architecture school, relationships can be tinged with racial undertones. A white professor with whom Alexander was on good terms said during a project critique that it appeared he was trying to please her rather than “find his own answer.” “She said, ‘Is that what your parents taught you—to always please the white folk?’” he recalls. He complained to a minority professor, and the other teacher, who was mortified, apologized. Still, “it was hard to wash the taste of something like that out of my mouth,” Alexander, who is 35, says. “I can handle it, but what if it was a younger guy or girl—would that be enough to derail them from their dream?”

Students may also be discouraged by the absence of African-American culture in most design curricula. “Throughout my architectural education, my own cultural history was absent,” said Mabel Wilson, a professor at Columbia University's Graduate School of Architecture, Planning and Preservation, during a Black Studies in Art and Design Education conference held last year at Parsons the New School for Design. “It

was all white Modernist boxes and Italian palazzos.”

One school that has taken steps to remedy this is the Maryland Institute College of Art (MICA), which offers a bachelor's degree in environmental design and next year will launch an architectural-design degree. Students can take classes such as “Africans in the New World,” which explores how Americans of African descent “responded aesthetically to the New World experience,” says noted scholar Leslie King-Hammond, founding director of MICA's Center for Race and Culture. The school also has a diversity board that closely examines how race and ethnicity are integrated into coursework and faculty-student relations. Often, professors have to “learn new things and expand their worldview,” says King-Hammond.

Many universities also give students hands-on experience in minority communities. The architecture school at the University of Illinois at Urbana-Champaign—which graduated the first black architecture student, Walter Thomas Bailey, in 1904—has long done work in cities such as East St. Louis, Illinois, where blacks account for 98 percent of the population. In 2005, the University of Michigan started the Detroit Community Design Center, which offers free or low-cost design services to area nonprofits.

In some cases, black students are taking it upon themselves to shape a college experience that speaks to their

## Black students can be deterred by high tuition, low starting salaries, and the absence of African-American culture in most design curricula.

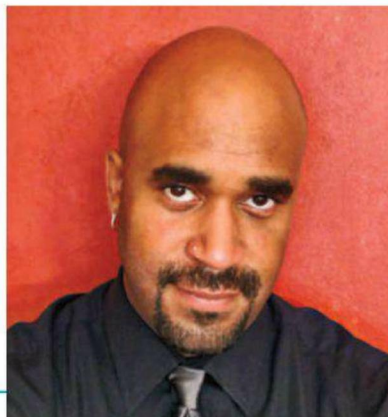
culture. Maya Corin Madison, a B.Arch. student at Syracuse University and the daughter of two architects, is a member of the Society of Multicultural Architects and Designers. The student group works on projects around the city, hosts fundraisers, and tries to bring minority architects to the forefront. “The black architecture community is really

close,” she says. “Whenever we have a guest lecturer who is a minority, not just black, we get excited.” That's not to say her sole inspiration comes from architects of color. Her favorite designers: “Frank Lloyd Wright, Bjarke Ingels, Corbusier, Mies,” she says. “I like the big architects.” ■

*Jenna M. McKnight is RECORD's former news editor and is now editor in chief of Architizer. Stephen Zacks, a New York City-based writer, contributed reporting to this story.*



**MAYA CORIN MADISON**, 21, is in her fourth year at Syracuse University's five-year B.Arch. program.



**NAMDI ALEXANDER**, 35, is pursuing an M.Arch. at the University of Minnesota. He is also interning with the BKV Group in Minneapolis.

# The Architecture of Architecture Schools

## by Laura Raskin and Asad Syrkett

As Marc Treib writes in an essay in Joan Ockman's *Architecture School: Three Centuries of Educating Architects in North America* (review, page 78), architecture-school buildings haven't changed much from their early-20th-century design roots: prominent drafting rooms and studios, surrounded by classrooms, lecture halls, and offices. Each iconic structure remains a symbol of the institution's educational mission. But with the rise of digital tools, increased class sizes, and an emphasis on collaboration and transparency in both architectural education and the workplace, schools must adapt. Many of them have. The following is a look at six structures renovated in the last decade, and how well they do—or do not—serve their clients: students. Most of these renovations have contended with a need to both preserve an icon and address the evolving requirements of students, faculty, and the demands of the profession. The degree candidates we spoke with feel passionately about their buildings' quirks—from favorite new views to skateboard-friendly hallways—and use them as case studies for learning. ■



**GUND HALL, HARVARD UNIVERSITY, CAMBRIDGE, MA. JOHN ANDREWS, 1972. INTERIOR RENOVATION BY BRUNER/COTT ARCHITECTS AND PLANNERS, 2010.**

As a student at Harvard's Graduate School of Design in the late 1960s, Leland Cott helped design Gund Hall's original desks. The 7-foot-tall workstations clogged the dramatic tiered studio space but blocked some cigarette smoke and noise. In 2010, Cott, now of Bruner/Cott, devised shorter wood desks with translucent tack boards and model carts on wheels. (A forthcoming renovation will address notorious climate issues, although some retrofits have been made to the HVAC systems.) Students may miss ample pinup space and more elbow room, but they like the increased daylight and improved interaction. *L.R.*





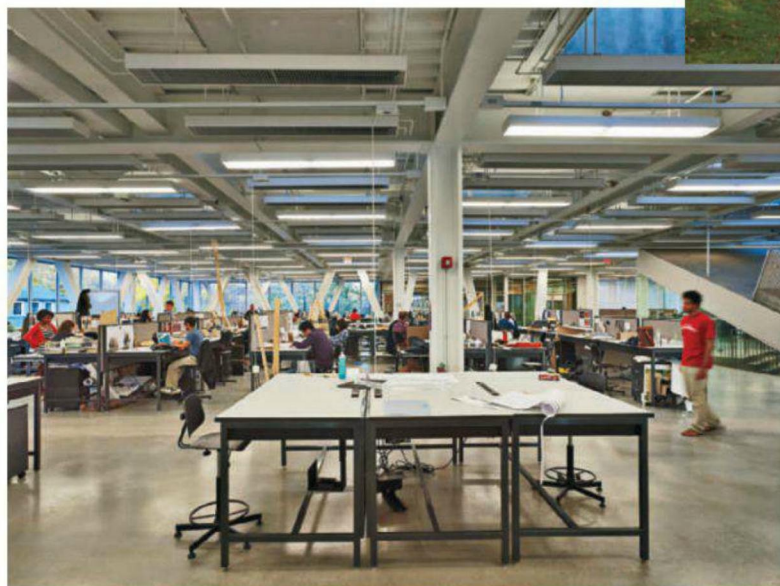
**S.R. CROWN HALL, ILLINOIS INSTITUTE OF TECHNOLOGY, CHICAGO. MIES VAN DER ROHE, 1956. RENOVATED BY KRUECK+SEXTON ARCHITECTS, 2005.**

Mies van der Rohe's iconic jewelbox for the Illinois Institute of Technology's school of architecture was looking its age—49—when Krueck+Sexton Architects won a bid to renovate it in 2005. Crown Hall's steel frame was corroding, and its signature black, lead-based paint needed to be stripped and replaced, as did its glass panels. A steady stream of visitors and Mies fans means working in what can feel like a "fishbowl," says third-year M.Arch. candidate Lauren Kottis. It also means having to rein in workspace messiness to preserve Crown's pristinely minimal aesthetic for tour groups. But, Kottis is quick to add, the building is an excellent teaching tool and all-around asset, helping attract powerhouse lecturers to the school. A.S.



**MILSTEIN HALL, CORNELL UNIVERSITY, ITHACA, NY. REM KOOLHAAS/OMA, 2011. ADDED TO RAND HALL (GIBB AND WALTZ, 1912) AND SIBLEY HALL (ARCHIMEDES N. RUSSELL, 1871).**

OMA's 47,000-square-foot addition to Cornell's architecture school connects new to old by attaching a horizontal box to the existing Rand and Sibley halls. Milstein includes a two-story, domed crit space, an auditorium, and studios housed in an enormous "plate." M.Arch. candidate William Smith says that to appreciate Milstein, one has to have spent time in Rand. "Rand was like a factory," he says. "Milstein is more like a corporate office where you don't want to make any dust." Time will tell whether a more carefree attitude will take hold. Smith's favorite spot is the upper third of the lecture hall at sunset: "It's a spectacular moment between inside and outside." L.R.



**SOUTHERN CALIFORNIA INSTITUTE  
OF ARCHITECTURE, LOS  
ANGELES, 1972. RENOVATED BY  
GARY PAIGE STUDIO/GPS, 2003.**

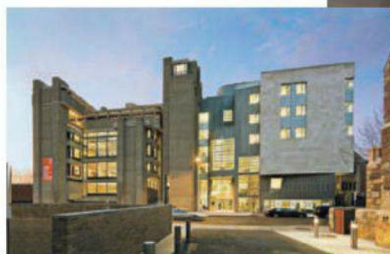
Los Angeles's Southern California Institute of Architecture, or SCI-Arc, is known for an educational approach that encourages experimentation and progressive thinking. But the self-contained school's quarter-mile-long, 61,000-square-foot building, a former freight depot renovated by SCI-Arc alum Gary Paige, has been criticized for being less than avant-garde and Paige's insertions too minimal. Some students don't mind the tabula rasa quality of the space: "It's great that the building doesn't impose anything on you," says first-year M.Arch. 2 candidate Solar Labrie. And the transparency of the long, skateboard-navigable space is "exciting," she adds. "You don't miss anything that's going on." A.S.



**PAUL RUDOLPH HALL (FORMERLY ART AND ARCHITECTURE  
BUILDING), YALE UNIVERSITY, NEW HAVEN. PAUL RUDOLPH,  
1963. RENOVATED BY GWATHMEY SIEGEL & ASSOCIATES, 2008.**

When architect Paul Rudolph's Art and Architecture Building opened in 1963, Ada Louise Huxtable, then the architecture critic of the *New York Times*, lauded it as a "spectacular tour de force," but student reaction was decidedly less enthusiastic. Degree candidates complained that the building was forbidding, its ceilings too low, and the workspaces alternately too hot or too cold. After an

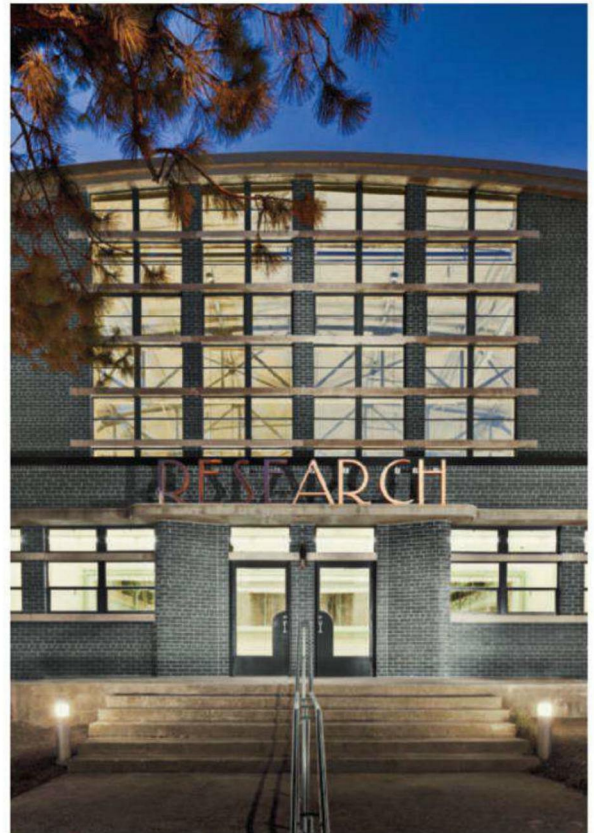
extensive \$126 million renovation (and an 87,000-square-foot addition) by Gwathmey Siegel & Associates in 2008, some minor problems persist, like a lack of pinup space, says Amrita Raja, a third-year M.Arch. student. But overall, Raja says, the building is "really considerate" to students and provides pleasant workspaces. An open plan also means better sightlines and more daylight through the building, Raja explains. Her fellow third-year student Altair Peterson concurs: "When you're gone for the weekend or for the summer, you get back and remember how great the building is." A.S.





**HINMAN RESEARCH BUILDING,  
GEORGIA TECH, ATLANTA.  
HAROLD BUSH-BROWN AND  
P.M. HEFFERNAN, 1939.  
RENOVATED BY NADAAA AND  
LORD, AECK & SARGENT, 2011.**

“You’ll never get an audience that is so much part of your medium as when you do a school of architecture,” says Nader Tehrani, principal and founder of NADAAA (formerly Office dA) and head of Massachusetts Institute of Technology’s architecture department. NADAAA, with Lord, Aeck & Sargent (LAS), turned the Hinman Research Building into an annex for the College of Architecture. While LAS restored the exterior, NADAAA “laid bare” the interior, with its 50-foot-high bay laboratory. The open plan of the ground floor is flexible studio space where students get to mix. A “crib” hung from the ceiling creates second-floor studio space and a lounge. “You see the meshing of older and newer technology and construction techniques and how they can really be in dialogue with each other. It’s fantastic,” says Steffann Plishka, a third-year M.Arch. candidate. “Being able to create really great environments without the same environmental costs is going to be a huge part of our profession. That’s important to see.” L.R.



[ BOOKS ]

# Academic Discourse

## by Aleksandr Bierig

**Architecture School: Three Centuries of Educating Architects in North America**, edited by Joan Ockman with Rebecca Williamson. Cambridge, MA: MIT Press, 2012, 400 pages, \$50.

**WHAT IS** the status of the “big book” today? The editors of *Architecture School*, along with the board of advisers of the Association of Collegiate Schools of Architecture—which initiated the book to celebrate its 100th anniversary—must have asked that question often while preparing this massive survey. As the field of architecture education develops, its historical territory becomes ever more populated by experts, which creates a culture of hesitancy about all things big. In that context, the implications of undertaking a “definitive” book like this must have been daunting and possibly paralyzing.

Yet the effort comes off well, for the most part. Led by the respected scholar Joan Ockman, contributors are largely well known, often returning to previous research. Ockman begins by stating the book’s aim: to “open up as many avenues as possible for future inquiry and, in doing so, to work against the tendency to produce a canonical history.” The project’s internal tensions could not be more neatly expressed.

The first half of the book is a continuous, “overlapping” history of the North American architecture school, from “Before 1860” to “1990–2012.” In chapters on early periods, which broadly follow the rise and fall of French Beaux-Arts influence and then the rise and fall of European Modernism, authors uncover some of the lesser-known “avenues” that Ockman hints at. Anthony Alofsin, for instance, writes that it was the University of Oregon that first broke from the pervasive Beaux-Arts approach of airless academicism by experimenting in the 1920s with actual building projects.

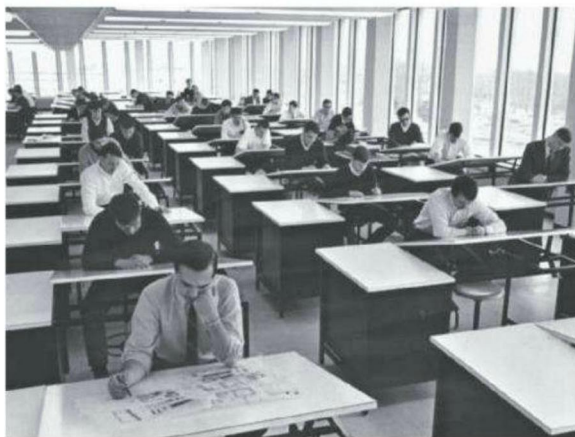
Essays on the period between 1920 and 1968 indicate another trend: the continued desire and failure of architecture to engage social and political issues substantively. This failing is truest in the period 1940–68, covered

by Ockman and Avigail Sachs. Their quotation from Whitney Young’s indictment of the field at the 1968 AIA convention still rings depressingly true. Young “accused the profession of ‘thunderous silence and complete irrelevance’” in relation to the political tumult of that era. His accusation is a shadow that haunts much of the book, depicting architecture education (and architects at large) as an accidental society of do-gooders who rarely manage to do good.

After 1968, the reader confronts familiar perspectives in essays on the recent past. Mary McLeod’s piece on 1968–90 recounts the same roll call we’ve heard for years—the Whites, the Grays, *Oppositions*, Deconstructivism, and so on. Worse is Stan Allen’s history of the years from 1990 to the present. Allen seems unconcerned with the discipline’s displacement by rationalized building practices in a culture of relentless economy and “optimization.” “Young firms,” for him, are represented in ideal terms: “technologically adept and agile, capable of making rapid adjustments as the project or the market requires.” This description disregards the actual situation of such firms, whose work often consists of small installations or renovations, drawn up by waves of unpaid interns.

Such problems, both past and present, would have been elucidated by some indication of the raw numbers. We are told how many students and schools there were, roughly, at certain times, but are given no larger indication of the rise and fall of enrollment or what, exactly, all these architecture students ended up doing. A good, though slightly out-of-date, counterpoint is Mary Woods’s excellent 1999 book *From Craft to Profession*. Woods tells the story of architecture schools in the 20th century with a devastating statistical clarity—enrollments rose 253 percent between 1960 and 1980, while construction in real dollars remained more or less stagnant. This kind of detail is almost completely lacking in the Ockman book.

However, that myopia is slightly improved in the second half of



OLD SCHOOL Architecture students hard at work at drafting tables at Kent State in 1967 (top) and MIT in 1898.

*Architecture School*, which examines topics that allow authors to apply larger historical trends to particular areas of discourse. Presented in encyclopedic format, it is a sampling of smaller histories—of architecture-school buildings and historic preservation, among others. For instance, Annmarie Adams’s essay on gender issues nicely shuttles between a genealogy of specific personalities and the enrollment numbers for women through the 20th century. The topics vary but are telling. What other field would include “disciplinarity” (its limits and identity) as an object of analysis?

This book presented a paradox: how to make a canonical history in a post-canonical era. It is somehow touching that such a history would be written for the centenary of the ACSA—a ritualistic return to arbitrary dates and anniversaries. The cycle of time remains a cliché from which we cannot escape. And the alphabetical arrangement of the second half betrays another stubborn tradition: We continue to put things in order, no matter how recalcitrant those things are to ordering. The result remains a mostly impressive effort and an archive of the concerns—both conscious and undeclared—of our moment. ■

Aleksandr Bierig is an M.Arch. candidate at Princeton’s School of Architecture and an editor of the school’s biannual magazine, *Pidgin*.





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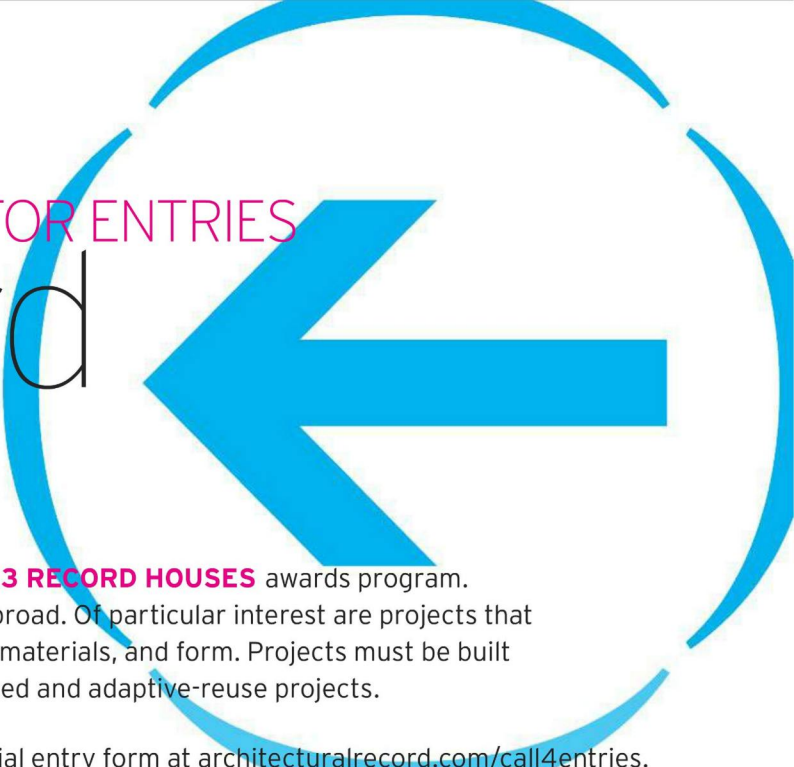


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The fee is US\$150 per entry and \$50 for each additional project. Download the official entry form at [architecturalrecord.com/call4entries](http://architecturalrecord.com/call4entries). E-mail questions to [arcallforentries@mcgraw-hill.com](mailto:arcallforentries@mcgraw-hill.com). Please indicate **GDGB** as the subject of your e-mail. **SUBMISSION DEADLINE: 2/15/2013.**



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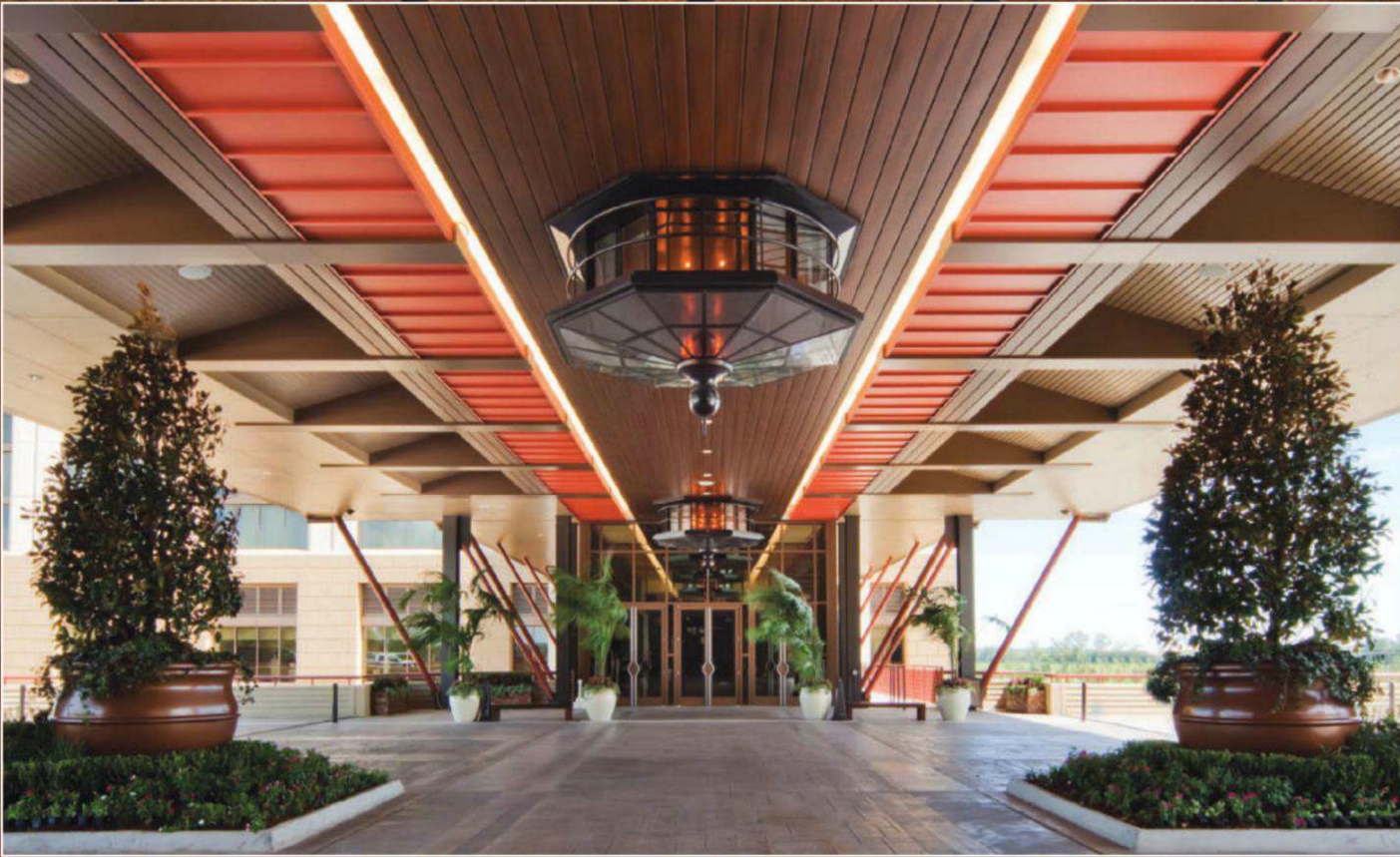
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# TOO BIG TO FAIL?

Long awaited and much debated, the enormous headquarters of CCTV finally opens, already a symbol of the new Beijing. But what does it actually say about architecture and China today?

BY CLIFFORD A. PEARSON

**PROMISING TO “KILL THE SKYSCRAPER,”** Rem Koolhaas and his colleagues at Office for Metropolitan Architecture (OMA) grabbed international attention in 2002 when they won the competition to design a huge headquarters in Beijing for China Central Television (CCTV), the state-run news and entertainment network. Polemical and hyperbolic as usual, Koolhaas said the skyscraper had become “corrupted” by its proliferation around the world and “negated by repetitive banality.” So instead of joining the race to build ever taller, his scheme bent the high-rise into a loop of interconnected activities. Four years after it was originally scheduled to open—in time for the network to broadcast the Beijing Olympics from its new home—CCTV is finally moving employees into the controversial building, a 5.1 million-square-foot structure that even before it was completed had imprinted its swaggering form on the fabric of the city and the mental map of its citizens.

The building shares a 45-acre site with a low-rise, ring-shaped service structure and a 31-story tower called the Television Cultural Center (TVCC), both of which OMA also designed. The service building provides power to the entire complex and houses security personnel, while TVCC will have a Mandarin Oriental hotel, a public theater, restaurants, and shops. TVCC famously burned in February 2009 when



**SIZE XL** Although “only” 768 feet tall, the 41-story CCTV building (left) has 5.1 million square feet of space for production, broadcast, and administration functions. Set near the city’s Third Ring Road, it has already become a landmark in a part of town that is changing from an industrial area to a new central business district (above). To its right is SOM’s 74-story China World Trade Center.



fireworks celebrating the lunar New Year engulfed the building's skin in flames just months before the hotel was set to open. It is being repaired and should be complete in 2013.

The site anchors a new central business district emerging from an industrial area built during the Mao era. Plans call for about 300 high-rises there, which is one reason why OMA took a different approach with CCTV. According to Koolhaas, three of the four other firms competing for the job (KPF, SOM, and Dominique Perrault) proposed skyscrapers, while only Toyo Ito offered something different (a disc-shaped structure with a small tower). "The form of our building was attractive to the client," says Koolhaas. "It set us apart."

That form derived from OMA's program-driven approach to design. "We presented the building as a diagram of all the company's components and made the argument that it was important that they confront each other," says Koolhaas. Earlier, OMA had worked for Universal Studios on a headquarters in Los Angeles and learned that media companies often suffer from being fragmented. So the firm connected CCTV's operations—including broadcasting, production, and administration—along a circulation loop that moved from the building's base up a sloping tower, across a right-angled bridge (called the overhang), and down a second sloping tower. The underground podium and large, right-angled base provided much more contiguous space for studios and production facilities than a skyscraper would have, which

appealed to the client's technology people, reports Koolhaas.

The OMA team was led by Koolhaas, Ole Scheeren (a partner until he left the firm in 2010), partner David Gianotten, and project manager Dongmei Yao. The firm worked closely with East China Architectural Design & Research Institute, which provided both architecture and engineering input.

**The exterior cladding and angled bracing obscure the building's scale and read as a kind of structural map with a formal beauty of its own.**

From the beginning of the design process, OMA collaborated with Cecil Balmond and a team of engineers at Arup. To resist the huge forces generated by two towers—each sloping six degrees in two directions—as well as significant potential seismic and wind events, Arup devised a scheme that turns the entire exterior into a continuous structural tube. This system is formed by a web of diagonal steel braces that expresses the pattern of forces acting on the building and serves as an important visual element on all of the facades. Where structural forces are greater, the web of braces is denser; where the forces are less intense, the web is looser.



#### MERCURIAL ICON

The building's unconventional form seems to change as you move around it, so its presence in the city shifts too (above and right). A web of diagonal steel bracing is visible on all facades and expresses the forces acting on the structure—dense where they are great and looser where they are less (opposite). The glazing has a monolithic gray tone, which helps it blend in with the city's notoriously polluted skies and hide dirt.

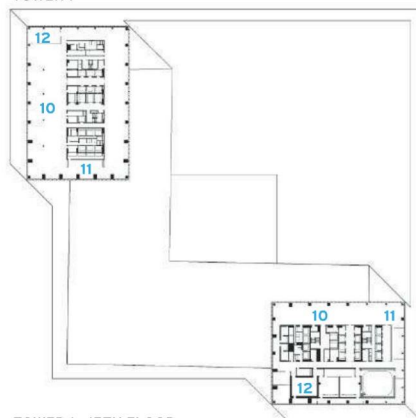




41ST FLOOR

- 1 PUBLIC LOBBY
- 2 TOWER LOBBY
- 3 KITCHEN
- 4 CANTEEN
- 5 GYM
- 6 HEALTH CENTER
- 7 MARKETING
- 8 DATA CENTER
- 9 STUDIO
- 10 OFFICES
- 11 LOUNGE
- 12 MEETING

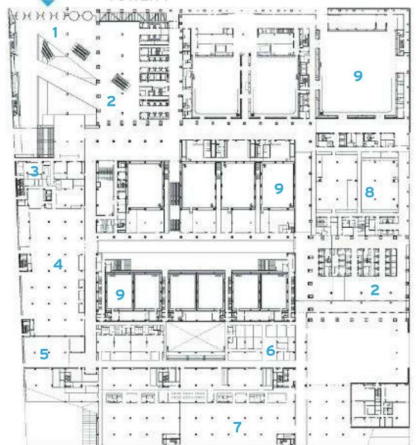
TOWER 1



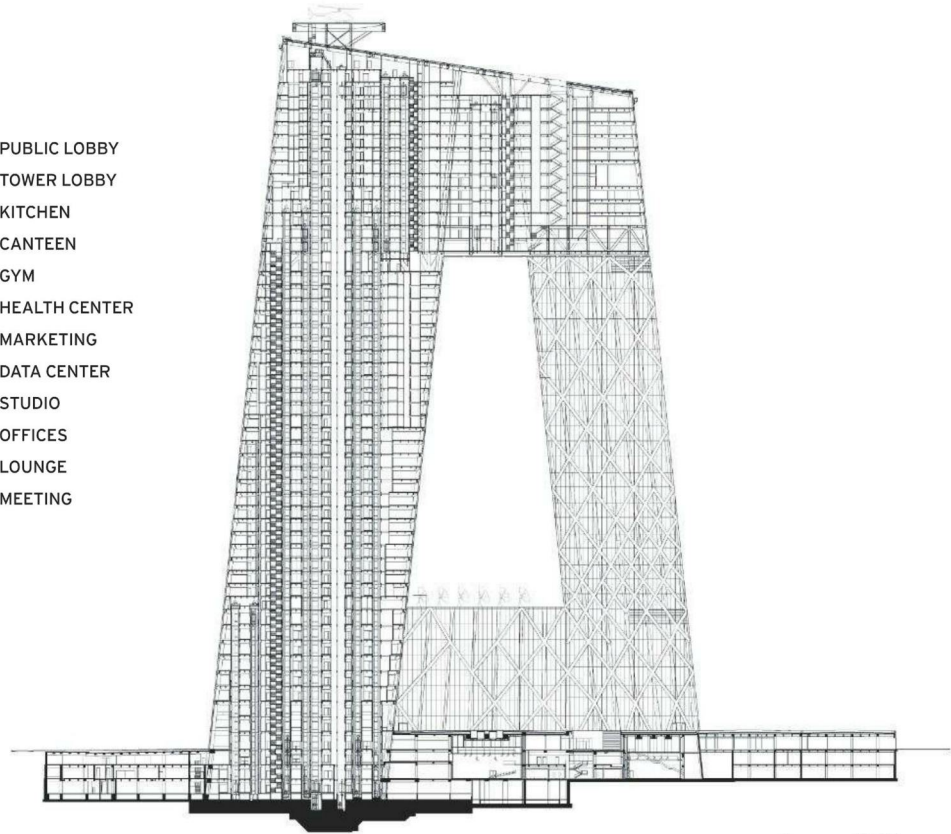
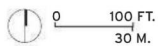
TOWER 1 - 15TH FLOOR  
TOWER 2 - 14TH FLOOR

TOWER 2

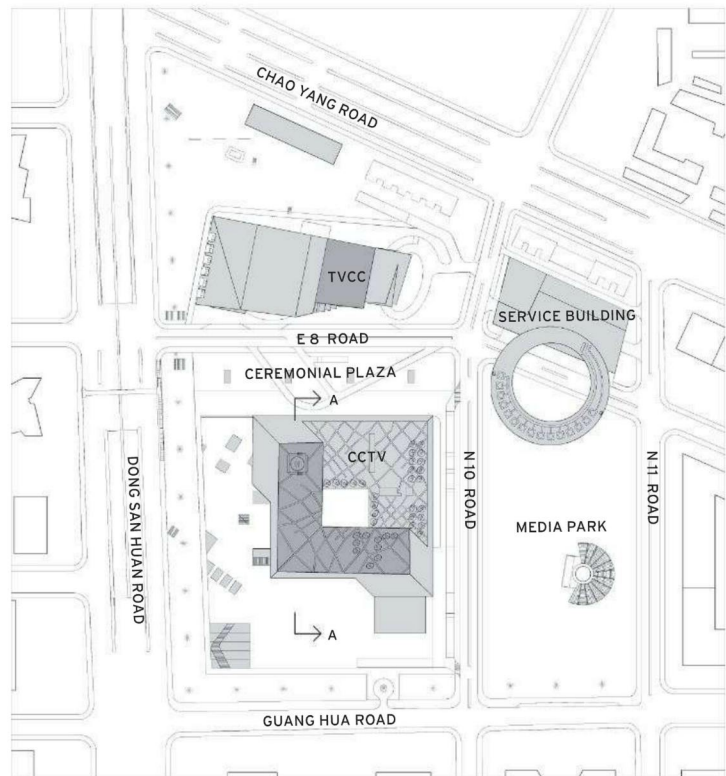
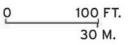
TOWER 1



GROUND FLOOR

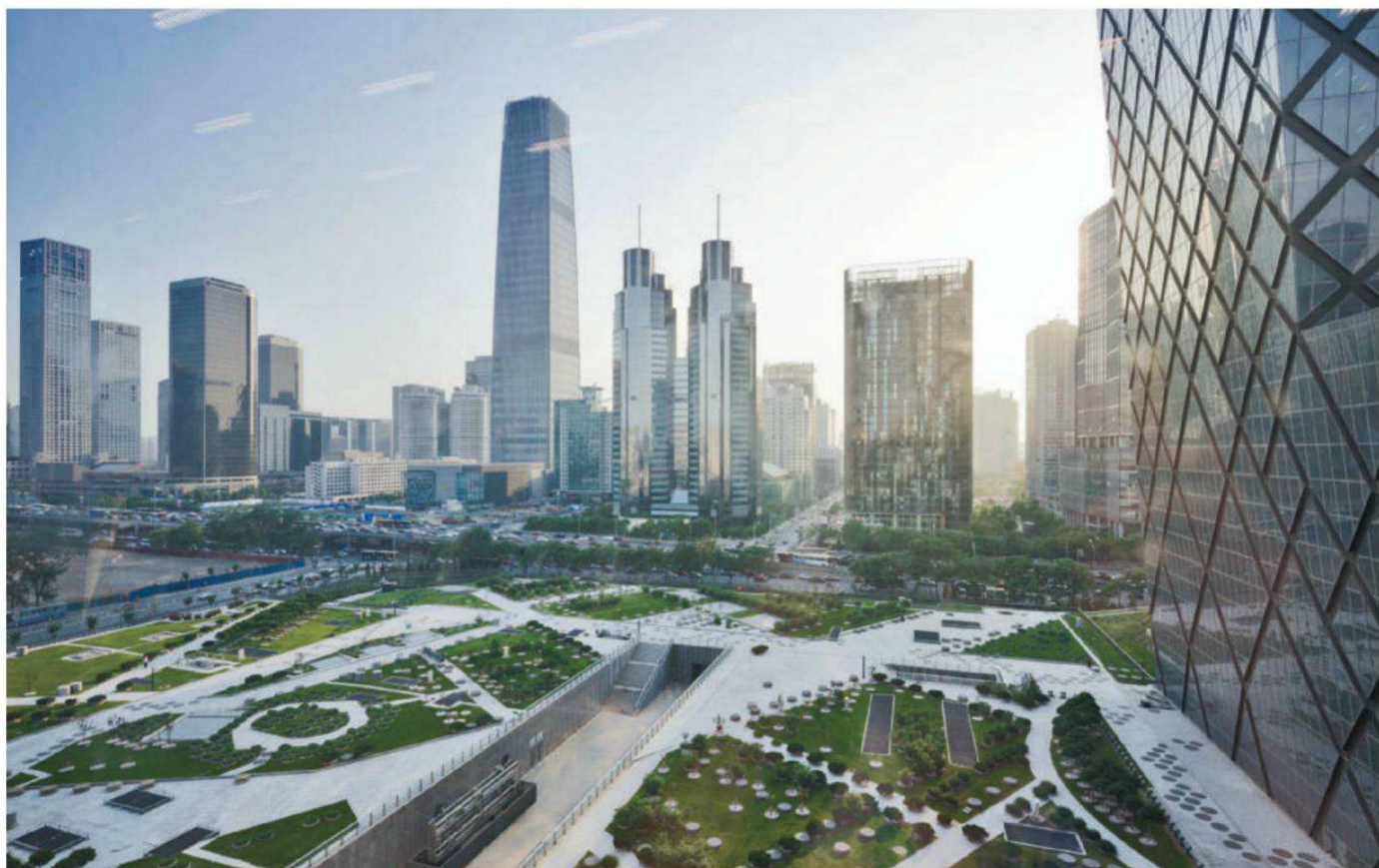


SECTION A - A



SITE PLAN



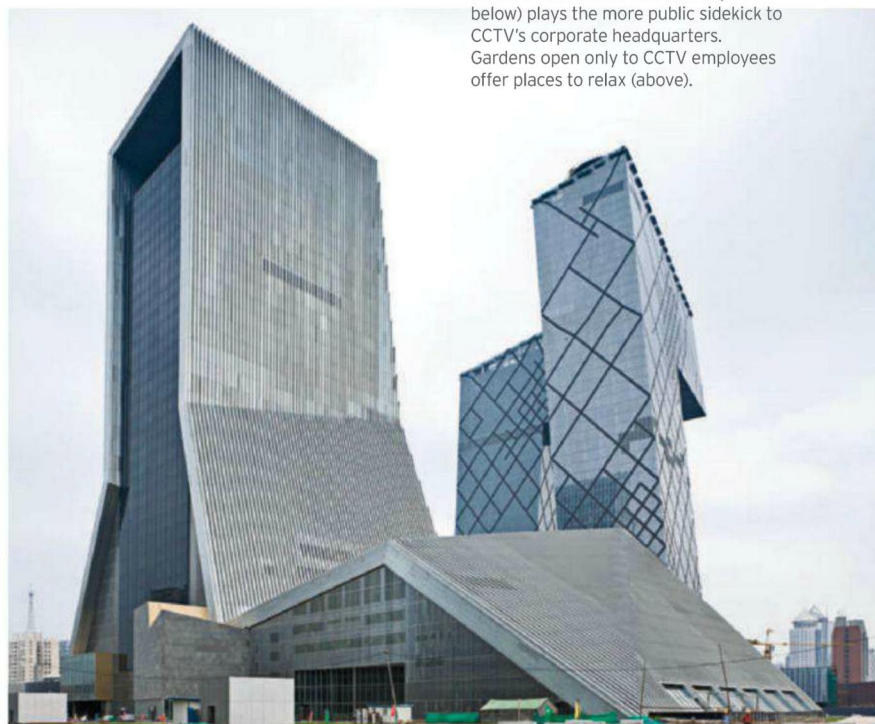


As a result, the exterior surfaces read as a kind of engineering map with a formal beauty of its own.

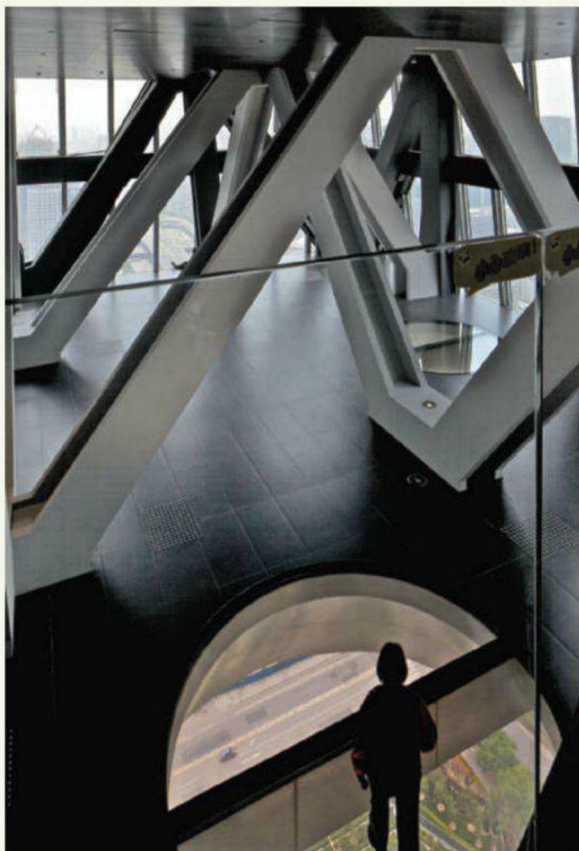
While the towers and exterior braces are angled, the interior cores' housing elevators, stairs, and risers are vertical. Arup and OMA had considered canting these elements as well, but the cost of angled elevators made it unfeasible. In addition to the cores, vertical columns support the towers' floor plates. Because the towers slant, these vertical columns can't rise the full height of the building. So two-story-deep trusses transfer loads at roughly halfway up the structure, and a two-story-deep transfer deck in the overhang carries loads from vertical columns to the external tube structure.

The architects clad the building in fritted glazing that reduces solar loads inside and creates a monolithic surface that mimics Beijing's notoriously gray skies. Most curtain-wall buildings in big Chinese cities look dirty almost immediately, but CCTV's glazing handles the pollution by blending in. Combined with the irregular pattern of the external bracing that obscures floor levels, the glass skin makes it hard to grasp the building's scale. In certain light and at certain distances, the 768-foot-tall structure seems almost to disappear. Yet seen from other angles and at other times of the day, it looms aggressively over apartment blocks. "From wherever you look at it, it keeps changing in form," says Scheeren. "It escapes a singular definition."

"In a city with a strong and permanent identity, it introduces a degree of uncertainty," says Koolhaas. "It changes



BINARY SYSTEM TVCC (left in photo below) plays the more public sidekick to CCTV's corporate headquarters. Gardens open only to CCTV employees offer places to relax (above).



## The Wow Factor

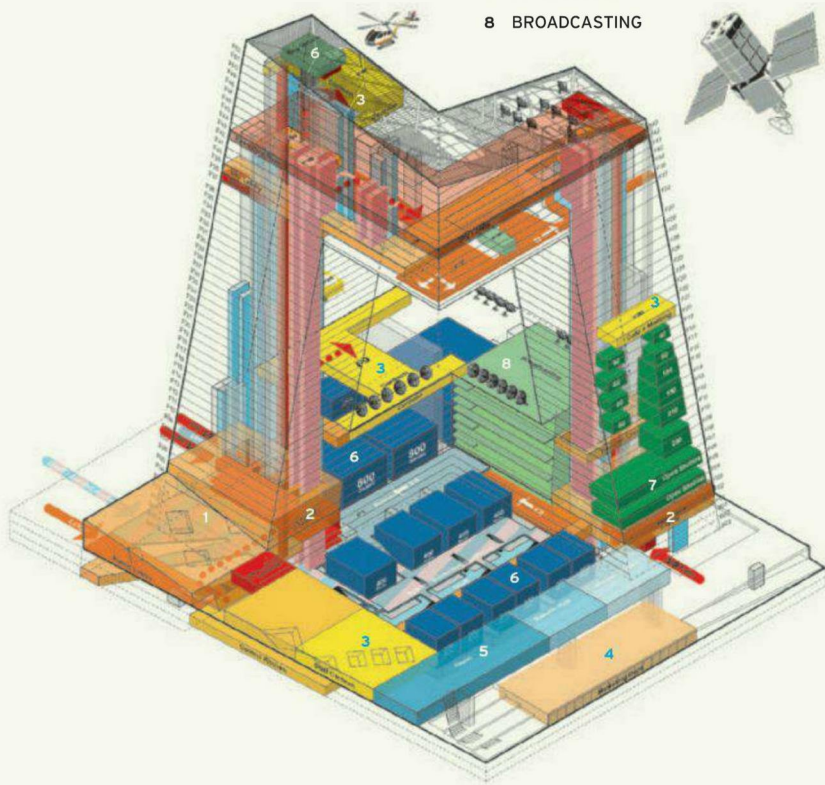
An engineering marvel, CCTV flaunts its technological prowess in its radical geometry and exposed steel bracing. And its most daring structural element is the “overhang,” a nine-to-13-story bridge that makes a right turn in midair as it spans the gap between the two angled towers. Looming 37 stories above the ground, it juts out 245 feet from one tower and 220 feet from the other. During construction, the two arms of the overhang were cantilevered from the towers before being connected to form a more stable bridge and complete the building’s continuous structural tube. Making that connection was a dramatic moment during construction and required a precise fit. Because the sun warms and expands the steel in each part of the building at a different time during the day, construction workers had to complete the task early in the morning when the arms are the same temperature. Visitors today who take the public tour through CCTV get a visceral understanding of the engineering feat when they arrive at the overhang and walk over three clear glass discs set in the deck of the 37th floor. A veritable forest of exposed steel bracing here also helps bring the construction story alive for anyone visiting the space. *C.A.P.*



**TORQUED LOOP**  
Exposed steel bracing forms a continuous tube structure that resists the huge forces generated by the building’s cranked and leaning forms (above). The piled raft foundations (left) extend beyond the footprint of the towers to act as a toe and distribute forces more broadly to the ground. On the 37th floor in the overhang, visitors can walk over glass portals and look down to the plaza.



- 1 PUBLIC LOBBY
- 2 TOWER LOBBY
- 3 CANTEEN
- 4 MARKETING
- 5 GYM
- 6 STUDIO
- 7 OPEN STUDIO
- 8 BROADCASTING



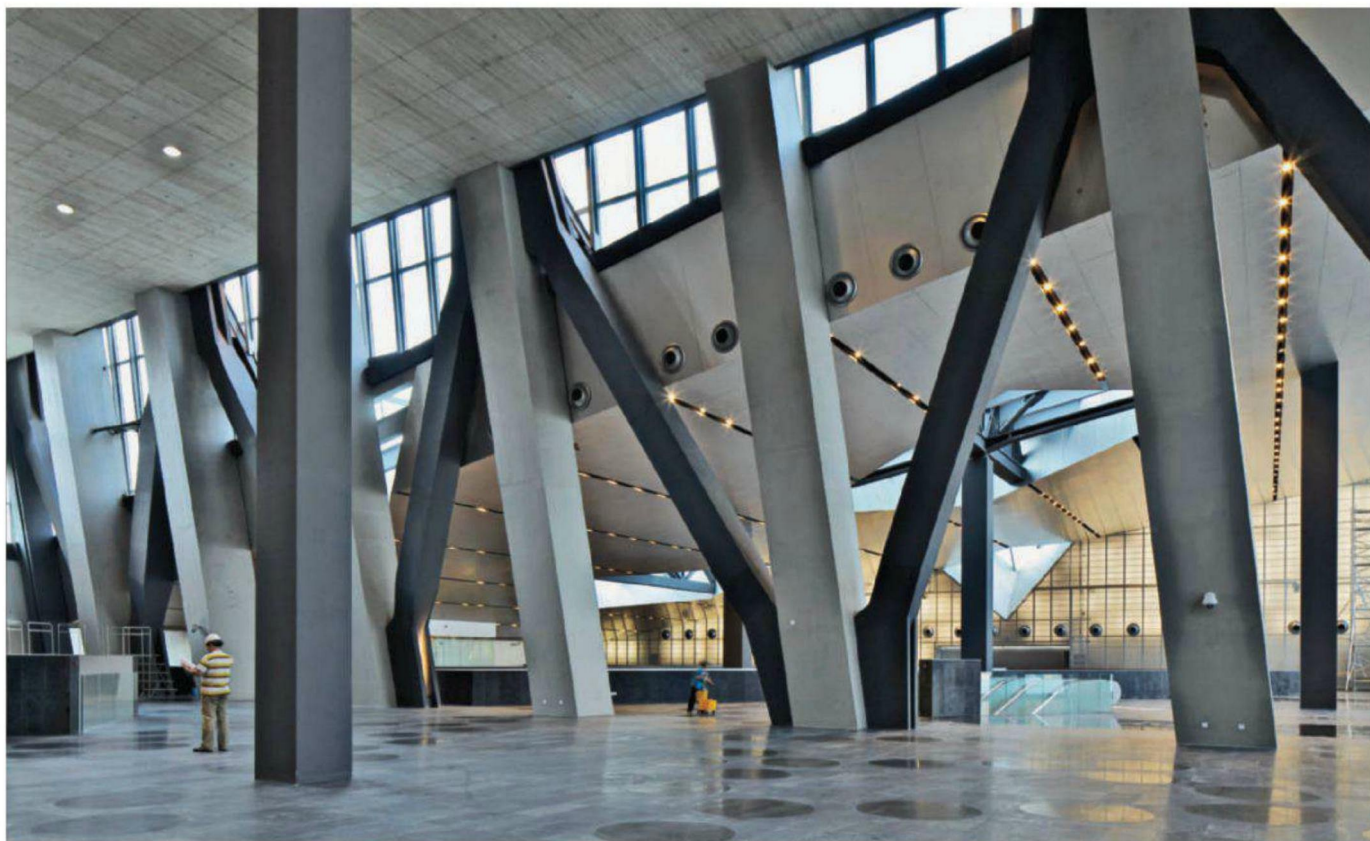
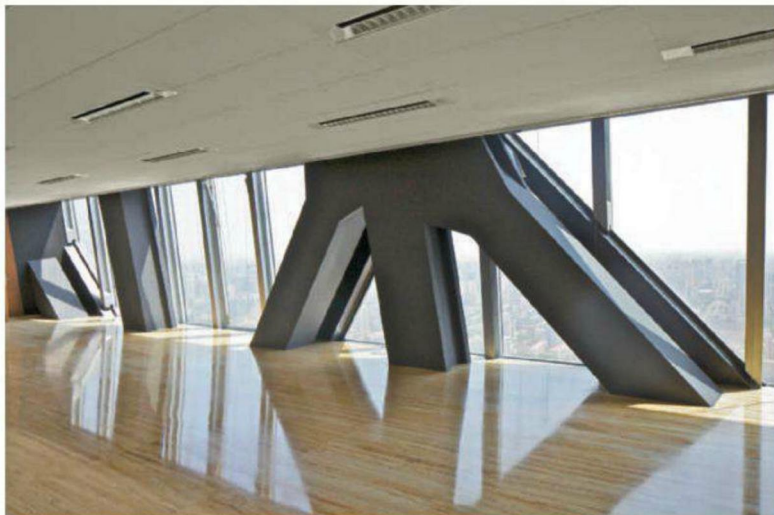
**BALANCING ACT** Countering criticism that its complex design is wasteful, Arup and OMA say the building required no more steel than a conventional structure of its size. The Chinese contractor erected the two angled towers (top photos) and then the cantilevers that were connected to each other early in the morning of December 8, 2007 (above).

from every angle—sometimes looking robust, sometimes fragile.” Although gigantic in square footage, it would have been almost three times as tall (about 2,300 feet) if it had been a single tower—nearly 700 feet taller than the Shanghai World Financial Tower, currently the tallest building in China. Its ambiguous scale informs even the nickname local residents have given it: *da kucha*, or “big undershorts.” For many years, its radical design alienated the local architectural establishment, which complained that OMA and other foreign firms use China as a laboratory for alien experiments.

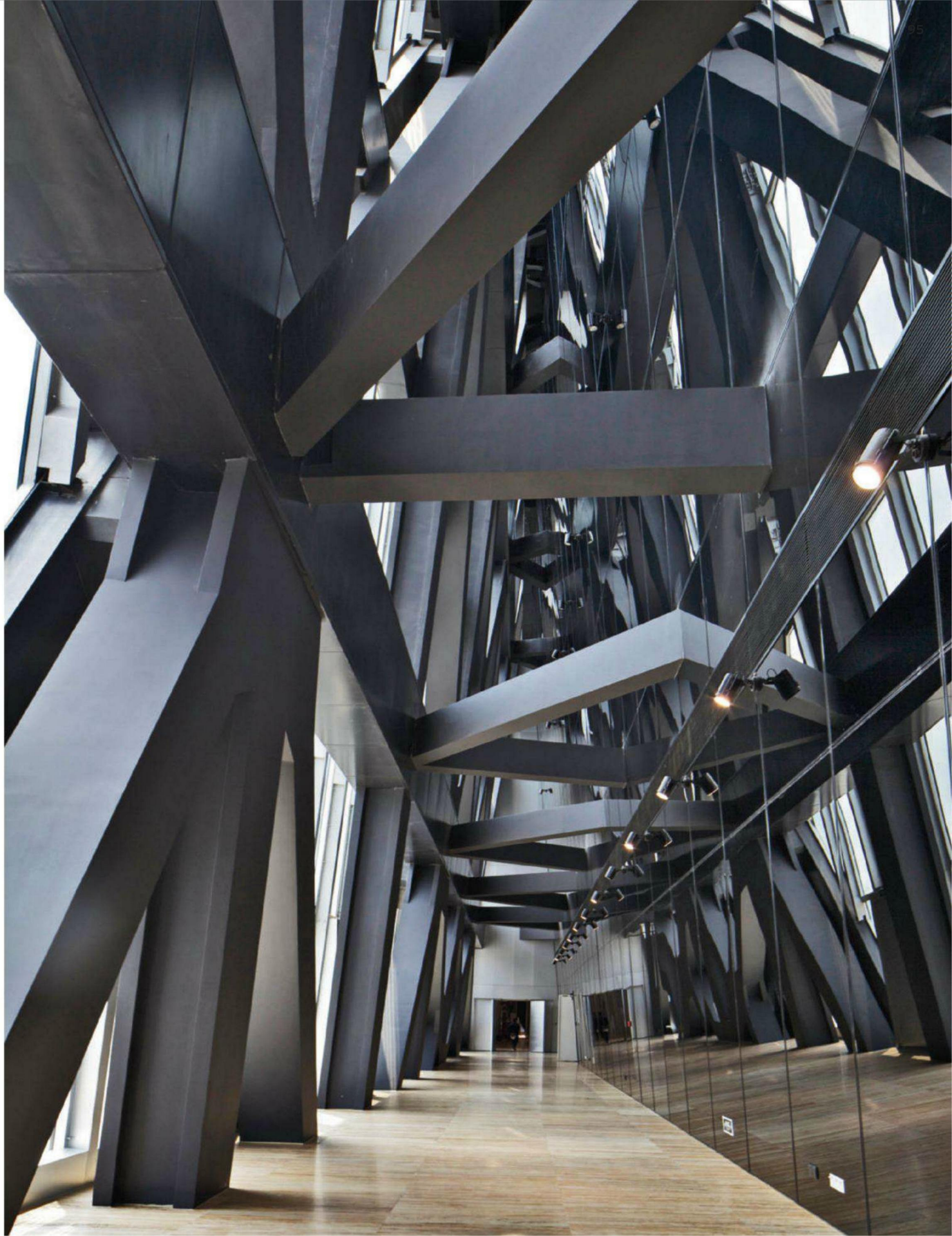
While big-name architects usually design only the shell and core on high-rise projects, OMA did the CCTV interiors too. Because of the complex’s vast size, the firm approached the interiors as a combination of generic and specific spaces. Entering from a plaza between CCTV and TVCC, visitors are dwarfed by the unstable-looking forms, then get a visual jolt from the dynamic lobby with its angled ceilings and imposing skylights. People arriving by subway emerge here too, ascending an escalator into the dramatic space. A public loop takes visitors past broadcast studios identified by colored panels set behind glass, through halls made grand by steel

**The building introduces a degree of uncertainty as it changes from every angle, says Koolhaas.**

**OUTSIDE IN** The architects let exposed structural elements such as bracing and columns animate the interiors—including generic office areas (below), one-of-a-kind spaces like the main lobby (bottom), and the circulation loop with its almost-Gothic arcaded perimeter hallways (opposite). Iranian travertine serves as one of the most common flooring materials (below and opposite), while a circular motif pops up in the lobby floor, the outdoor gardens, and the clear discs on the 37th floor.







PHOTOGRAPHY: © PHILIPPE RUAULT (THIS SPREAD)



## credits

**ARCHITECT:** Office for Metropolitan Architecture – Rem Koolhaas, Ole Scheeren, David Gianotten, Shohei Shigematsu, Ellen van Loon, Victor van der Chijs, partners; Dongmei Yao, project manager

**ARCHITECT OF RECORD:** East China Architectural Design & Research Institute (ECADI)

**ENGINEERS:** Arup/ECADI – Cecil Balmond, Chris Carroll, Michael Kwok, Rory McGowan, Paul Cross, Xiaonian Duan, Craig Gibbons, Goman Ho, Richard Lawson, Alexis Lee, Andrew Luong, Chas Pope, design team

**CONSULTANTS:** Front (facade); Inside/Outside (landscape); 2x4 (signage/graphics); Qingyun Ma (strategy)

**GENERAL CONTRACTOR:** China State Construction Engineering Corp.

**SIZE:** 5.1 million square feet

**COST:** \$795 million–\$900 million

**COMPLETION DATE:** May 2012

## SOURCES

**CURTAIN WALL:** Beijing Jangho Curtain Wall

**GLAZING:** CSG Holding

**ELEVATORS/ESCALATORS:** Shanghai Mitsubishi Elevator

arcades, and eventually to the spectacular overhang, where—if they dare—they can walk over clear glass discs set in the floor and look 37 stories down. Throughout, OMA used a simple palette of materials to help with navigation, wrapping one tower's core in Cor-Ten and the other in aluminum, and cladding floors in public spaces with creamy travertine.

Koolhaas has been attacked by some people for working for the mouthpiece of the Chinese Communist Party. But he says, “We are part of a generation of architects that for the first time is able to work on a global scale, and that means engaging different kinds of regimes. Our work is based on a longer engagement, as these countries change.”

Has CCTV killed the skyscraper? Of course not—a fact made clear by the towers starting to crowd around it. But it offers an intriguing alternative, one that uses its odd geometry to provoke questions of architectural etiquette—such as how to fit into (and stand out from) a context in flux. Its awkward form, though, grows on you, like a geeky classmate who might seem strange at first but increasingly smart as you get to know him. The audacity of the building's structural gymnastics and its innovative approach to scale and expression could only happen right now in China, a country trying hard to convert its cash reserves into global prestige and one where clients are willing to assume high levels of risk. CCTV represents a remarkable moment in Beijing's history, one that may already be slipping away as China's radical transformation slows. ■

**OCCUPIED SPACE**  
CCTV began moving into the building in the spring and broadcast the London Olympics from its new studios this summer, four years after it had hoped to cover the Beijing Games from there. About 10,000 people will work in the building, which had an official construction budget of \$795 million but has been reported to have cost at least \$900 million. A canteen will occupy a dramatic light-filled space near the top of the building (top). The building now comes alive at night (opposite).



Ellipse Sky | Tokyo | Keiko + Manabu



**TALL ORDER** A curl of molded concrete connecting all four levels, a spiral stair stands on the building's south side—the most desirable place for an entrance in Japan. Mirroring the elliptical arches on the facade, its subtle oval plan, coupled with different ceiling heights at every level, made for complicated construction.

# LABOR OF LOVE

Two young designers deliver a refined and spirited concrete structure to a client looking for a unique family home and rental complex.

BY NAOMI R. POLLOCK, AIA  
PHOTOGRAPHS BY TAKUMI OTA

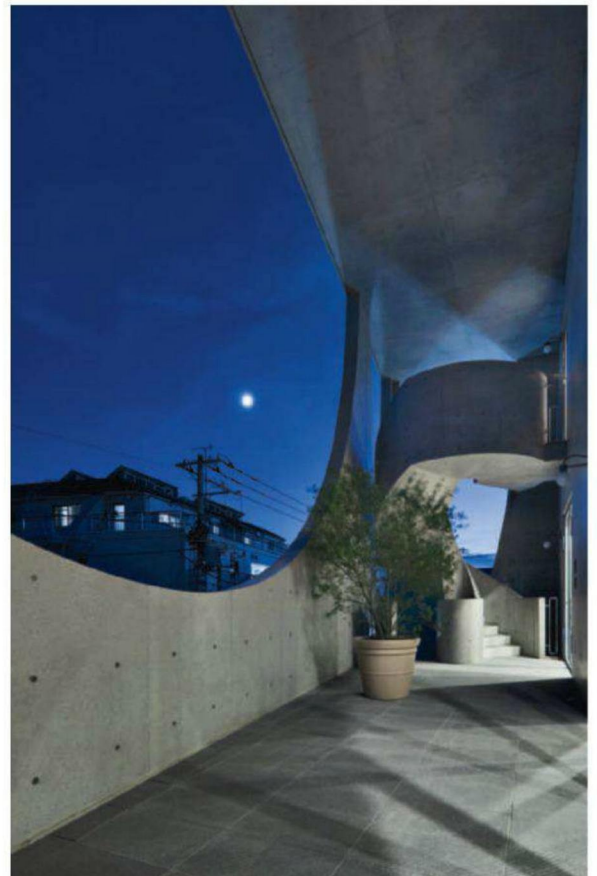
**SOFT CONCRETE** may be an oxymoron, but Ellipse Sky, a four-story residential building designed for an obstetrician, his family, and several tenants, deftly pokes holes in that notion. A concrete box on the western edge of Tokyo, the house is the first freestanding structure by Keiko + Manabu, a young design duo specializing in commercial interiors. The pair teamed with engineer Akira Suzuki to craft a building that mollifies the hard material with swooping arches, graceful details, and walls as smooth as a baby's bottom.

The decision to build with concrete was a given from the start when the client purchased a plot near his birthing center and invited three firms—all with female principals—to participate in a design competition. Approaching the brief with the vision and sensitivity of interior designers, partners Keiko Uchiyama and Manabu Sawase presented a large-scale (1:20), easy-to-understand model and landed the commission. "This is a very important scale for us," says Uchiyama. "It is where you can imagine the inside from the outside."

Connected by an exterior concrete stair and elevator, the building consists of a duplex apartment on the top two floors for the doctor, his wife, and their two children (both medical students), independent quarters for his mother on the second floor, and six duplex rental units accessed directly from a garden walk at grade. But the project took three years to complete, partly because of the laborious construction process needed for the concrete's carefully conceived forms.

Wanting to offset the rigidity of the cubic building, the design team devised a facade punctuated by a series of apertures: large ones that maximize unimpeded sky views from within, and small ones that edit out the neighborhood dominated by small-scale apartment buildings and single-family homes. A tall, narrow arch framing the elegant spiral stair marks the entrance to the family quarters. "We wanted many openings, so the wall had to be as thin as possible," notes Uchiyama. Affixed to the building for stability, but essentially self-supporting, the facade measures a mere 9 inches thick at the edge of the arches.

Because of their shape, the wall's convex curves could not



be completed with straightforward pours, requiring vibration to coax the concrete under inverted crowns. Yet this was child's play compared with the complex 3-D formwork used for the curvaceous stair, with its subtle oval plan and concave undersides, and the varying ceiling heights at every level.

This dynamic element spirals up to the doctor's home, a 2,960-square-foot duplex entered on the third floor. Here an L-shaped terrace mitigates the site's irregular geometry, while shielding the interior from direct sunlight with a cantilevered roof 20 feet above. Inside, a foyer leads to a reception room and the family's open living/dining room and kitchen, framed by full-height, arched windows facing the terrace. A bathroom, workroom, and master bedroom are tucked behind these public areas. Internal stairs connect to the children's rooms and a second bath above. Compact by comparison, each 431-square-foot rental unit features a multi-purpose space on the ground level and sleeping quarters

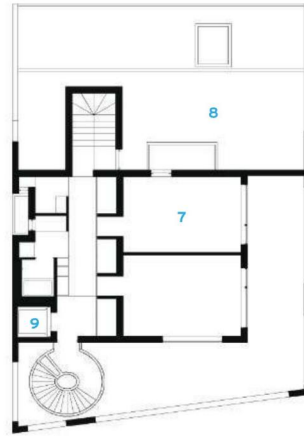
#### FRAMING THE VIEW

Contrasting sharply with the low-scale apartment buildings and single-family homes nearby, the swooping arches—no two are the same—admit plenty of daylight and sky views while editing out the surroundings (above and top right). Outside the owner's duplex, the large openings frame a covered, L-shaped terrace enclosing the living/dining room on the third floor (right).

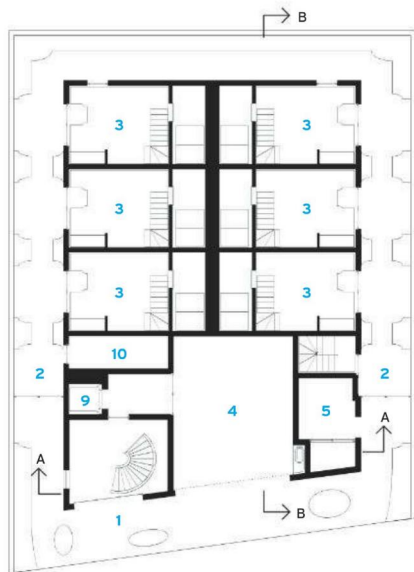
- 1 GATE TO OWNER DUPLEX
- 2 GATE TO RENTAL DUPLEX
- 3 RENTAL DUPLEX
- 4 GARAGE
- 5 BIKE STORAGE
- 6 MOTHER-IN-LAW APARTMENT
- 7 OWNER DUPLEX
- 8 TERRACE
- 9 ELEVATOR
- 10 MECHANICAL ROOM



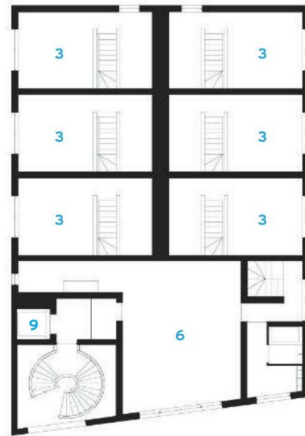
THIRD FLOOR



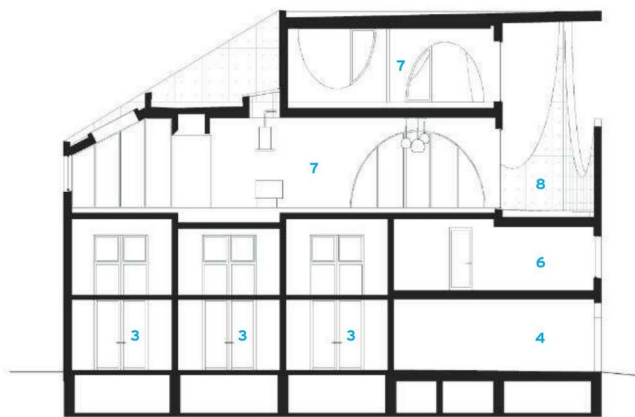
FOURTH FLOOR



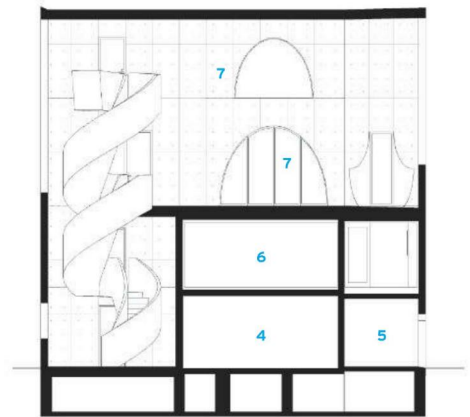
FIRST FLOOR



SECOND FLOOR



SECTION B - B



SECTION A - A

credits

**DESIGNER:** Keiko + Manabu – Keiko Uchiyama, Manabu Sawase, design principals  
**ENGINEER:** ASA Associates – Akira Suzuki (structural)  
**CLIENT:** withheld  
**CONSULTANTS:** Izumi Okayasu (lighting design); Edaya (landscape)  
**GENERAL CONTRACTOR:** Heisei Construction  
**SIZE:** 7,677 square feet  
**COST:** withheld  
**COMPLETION DATE:** August 2012  
**SOURCES**  
**FENESTRATION:** Showa Front Co. (windows, metal/entrance doors); Sanken-Kogei (wood, sliding)  
**LIGHTING:** Maxray, Panasonic, Daiko, Endo, Diesel  
**FURNITURE:** Keiko + Manabu, Molteni&C, Vitra  
**WALL COVERING:** Farrow & Ball  
**ELEVATOR:** Panasonic



**INTIMATE SPACES**  
Keiko + Manabu infused the building with interior-design techniques: A garden walk adds charm to the rental apartments (left); custom-designed furniture, like a glass-topped coffee table bolstered by buoys, gives the client's duplex a unique style (right); a playful, curtainlike window wall on the terrace relieves the concrete facade and frames views from the master bath (below).



above—perfect for a couple with a baby.

Uchiyama and Sawase carefully considered wall surfaces and details. “In the United States, fun finishes are common, but because Japanese houses are smaller and people rarely entertain at home, they get less attention,” Uchiyama explains. They used patterned wallpaper and decorative paint to add homey touches to the rentals, and drew from their usual palette of commercial materials—tile, terrazzo, and slatted window blinds—to complement the concrete surfaces within the doctor's home.

In the end, the concrete itself showcases the designers' talents most effectively. Treating the interior with the same finesse as the building's large architectural gestures, they created velvety concrete walls by coating the formwork with urethane. Then they softened harsh, rectilinear wall openings and corners by refining them with playful cutouts.

Thanks to exacting design standards and highly skilled contractors, legions of Japanese architects have been achieving remarkable results with concrete since before Uchiyama and Sawase were born. But few have fundamentally changed its character and expression. By placing as much value on the detailing inside Ellipse Sky as on the wow factor of the building's external form, Keiko + Manabu has mastered the tough material's tender side. ■

*Naomi R. Pollock is the Tokyo-based special international correspondent for RECORD and author of the recently released Made in Japan (Merrell Publishers, 2012).*



Giant's Causeway Visitor Centre | County Antrim, Northern Ireland | Heneghan Peng Architects

# BELOW THE FOLD



An entryway to a surreal seaside landscape nods to the natural rock formations there while not overshadowing them.

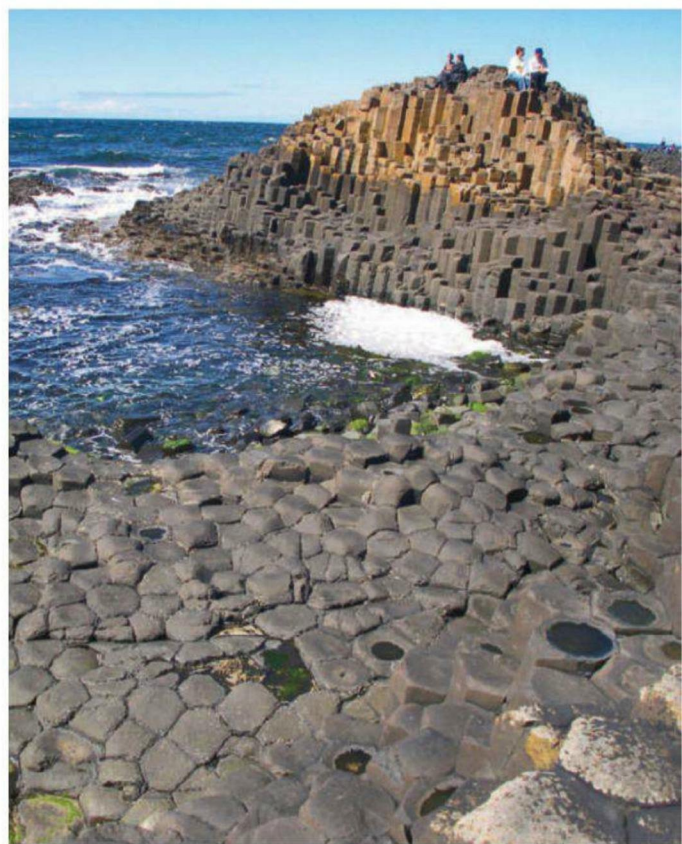
BY CHRIS FOGES

**MASS TOURISM** has a paradoxical effect: The infrastructure for access and interpretation it demands can obscure the very thing visitors come to see. Wilderness is mediated and culture commodified. Tour buses block the postcard view.

Sightseers have flocked to the Giant's Causeway on the coast of Northern Ireland since the 19th century, and today half a million people a year travel to this craggy formation of volcanic basalt columns lining a string of steep-sided bays. For the last 12 years they have been greeted by a dreary range of timber sheds, installed after a permanent visitor center was destroyed by fire. In 2005 the government organized an international design competition for a replacement befitting a UNESCO World Heritage site. The newly complete \$30 million building, by Dublin-based Heneghan Peng, is exemplary in its balance of competing demands, making space for commercial and transport requirements while recognizing that these should not intrude on visitors' experience of the place.

Many competition entrants exploited the prominence of the cliff-top site above the western end of the causeway, proposing flamboyant structures that would dominate views from inland as well as from the water's edge. Heneghan Peng took a different approach, folding its building into a remade landscape in a care-





**MYTHIC PROPORTIONS** Formed by volcanic activity 50 million years ago, the Giant's Causeway (above) comprises over 40,000 polygonal columns up to 39 feet tall. In legend it is said to be the vestige of a bridge to Scotland built by an Irish giant, Fionn mac Cumhail, and destroyed by a rival Scottish giant, Benandonner, as he fled in fright at the prospect of a fight.

Two folds in the landscape (left) negotiate a 20-foot level change across the site and define the building and parking lot. Between them a ramp leads to the "restored" ridgeline.

ful choreography of concealment and revelation.

From the shore the center is essentially invisible; it fills a gap in the existing ridgeline, but is screened by man-made berms that read as part of the natural landscape. From cliff-top trails, too, the accessible grass roof hides the building below. To the south, however, architecture emerges from the manipulated topography. "It was important not to bury the building—that seems too easy—but to work with both the building and landscape form," says architect Róisín Heneghan, who runs the office with husband and former Harvard GSD classmate Shih-Fu Peng.

Approaching the center from the nearest town, Bushmills, the road brings visitors to the foot of a green ramp leading up to the ridge. To the west, the main body of the 19,375-square-foot building pushes upward as if subject to the same eruptive force as the stones of the causeway. Its two principal facades, composed of close-spaced rows of sharp-angled black basalt columns, taper off into the distance. The first diminishes as the ramp alongside it ascends to meet the ridge, while the roofline of the second drops gradually until it meets the ground next to an existing hotel to the west.

East of the grassy slope, the building's angular volume is echoed by a void—the

negative to its positive—where the ground has been excavated to make a parking lot, crisply defined by the center's columnar facade and a smooth basalt retaining wall.

The stone is beautifully reflective of the ever-changing weather, shining like a mirror in sunlight and jet black in the rain. The choice and deployment of material make a direct, almost literal reference to the causeway, but the apparent simplicity of the idea belies the complexity of its execution. Basalt cannot be cut thin enough for cladding, so the 208 columns are formed from over 14,000 stacked stone blocks, in a variety of shapes and sizes, that fit together with extraordinary precision—a tribute to the architects' digital model and the stonemason's craft.

Visitors can choose from three routes to the head of the causeway trail: over the ramp, via a tunnel from the parking lot, or—for those willing to pay—through the visitor center. The interior arrangement underscores the sense that the

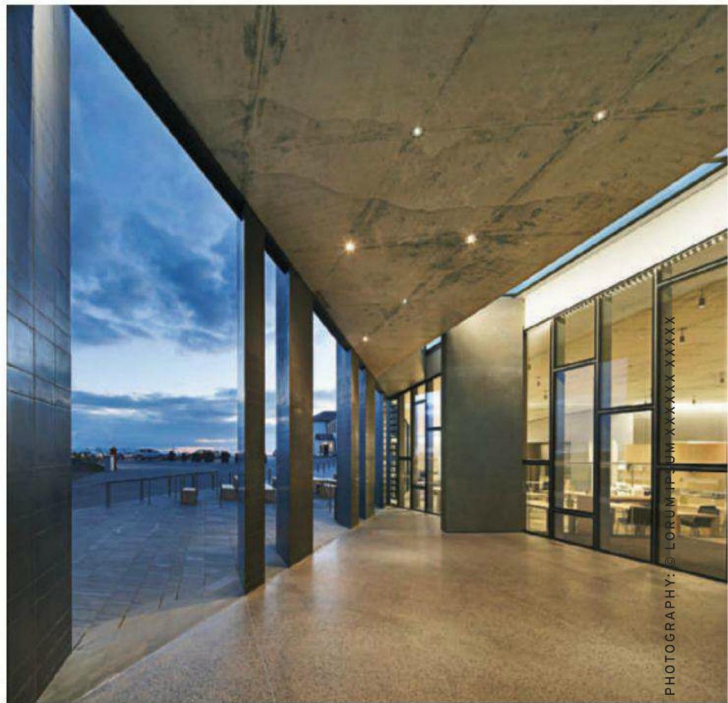
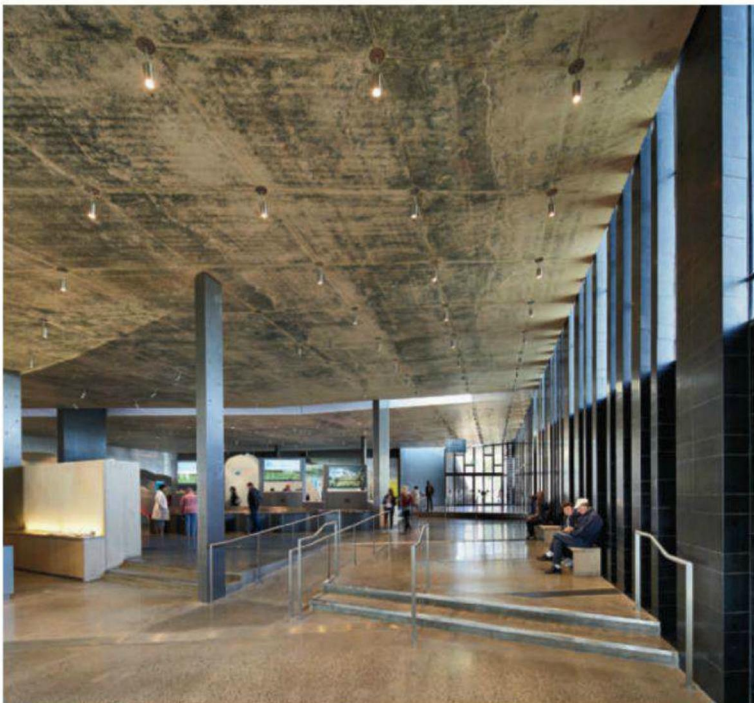
- 1 MAIN ENTRANCE
- 2 ADMISSIONS
- 3 CAFÉ
- 4 SHOP
- 5 EXHIBITION
- 6 BACK OF HOUSE
- 7 PUBLIC TOILETS
- 8 BYPASS ENTRANCE
- 9 REAR ENTRANCE
- 10 GRASS RAMP
- 11 GRASS ROOF
- 12 BUS LOOP/LOWER COASTAL PATH
- 13 ROCK FORMATIONS
- 14 RIDGELINE/UPPER COASTAL PATH
- 15 CAUSEWAY HOTEL
- 16 SCHOOLHOUSE MUSEUM
- 17 MAIN PARKING

14

13

12

SITE PLAN



PHOTOGRAPHY: © LORUM LTD. BM XXXXXXX XXXXX

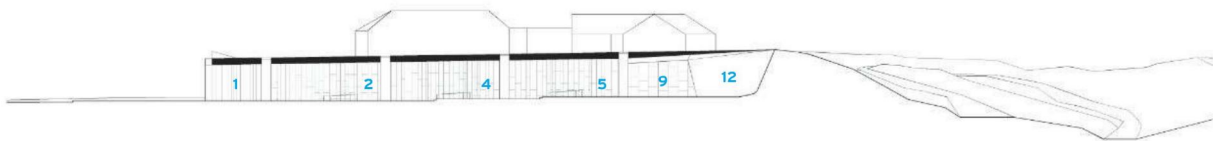
**VIEWPOINT**

The accessible green roof (right and below) offers panoramic vistas over land and sea. A bead-blasted steel balustrade was installed in place of the architects' preferred glass, as local planning conditions prohibited the use of reflective materials.

Inside, the concrete ceiling and floor (opposite) have a high recycled content and—along with measures such as ground-source heating and cooling and graywater recovery—earned the building an "Excellent" rating by the BREEAM sustainability measure. Quintuple-glazed skylights aligned with steps in the floor plate admit views of visitors walking on the landscaped roof above.

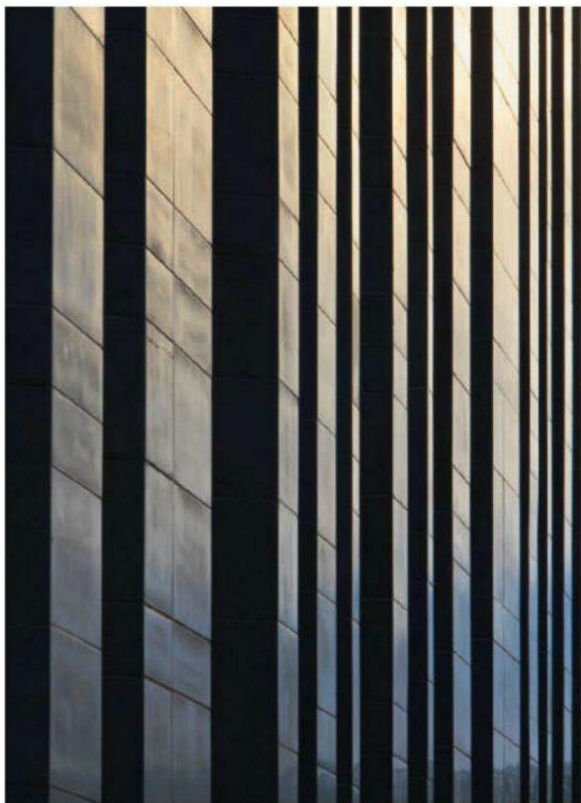


SECTION A-A



SECTION B-B

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15 M.

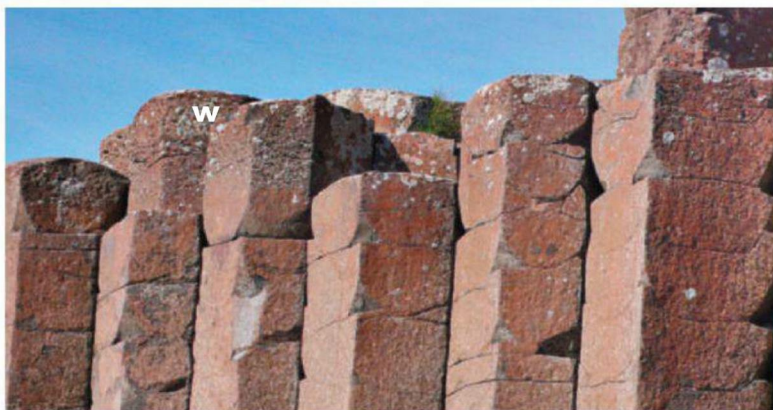


center is a “passage” through the ridge, not the final destination: From the entrance portico at the southern corner, a bright splash of daylight at the back of the cavernous room draws the eye along a broad promenade toward the exit.

To the left, the main components of the program—a café, gift shop, and exhibition area—jostle uncomfortably in the single volume. A more emphatic partitioning of the space envisaged by the competition scheme was dropped to increase flexibility, and retail now dominates. Nevertheless, the room’s fundamental quality remains evident: Daylight spills in from high windows and lofty skylights, and the finely detailed folded concrete roof and steel-plate columns lend elegance to material robustness. The stepped section of the basalt-flecked polished concrete floor presages the fractured pavement of the causeway.

There is not a right angle anywhere. Heneghan Peng established four axes through the site as an organizing principle, and the logic of this somewhat arbitrary grid is followed with maniacal consistency—from the massing of the terrain and placement of the structure to the shapes of trash cans and ticket machines. This discipline might have produced sterile or incommensurable spaces, but the imagination and effort with which the concept has been translated into built fabric gives the whole project a rich internal coherence and another connection to the causeway, whose polygonal stones hint at the variety within nature’s underlying geometric order. This is truly a building in and of its place. ■

*Chris Foges is the editor of the London-based journal Architecture Today.*



#### HIDDEN ORDER

There are three mullion types in the facade (left and below). The largest elements help to carry the load of the roof and are composed of basalt blocks arranged around concrete cores; medium-sized mullions are self-supporting stacks of stone; the slimmest are threaded with post-tensioned steel cables. Blocks were cut in three heights and arranged with consistent horizontal joints at regular intervals. The locally quarried stone is thought to come from the same lava flow that formed the causeway (above).



#### credits

**ARCHITECT:** Heneghan Peng Architects – **Competition:** Shih-Fu Peng, Róisín Heneghan, project directors; Chris Hillyard, Aideen Lowery, Marcel Piethan, team; **Design & Construction:** Shih-Fu Peng, Róisín Heneghan, project directors; Julia Loughnane, project architect; Monika Arcynska, Jorge Taravillo Canete, Chris Hillyard, Kathrin Klaus, Carmel Murray, Padhraic Moneley, Catherine Opdebeek, Helena del Rio, team **ENGINEERS:** Arup (structural and fire); Bennett Robertson (m/e); Dewhurst Macfarlane & Partners (facade); WYG Group (civil)

**CONSULTANTS:** Mitchell + Associates (landscape); Event (exhibition); Bartenbach LichtLabor (lighting) **GENERAL CONTRACTOR:** Gilbert-Ash **CLIENT:** National Trust **SIZE:** 19,375 square feet **COST:** \$17.7 million **COMPLETION DATE:** May 2012 **SOURCES** **DOORS:** Schüco (metal); Besam (sliding); Boon Edam (revolving) **HARDWARE:** Assa Abloy, Dorma

The image features two modern ceiling fans against a vibrant pink background. The background is decorated with a series of concentric white circles that create a ripple effect. In the upper left, a smaller ceiling fan with three light-colored blades is suspended. In the foreground, a larger ceiling fan is shown from a low angle, highlighting its sleek, metallic, teardrop-shaped motor housing and its three wide, flat blades. The fan's light fixture is illuminated, casting a warm glow.

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# Legal Threshold

Philadelphia

Kennedy & Violich lighten up traditional materials in a new building for the University of Pennsylvania's law school.

By William Hanley

PHOTOGRAPHS BY BARRY HALKIN



**GOLKIN HALL**, the latest addition to the University of Pennsylvania's law school, announces itself with a contradiction. On a narrow Philadelphia street, opposite a row of historic townhouses and sidewalk cafés, a two-story marble curtain marks the entrance to the new building. The material looks heavy, but as it nears the ground, the individual fixed-in-place plates that make up the form begin to twist away from one another, allowing light to pass through and creating a feeling of weightlessness.

Part sunshade and part sculpture, this "threshold object," as Sheila Kennedy of Boston-based Kennedy & Violich Architecture (KVA) calls it, not only introduces the new hall but was also designed to signify the school's approach to legal education. While KVA employed traditional "law school" materials—marble, wood, masonry—they appear in ways that confound their typical severity and heft with a sense of lightness and transparency. In contrast to its neighbor, Silverman Hall, an august neo-Georgian building by Cope and Stewardson completed in 1900 and ornamented with a similar palette, Golkin Hall appears permeable and approachable. Silverman is "this big forbidding thing, and that's what law was," says Penn Law's dean of students, Gary Clinton. "Legal education used to be what occurred within those walls, but it's now about what's going on in the city and on the rest of campus."

A four-level steel-framed structure, Golkin completes Penn Law's ring of buildings, which grew throughout the 20th century to wrap an entire city block, eventually enclosing a central courtyard. The school's expanding programs and growing faculty prompted officials to replace a one-story 1960s building with a new facility that would house faculty and administration offices, as well as a 350-seat auditorium, a moot-court room, and a student center. The school held an invited competition and selected KVA, challenging the firm to design a building that would accommodate the substantial program but wouldn't dominate the courtyard or the townhouses across the street. "To add 38,200 square feet where there had been just 14,000 without losing the character of the school was a burden," says partner Frano Violich. "It's



#### TWEAKING TRADITION

The roofline of Golkin Hall steps down in height from its historic neighbor Silverman Hall (left). Oak-veneered paneling—a nod to the heavier cherry panels of a traditional law office—in the atrium continues the angles of the marble curtain at the entry (below). Light wells bring daylight into the below-grade moot-court room (below left).



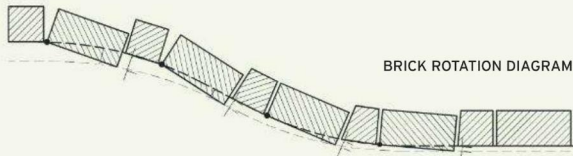
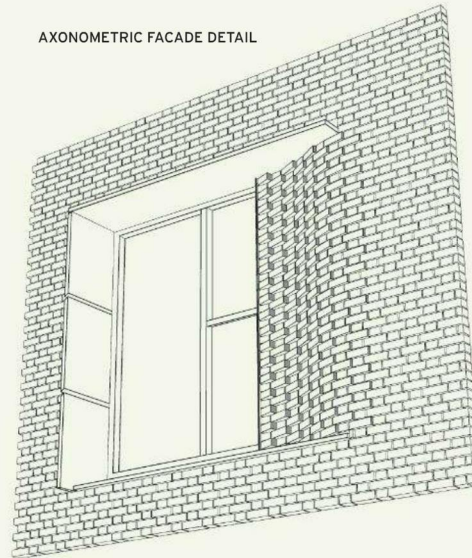


## Light and Craft

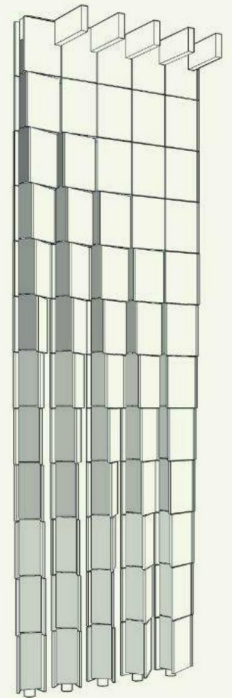
Kennedy & Violich designed Golkin Hall's marble curtain starting with pairs of panels – laser-water-cut to 1.25 inches thick – attached to a metal armature in a 5-by-12-unit grid. Then the firm positioned the panels using a software script based on extensive solar modeling that accounted for the arc of the sun at different times of year. Pairs begin parallel to one another at the top of the form (Figure 1). As they move down, the panels rotate and tilt toward one another (Figure 2) until those lowest and closest to the facade (Figure 3) point 90 degrees away from their counterparts at the top. Though the panels are fixed in place, the tracking of light across the form is designed to create the illusion of movement. Tapered masonry on the east side of the window frames also conforms to the movement of the sun. Using the same flemish bond as the majority of the facade, digitally modeled courses of brick on the east side of the windows curve toward the jambs to allow morning light in. (The conventionally built brickwork shows impressive craftsmanship.) In the afternoon, 1-inch gaps between the beveled edges of marble sunshades cast sharp rays of light back onto the brick. “We were inspired by Cope and Stewardson’s law-school building, its excess of craft, and the light effects on its facade,” says Violich. “The materiality of masonry and stone express a new craft of digital design and digital fabrication.” *W.H.*



AXONOMETRIC FACADE DETAIL



BRICK ROTATION DIAGRAM



MARBLE-CURTAIN DETAIL

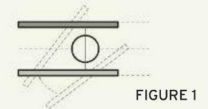


FIGURE 1

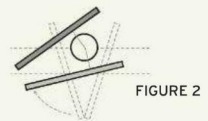


FIGURE 2

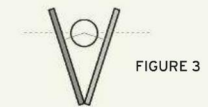


FIGURE 3

really a ship in a bottle.”

To maintain a narrow footprint, the firm buried the largest components of the program—the auditorium, courtroom, and student center—and placed offices and meeting spaces on the upper floors. And to keep the building from becoming a monolithic presence on the street, KVA separated it into two distinct volumes—one rising to just beneath Cope and Stewardson’s cornice. They placed the primary vertical circulation in the fissure between the forms, stacking two double-height spaces into a four-story, glass-enclosed atrium that is now the school’s entrance. “As you walk along the sidewalk, you see light and a trickle of green from the courtyard breaking up a pretty substantial facade,” says Violich.

At the entry, the angles of the plates that make up the marble curtain are calibrated to the arc of the sun (see side-

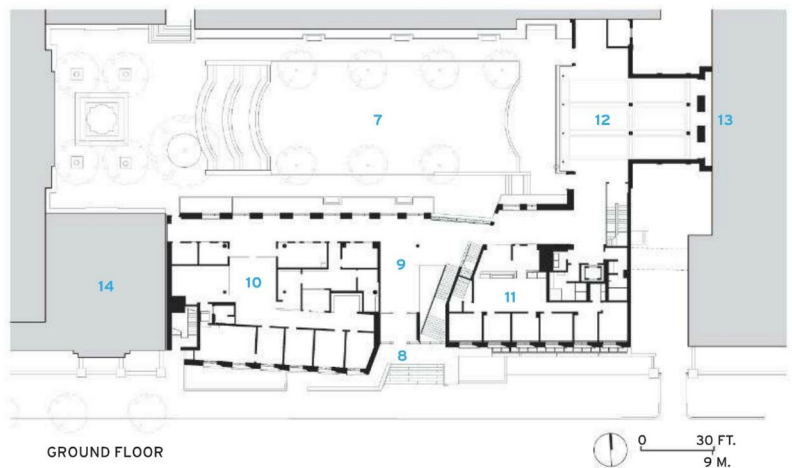
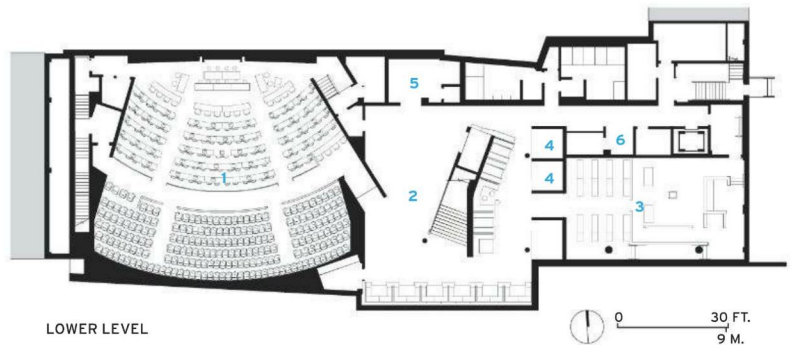
bar, above) to regulate daylight entering the atrium while allowing it to reach all the way down to the below-grade student center. To admit even more sun, the designers made the rear of the building nearly 50 percent glass and removed several trees from the courtyard to bring light into the lower levels. A series of light wells also pull daylight into the building’s upper floors and the submerged moot-court room. “At every penetration, from the front door to the windows, there is a gesture made to how light might enter,” says Violich. The most unusual instance happens on the building’s front facade, where the brick tapers into the east side of the window frames to admit morning light, while surprisingly thin marble sheets act as sunshades on the west side. With these strategies and other energy-saving measures, the project team is pursuing a LEED Silver certification.



**LAW OF THE LAWN**  
With glass on two sides, Golkin Hall's entrance (left) connects the school's courtyard to the street. Like the courtyard, a series of green roofs (right, foreground) serve as gathering places while helping the building comply with Philadelphia's strict water regulations—the first inch of a rain event must be managed on site. Part of KVA's project, a renovated, skylight-capped lounge on the east side of the courtyard (right, background), connects Golkin Hall to other Penn Law buildings on the ground level. Its green roof provides an outdoor path between buildings on the second floor.

Inside the atrium, sightlines to the offices above, the student center below, and the buildings across the courtyard quickly orient visitors and connect them to the activities of the school. "Twelve years ago, people's laptops were pulling them away from the school—everyone's kitchen table became their library," says dean of students Clinton. "But because so much of legal education is about the interactions between people, we needed to start providing opportunities for that." Students on the school's building committee suggested the café-style banquettes in the student center, and KVA, recognizing the demand for meeting places with varying degrees of privacy and formality, inserted small conference rooms immediately adjacent to this seating. Upstairs, gathering areas range from a typical glass-enclosed conference room to a terrace set among the building's green roofs and a slightly surreal lounge, where you can sit in a leather armchair perched very close to the roofline of the townhouses across the narrow street.

While embracing its neighbors, Golkin Hall transforms the Penn Law complex from a cloister into a hub befitting a school where students spend much of their time out working in the city. The heavy materials look a bit strained in their delicate applications, but they succeed in connecting the traditional to the contemporary and expressing a new pedagogical ideal. "The law can be so grave sometimes, so heavy and ponderous," says Violich. "Our facade tried to be pretty serious, but there are moments—such as when the brick starts to soften as it becomes a window, and the marble entrance becomes a curtain—that we hope add a lyrical quality to it." ■





- |                         |                           |
|-------------------------|---------------------------|
| 1 AUDITORIUM            | 8 ENTRY                   |
| 2 STUDENT CENTER        | 9 LOBBY                   |
| 3 MOOT-COURT ROOM       | 10 DEAN'S OFFICE SUITE    |
| 4 STUDENT MEETING ROOMS | 11 ADMINISTRATIVE OFFICES |
| 5 CAFÉ                  | 12 LOUNGE                 |
| 6 STUDENT LOCKERS       | 13 SILVERMAN HALL         |
| 7 COURTYARD             | 14 TANENBAUM HALL         |

### credits

**ARCHITECT:** Kennedy & Violich Architecture – Sheila Kennedy, partner; Frano Violich, partner in charge; Veit Kugel, project architect; Greg Burchard, project manager; Susan Morgan, senior associate

**ENGINEERS:** Richmond So (structural); AHA Consulting Engineers (m/e/p); Stantec (civil)

**CLIENT:** University of Pennsylvania Law School

**CONSULTANTS:** Richard Burck Associates (landscape); Tillotson Design Associates (lighting); Picco Engineering (stone)

**SIZE:** 38,200 square feet (gross)

**COST:** \$33.5 million

**COMPLETION DATE:** January 2012

### SOURCES

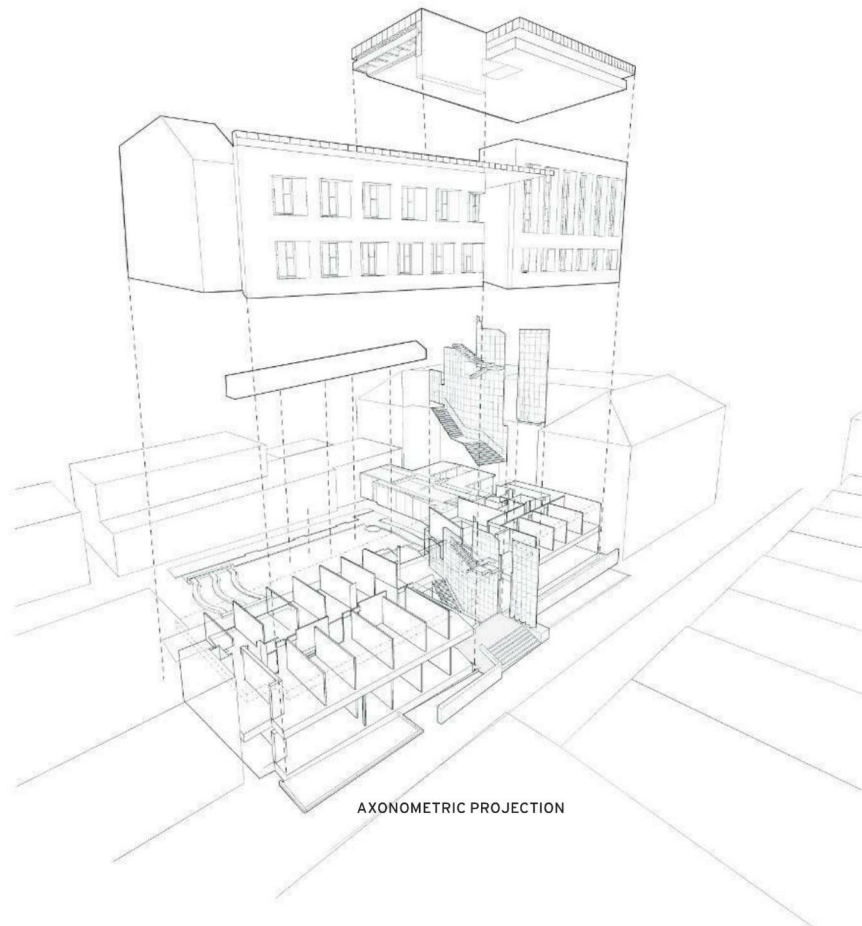
**EXTERIOR CLADDING:** Diener Brick (masonry); Vermont Imperial Danby Marble

**METAL/GLASS CURTAIN WALL:** National Glass & Metal

**GLAZING:** Viracon

**CUSTOM WOOD PANELING:** Parisi Inc./Royal Store Fixture

**TRACKABLE COVERING:** Forbo



AXONOMETRIC PROJECTION

# Rising Star

Bowling Green, Ohio

Snøhetta's first completed U.S. project emerges from the earth like a high-tech outcropping, enlivening a Midwestern campus.

By **Steven Litt**

PHOTOGRAPHS BY  
BRUCE DAMONTE



## FUNCTIONAL SCULPTURE

Completed in 2011, the wedge-shaped \$31.7 million Wolfe Center for the Arts (above) houses Bowling Green State University's departments of theater and film. A green roof (left) ramps up the east side of the building, giving students an alternate route to classrooms that flank a second-floor outdoor terrace.

The lobby (right) includes an architectural concrete stair that serves as a classroom, a bandstand, and a vantage point for people-watching.



**THE NEW WOLFE CENTER** for the Arts at Bowling Green State University (BGSU)—the first building to open in the U.S. by the Oslo-based firm Snøhetta—takes you completely by surprise. It’s a shimmering metallic wedge that rises out of its prairielike northwest Ohio terrain as though it were a sci-fi apparition. A green blanket of turf rides up part of its back to a second-story terrace edged with classrooms, blurring the distinction between ground and building. The fly loft for a proscenium theater inside rises higher still in the center of the sloping mass like a mountainous crag. The Snøhetta team treated the 98,000-square-foot building like a boulder carried and deposited by the glacier that once buried the region and eventually created the Great Lakes. The firm didn’t want to echo the Midwestern horizon in the manner of the repeated horizontals of Frank Lloyd Wright’s Prairie Houses, says Vanessa Kassabian, the director of design in Snøhetta’s New York office and project architect for Wolfe. Instead, the designers created a second focal point by tilting their building upward out of the earth in a way that recalls the firm’s Alexandria Library in Egypt, the pivotal 1989 commission that brought Snøhetta international recognition. “As the building emerges, it draws your eye up into the sky and gives you more of an uplifted feeling,” says Kassabian.

Inside the Wolfe Center, which houses the university’s theater and film departments, a soaring, two-story lobby leads to a grand staircase and social-gathering spaces flooded with daylight that spills in from large, west-facing windows and a skylight. The staircase—one of the building’s signature features—calls attention to itself as a crisp sculptural object in architectural concrete that invites students to use it for circulation and as a gently sloping bleacher for hanging out and people-watching. A pair of east-west corridors on the first and second levels of the building extend from the upper and lower lobbies to flank the large central volume containing the building’s primary, 400-seat theater, an intimate, enveloping space with excellent acoustics and sightlines. Skylights and axial vistas along the corridors make it easy to find two smaller stages, plus studios for film and dance, general-purpose classrooms, and faculty offices. Also key to the scheme’s legibility is a large, skylighted passageway that cuts north-south through the center of the building, creating an internal street that invites casual encounters throughout the day and links the theaters to a large backstage scenery shop.

The Wolfe Center’s structural system of bearing concrete masonry units supports precast-concrete plank floors and the building’s structural steel roof. The system frames the cast-in-place shell of the primary theater. The building’s simple, durable, and austere material palette includes lobby and corridor floors of ground and polished concrete and walls of architectural concrete and plywood panels stained in tones of chocolate gray.

The building earned a LEED Silver rating in part because of features like its sloping green roof, water-conserving plumbing fixtures, and the use of construction materials from within the region. Even so, the Wolfe Center doesn’t change the basic order of BGSU as an automobile-oriented campus on 1,300 acres of dead-flat land about 22 miles south of Toledo. In that sense, it is simply the newest large object



on a campus otherwise dominated by generally bulky, undistinguished buildings from the 1960s and '70s that are widely spaced among parking lots and long straightaways that discourage walking.

Nevertheless, the Wolfe Center produces a delightful jolt. With the choice of Snøhetta, officials of the 17,000-student university and the primary private donors to the \$31.7 million project—northwest Ohio arts patrons Frederic and Mary Wolfe of Perrysburg and Thomas and Kathleen Donnell of Findlay—were deliberately selecting a high-profile firm. (The 2006 assignment followed by two years Snøhetta's commission to design the 9/11 Memorial Museum in New York with Davis Brody Bond Aedas.) The university also recognized the need to compete with other state and private colleges and universities in the Midwest that are investing in campus-edge retail and housing districts or iconic buildings. "We were interested in a firm that was visually a superstar, but not interested in working with a big ego," says Katerina Ruedi Ray, head of the BGSU School of Art and a member of the university's client team.

The site for the building, strategically positioned between the university's music and fine-arts centers, provided an opportunity to draw students together from different departments and make the building a campus crossroads—which is very much how it functions. University officials were delighted that, thanks to a drop in the cost of labor and materials during the recent recession, the building came in a whopping \$10 million under budget. Nevertheless, Ray is disappointed that a café was cut from the project and that a huge parking lot was allowed to remain out front. "I'm still mad about that," she says. But Ray and others on campus are proud of having shown that BGSU can procure world-class architecture. The big question now is whether the university can rise to the occasion again, not just by adding important new buildings but by making its sprawling campus more beautiful, walkable, and sustainable overall. ■

*Cleveland-based Steven Litt is the art and architecture critic of the Plain Dealer.*

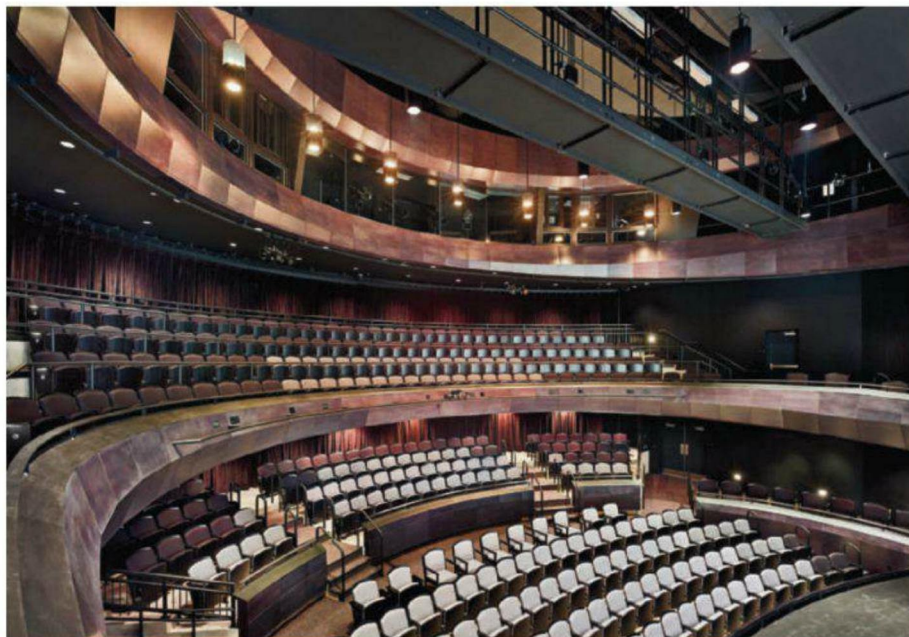
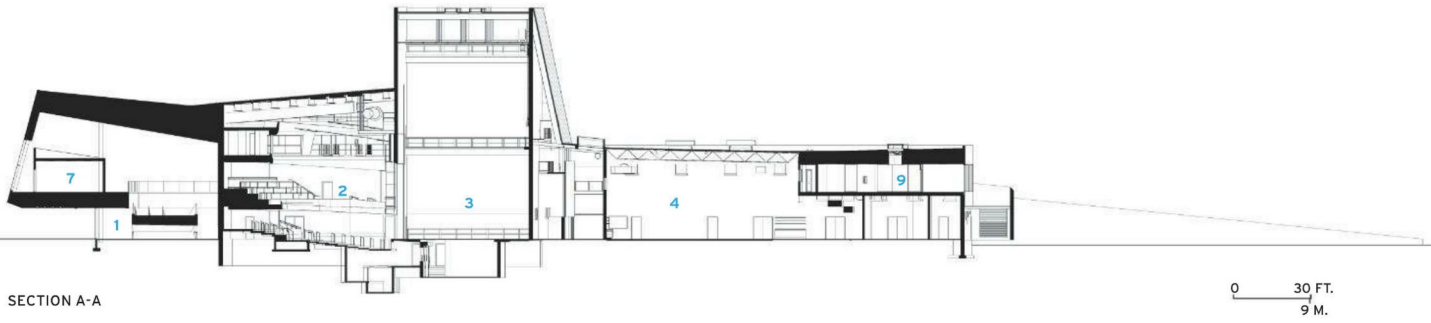


#### AVENUE OF THE ARTS

A skylighted double-story passageway (above) bisects the Wolfe Center and provides a shortcut for students going to and from the neighboring buildings housing the university's art and music programs.

The fabric and painted-plywood finishes inside the 400-seat proscenium theater (opposite) rely on a palette of grays and blacks that helps focus the audience's attention on the stage.

A dance studio (left) has generous west-facing glazing that makes the activity inside the building visible on the exterior.



credits

**ARCHITECT:** Snøhetta – Craig Dykers, partner in charge; Vanessa Kassabian, project architect; Elaine Molinar, Nicolas Rader, Scott Melancon, Claire Fellman, Knut Bjørgum, project team

**ARCHITECT OF RECORD:** The Collaborative Inc.

**CONSULTANTS:** Korda/Nemeth Engineering (structural, m/e/p); Akustiiks (acoustics); Theatre Projects (theater)

**CLIENT:** Bowling Green State University

**GENERAL CONTRACTOR:** Rudolph/Libbe

**SIZE:** 98,000 square feet (gross)

**COST:** \$31.7 million

**COMPLETION DATE:** December 2011

SOURCES

**METAL CLADDING:** Centria

**CURTAIN WALL:** Kawneer

**GLAZING AND ENTRANCES:** Oldcastle BuildingEnvelope

**SKYLIGHTS:** CPI Daylighting

**ACOUSTICAL CEILINGS:** Armstrong

# Second Life

Pasadena, California

Architectural Resources Group renovates a historic laboratory building, combining respect for the past with technical innovation and energy conservation.

By Joann Gonchar, AIA

PHOTOGRAPHS BY DAVID WAKELY



**RICH IN HISTORY** Built in 1932, Caltech's Linde Center for Global Environmental Science contains features common to Spanish Colonial Revival buildings, such as its stately groin-vaulted first-floor corridor (right). It also has decorative details that refer to its original use as the home of the astronomy and astrophysics departments, including the solar and zodiac symbols on its stucco-and-cast-stone facades (this photo).

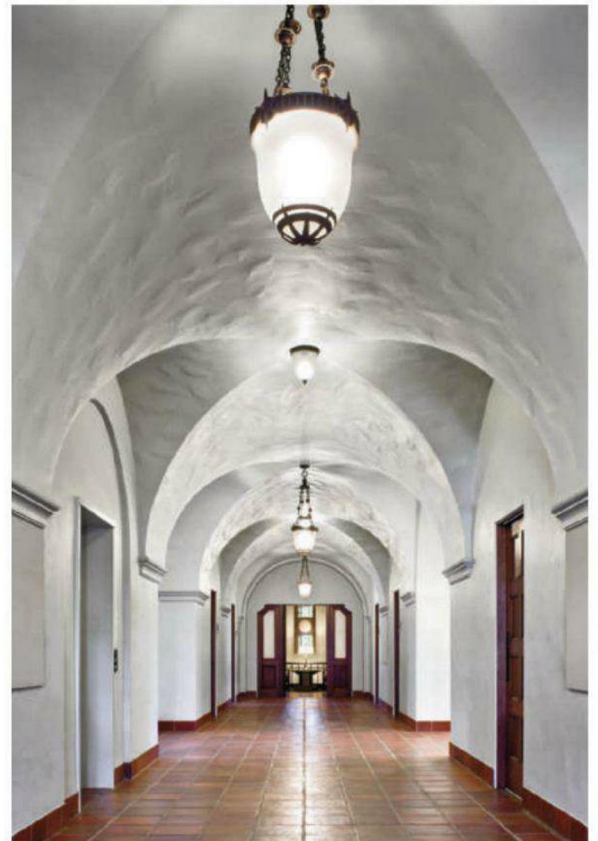




**WHEN CALIFORNIA** Institute of Technology (Caltech) officials decided to renovate an elegant Spanish Colonial Revival laboratory building and make it into a center for climate-change research, they were determined to create a facility that reflected the ideals of its occupants. For the Linde Center for Global Environmental Science, they decided to go beyond LEED Gold certification, the campus standard for new construction. They set their sights on Platinum, a level of certification that the designers maintain is unprecedented for the rehabilitation of a historic laboratory building.

The \$25 million project, completed in January 2012, preserves the character and fundamental organization of the 45,000-square-foot former home of the university's astronomers and astrophysicists, with its two stories of public spaces and faculty offices above three levels of below-grade laboratories. The 1932 structure designed by Mayers, Murray & Phillip, a successor firm to Goodhue Associates (the architect responsible for many of the buildings on Caltech's predominantly Mission-style Pasadena campus), now serves as a model of energy efficiency.

After housing the astronomers for nearly eight decades, most of the building's important original features were "tired" and worn, although largely intact, says Aaron Hyland, a principal with Architectural Resources Group (ARG), the San Francisco firm that led the renovation. ARG





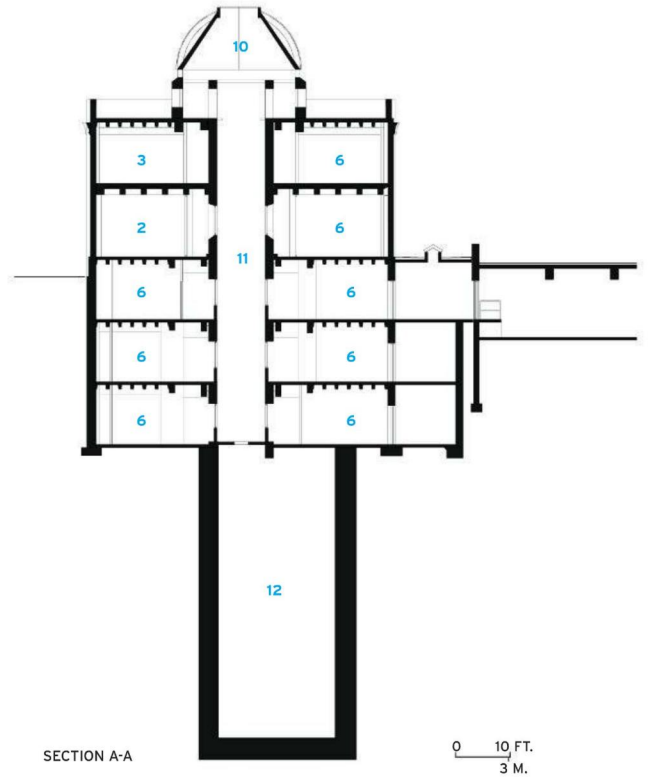
called for careful patching, cleaning, and refurbishment of elements such as the handsome stucco-and-cast-stone facades, with ornament alluding to the sun and the stars, and a groin-vaulted corridor with original brass and frosted-glass pendant light fixtures. The firm also devised sensitive insertions including floor-to-ceiling glass partitions that transform a former library into a pair of seminar rooms without disturbing distinctive elements like a stenciled barrel-vaulted ceiling made of board-formed concrete.

The subterranean research spaces, on the other hand, required a complete overhaul. Haphazard modifications had left the laboratories with circuitous circulation and very low ceilings. “They felt like caves,” says Paul Wennberg, a Caltech professor of atmospheric chemistry.

Even in its pre-renovated state, Linde possessed several qualities that would help it meet Caltech’s ambitious perfor-

mance targets, according to team members. They cite inherently sustainable features common in buildings constructed before World War II, including the significant thermal mass provided by its concrete structure, which reduces peak cooling and heating demands, and the deeply recessed windows, which make up only about 15 percent of the building envelope and help mitigate solar gain. As part of the renovation, designers have retained the windows’ historical steel casement frames, but have improved the glazing’s shading coefficient and its visible-light transmittance by replacing the original single-pane glass with laminated glass. In addition, the team added interior light shelves to the windows—a feature intended to create the effect of a baseball cap, says George Loisos, principal of Alameda, California–based Loisos + Ubbelohde, the project’s daylighting consultant. Their purpose is to reduce glare

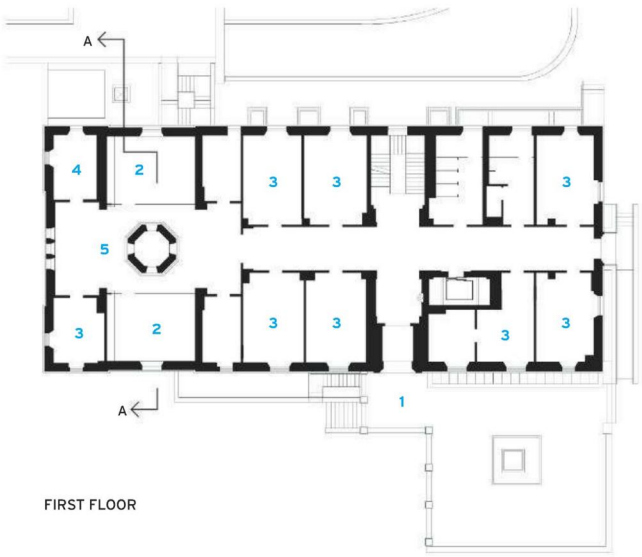
**LIGHT TOUCH** The library (above) now houses a pair of seminar rooms created without disturbing important original features, such as the ceiling’s stenciled concrete barrel vaults. The space also includes a real-time image of the sun projected by the refurbished rooftop coelostat (opposite).



SECTION A-A

0 10 FT.  
3 M.

- 1 ENTRY
- 2 SEMINAR ROOM
- 3 OFFICE
- 4 PANTRY
- 5 LIBRARY
- 6 LABORATORY
- 7 ANALYTICAL-INSTRUMENTATION ROOM
- 8 MECHANICAL ROOM
- 9 ELECTRICAL ROOM
- 10 COELOSTAT DOME
- 11 SOLAR SHAFT
- 12 CHILLED-WATER STORAGE



FIRST FLOOR



BASEMENT

0 20 FT.  
6 M.

rather than bounce daylight farther into the room, he explains.

The glazing's performance still isn't optimal from a thermal standpoint, says San Francisco-based Peter Rumsey, managing principal of Integral Group, the project's mechanical and plumbing engineer. "But there isn't very much of it."

Linde's most unusual original feature is its coelostat (pronounced *seel-o-stat*), an astronomical instrument with flat mirrors that turn slowly to reflect a beam of light continuously into a fixed telescope. (Such a device produces a stationary image of the sun and differs from a heliostat, which creates a rotating image.) But by the time the astronomers moved out of the building, the apparatus, which sits on the roof under a domed enclosure, hadn't been used for at least two decades, and there was no longer anyone on campus with the expertise to operate it. The new occupants wanted to remove the apparently obsolete device and increase available floor area by demolishing the coelostat's approximately 8-foot-diameter octagonal shaft that extends from the roof and through the structure.

But the design team lobbied hard for retaining the solar telescope, since it had been integral to the original program, eventually convincing the client to return the apparatus to working order. "The story of the coelostat is part of the story of the building," says Loisos, who helped design the coelo-

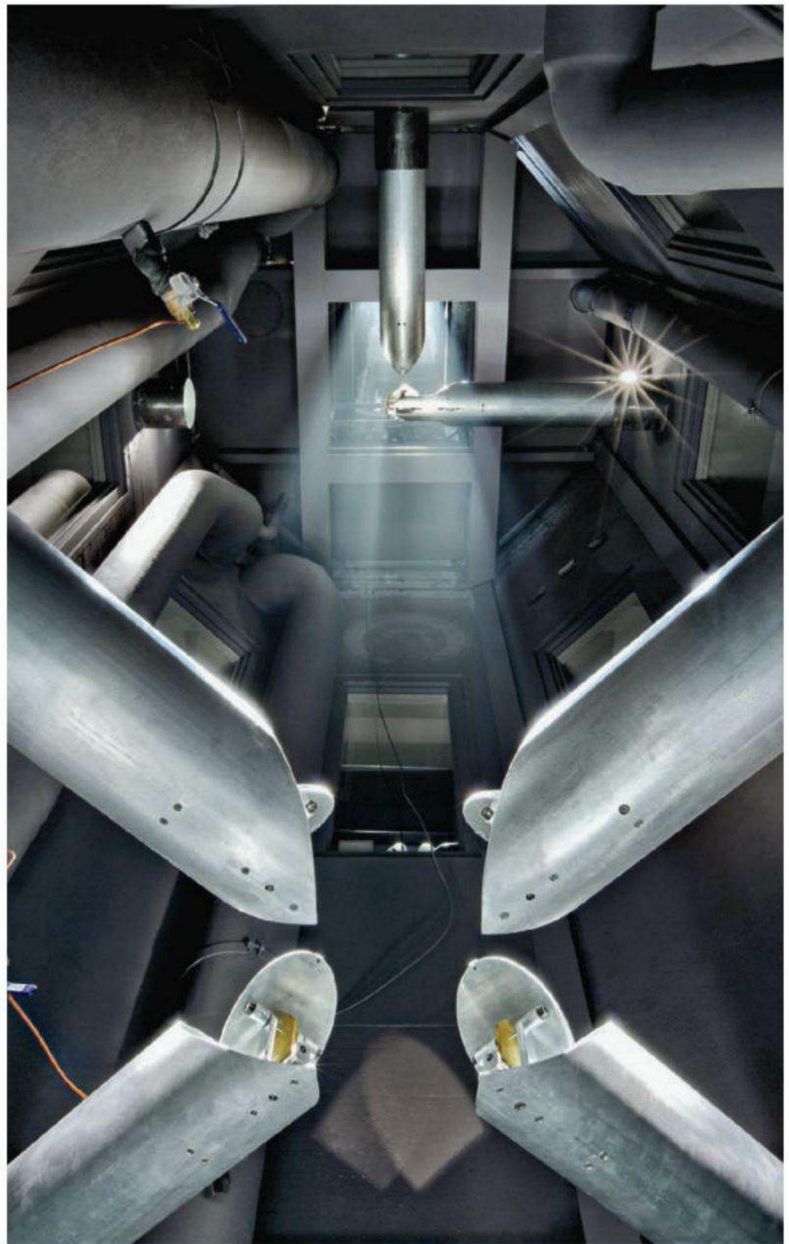
**"The story of the coelostat is part of the story of the building," maintains daylighting consultant George Loisos.**

stat's overhaul. He adds that Linde had also served as the base for the development of the famous 200-inch Hale Telescope at the university's Palomar Observatory, near San Diego. And at one time, the building's roof had housed several other historically significant instruments for study of the heavens, including a working 1:10 prototype of the Hale Telescope under a second dome.

The now-refurbished coelostat is used to produce a real-time image of the sun through a window into the part of the shaft that runs through the library. Here the image, created by means of a 6-inch-diameter telescope and a rear-projection screen suspended in the shaft, serves as an almost "tactile" reminder of the building's history, says Loisos, who points out that details such as sunspots and the passage of clouds are visible.

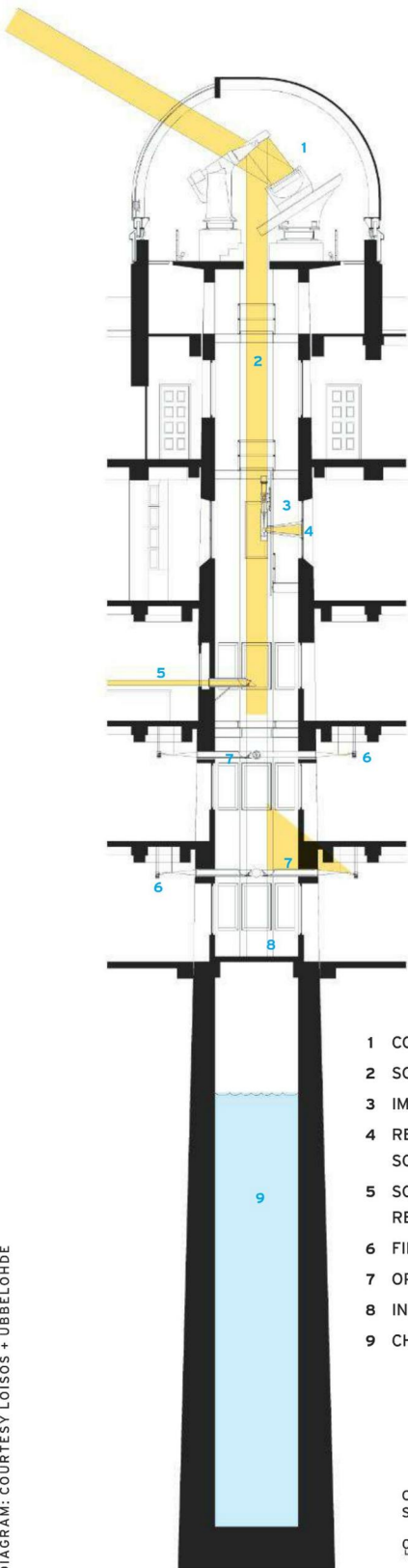
The renovated building also includes seven fiber-optic fixtures, designed and built by Loisos's firm, that route the sunlight into the labs. Unfortunately, due to difficulties restoring the coelostat's mirrors and the lingering presence of construction dust, the fixtures are only about half as bright as expected—making them an instructive demonstration of a fiber-optic application but a poor source of general illumination.

Even though the client initially resisted retaining the coelostat, several faculty members have incorporated the device into their research. For example, Wennberg uses the instrument to direct sunlight into a spectrometer in the building's subbasement. He then analyzes the resulting



#### LIGHT PIPES

Linde has custom-designed fiber-optic lighting fixtures (left) that guide sunlight from the coelostat into the laboratories. The illumination system includes silvered mirrors and lenses housed within optical tubes (above) for concentrating and directing the daylight.



- 1 COELOSTAT
- 2 SOLAR SHAFT
- 3 IMAGING TELESCOPE
- 4 REAR PROJECTION SCREEN
- 5 SOLAR BEAM FOR RESEARCH
- 6 FIBER-OPTIC FIXTURES
- 7 OPTICAL TUBES
- 8 INSTRUMENTATION ZONE
- 9 CHILLED-WATER STORAGE

COELOSTAT SECTION DETAIL  
 0 10 FT. 3 M.



spectra to identify greenhouse gases and other pollutants in the air in the Los Angeles basin.

The project team found other innovative uses for parts of the solar telescope's infrastructure. For instance, a pit that extends the coelostat shaft 60 feet below the lowest laboratory level once housed research equipment now considered unnecessary. The pit has been repurposed as a 60,000-gallon storage tank and incorporated into Linde's mechanical system. The tank holds water that is circulated at night through a rooftop cooling tower to produce medium-temperature chilled water for the building's cooling system without a compressor. In Pasadena's dry climate, the design team estimates, it will be able to keep Linde's occupants comfortable for about half of the year without the need for supplemental cold water from the campuswide chiller system.

As part of a holistic approach to indoor climate control, the water cooled on the rooftop is delivered to the building's occupied spaces through radiant panels and chilled beams. Because of the reliance on water for cooling, fan energy is required only for moving the air needed for ventilation. And because water is a vastly more efficient medium for transferring heat than air is, Linde's mechanical system occupies far less space than a conventional variable-air-volume (VAV) system and is quieter, explains Rumsey, who estimates that a 1-inch water pipe provides the same amount of cooling as an 18-inch-diameter duct. This space savings is especially advantageous at Linde, where laboratory floor-to-floor heights are only 11 feet 6 inches, compared with a height of about 16 feet for a typical new laboratory building.

The designers have further maximized the available room height by eliminating suspended ceilings in the laboratories and leaving the radiant panels and other utilities and services exposed. The omission of the hung ceilings should also facilitate the inevitable replacement of equipment and the reorganization of the laboratories, points out Wennberg. "Research is by nature dynamic," he says.

Linde takes advantage of several nontraditional sources of energy. It has a 100-kilowatt biogas-fired fuel cell—one of

**TIGHT FIT** The project team made the most of limited floor-to-floor heights in the laboratories by relying on water circulated through radiant ceiling panels for cooling instead of a traditional variable-air-volume system. Leaving all overhead utilities exposed also helped maximize the available height and should facilitate the inevitable reconfiguration of the research spaces.



several connected to the campus grid—and a 50kW natural-gas-fired fuel cell that serves as a backup power source in case of outages. A 30kW photovoltaic array is also planned for Linde's roof.

Although the building displays a variety of unusual generation sources, the project team and the client focused their attention on reducing the building's power demand rather than increasing supply. Toward that end, Caltech commissioned a study of the building's plug loads (those loads not associated with lighting or the HVAC systems), including those attributed to the lab equipment. "Typically, this equipment is not ours to design, but these users were very engaged," says Rumsey.

Working with manufacturers and the client, engineers from Integral Group identified opportunities for replacing some of the less-specialized research-related equipment. For example, they determined that heat exchangers relying on the water chilled by the building's rooftop tower could be substituted for the dedicated chillers for the laboratory's mass spectrometers. By instituting such measures, Linde has already achieved a 40 percent reduction in plug loads in comparison to a typical lab. Rumsey expects an additional 20 percent savings over time as outmoded equipment is gradually replaced with more energy-efficient models.

Taking into account all its conservation strategies, Linde is designed to operate using only about 30 percent of the energy of a typical lab in the same climate zone. The project earned its LEED Platinum designation earlier this year—an achievement that has given Caltech administrators the confidence to consider even more ambitious projects. Bradley Smith, senior project manager for the school's design and construction department, says he hopes to take on the Living Building Challenge—a "beyond LEED" certification program with a host of tough-to-achieve requirements, including net-zero energy and water operations—for a 250-bed residence hall slated to start construction in 2014. ■

**QUIETER AND BRIGHTER** The architects made a few carefully considered changes to Linde's public spaces, including the second-floor corridor. Here they replaced the original painted concrete floor with cork and added skylights.



### Continuing Education

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### Learning Objectives

- 1 Identify features common in pre-World War II buildings that are inherently sustainable.
- 2 Discuss strategies for historically sensitive and energy-conserving renovation.
- 3 Describe environmental-control systems appropriate for laboratory buildings.
- 4 Explain how a coelostat works and discuss the historical significance of the coelostat at the Linde Center for Global Environmental Science.

AIA/CES Course #K1211A

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### credits

**ARCHITECT:** Architectural Resources Group – Bruce Judd, partner in charge; Aaron Jon Hyland, managing principal; James McLane, associate principal; Susan McDonald, project manager

**CONSULTANTS:** John A. Martin & Associates (structural); VCA Engineers (civil); Integral Group (mechanical/plumbing); Integrated Design Associates (electrical); Loisos + Ubbelohde (daylighting); Starman Systems (coelostat automation)

**CLIENT:** California Institute of Technology

**GENERAL CONTRACTOR:** Del Amo Construction

**SIZE:** 45,000 square feet (gross)

**COST:** \$25 million

**COMPLETION DATE:** January 2012

### SOURCES

**LAMINATED GLAZING:** GlasPro, Southwall Technologies

**SKYLIGHT GLAZING:** Oldcastle BuildingEnvelope, PPG Industries

**LIGHTING-CONTROL SYSTEM:** Lutron

**FUEL CELLS:** Bloom Energy, Altergy

# AUTOMATES EVERY OCCASION



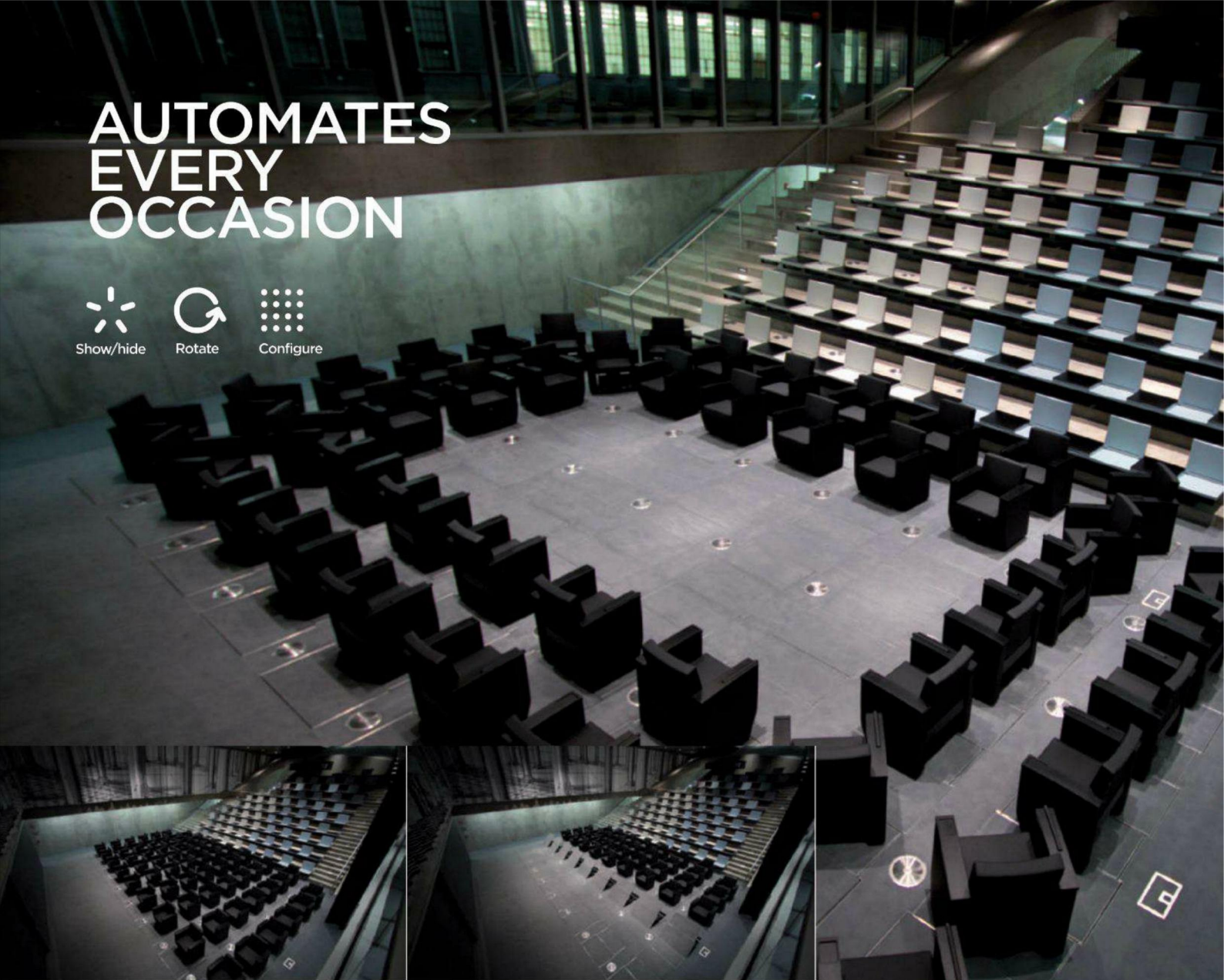
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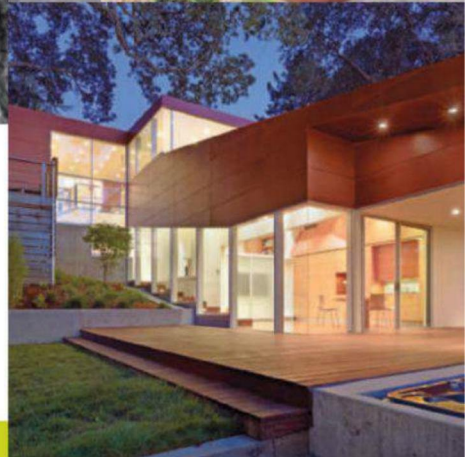


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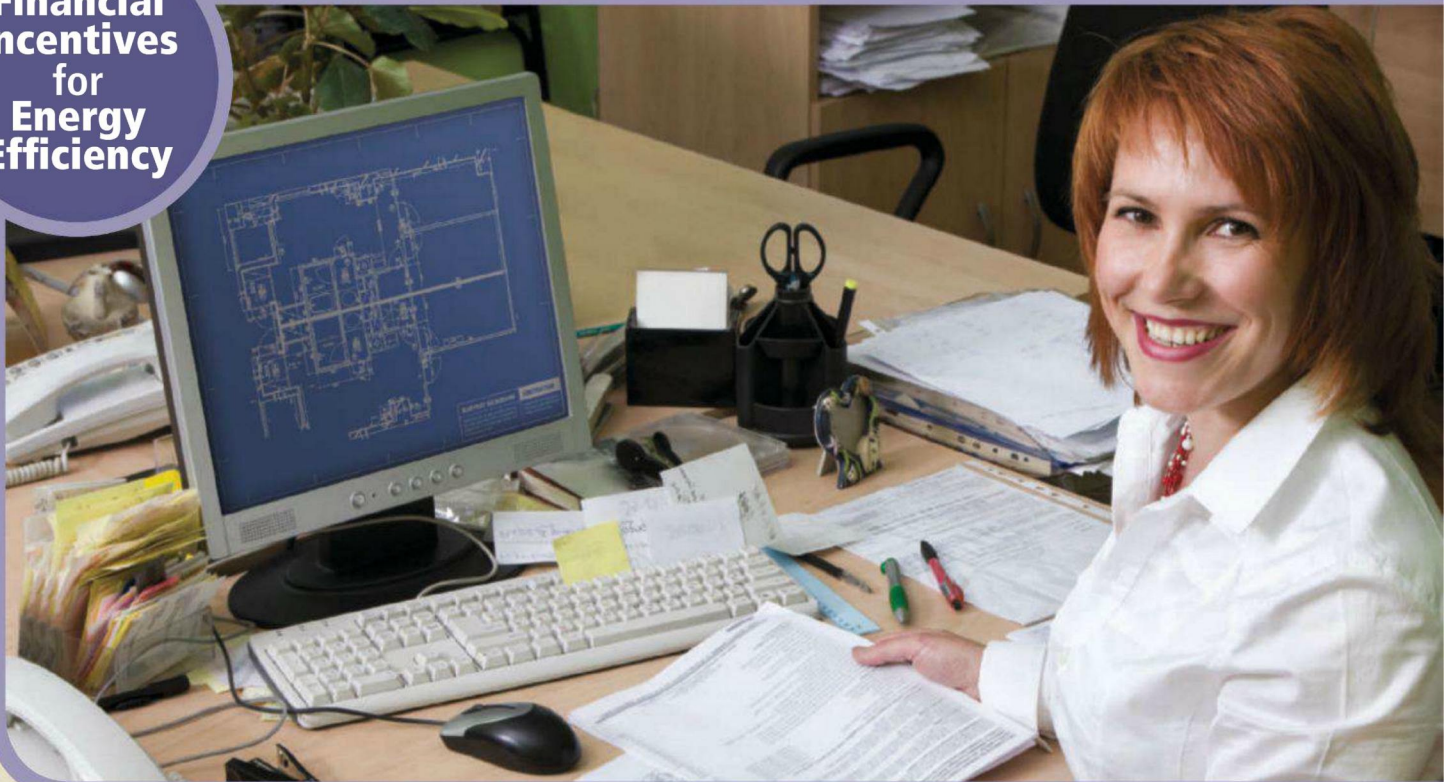
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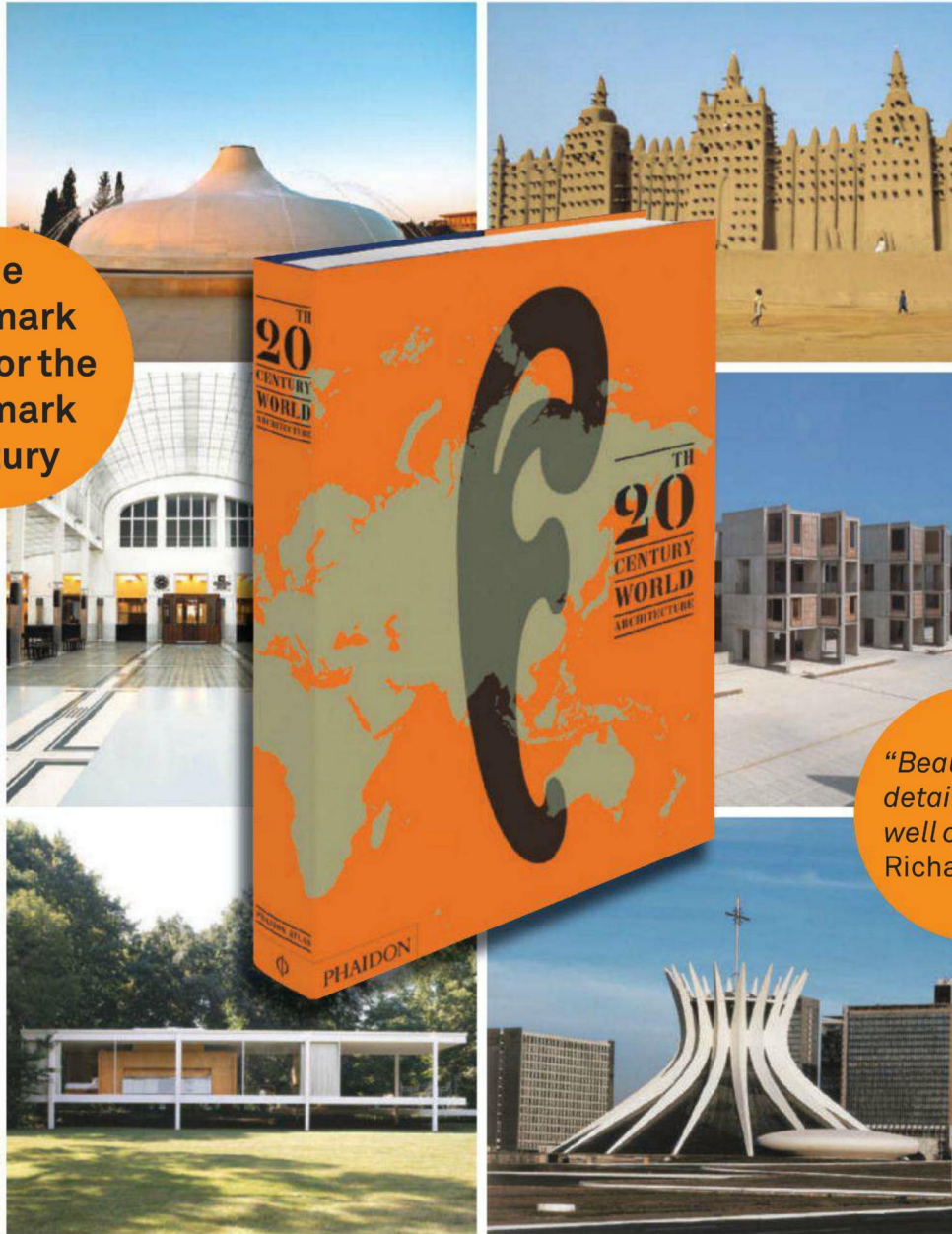
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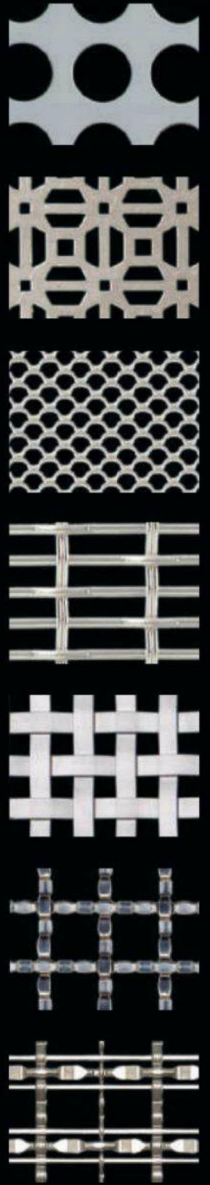
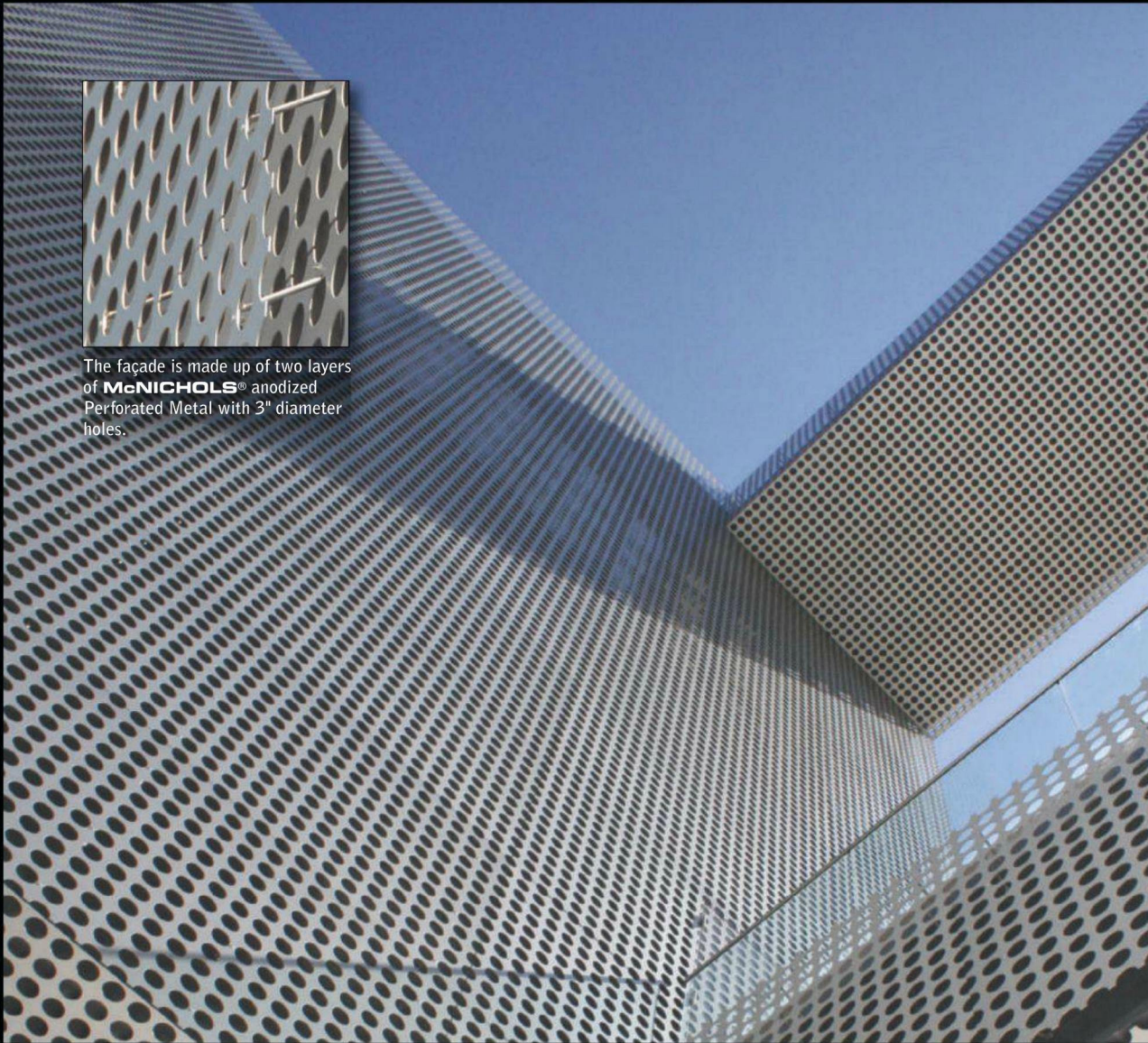


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# Guiding Lights

The angled rays of the sun filtering through stained glass and the hypnotic flicker of a candle's flame are potent tools, used for centuries to illuminate the world's spiritual places. The designers of the following projects produce a similarly luminous power, with subtle and sophisticated technology, to evoke serenity, meditation, and awe—and still shed ample light on the scriptures.

- 134 Church at Worth Abbey
- 137 Temple Beth Elohim
- 141 Quaker Meeting House, Sidwell Friends School

The soaring sanctuary of Francis Pollen's church at Worth Abbey, a model of 1960s ecclesiastical architecture, was belatedly completed and illuminated by Heatherwick Studio and DPA Lighting Design.

## Church at Worth Abbey Crawley, U.K. Heatherwick Studio DPA Lighting Design

By Linda C. Lentz

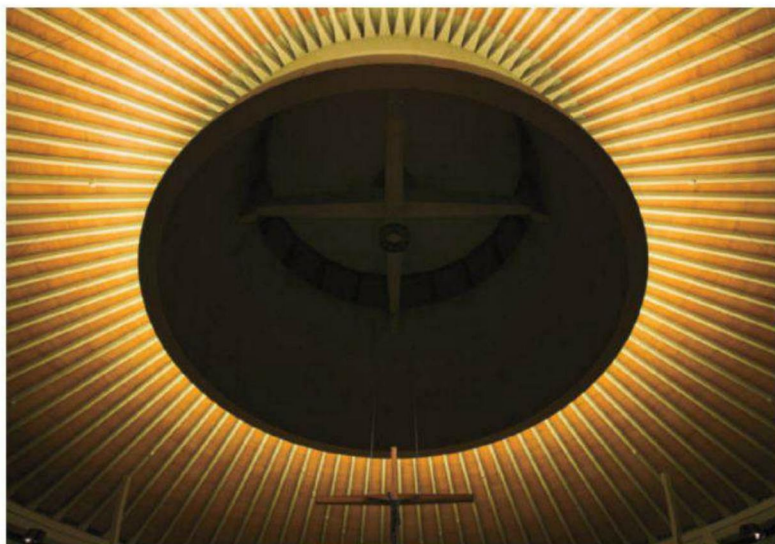
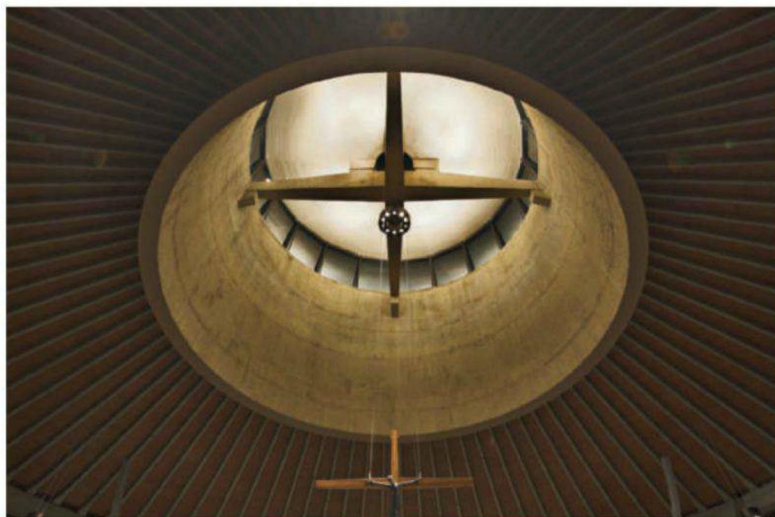
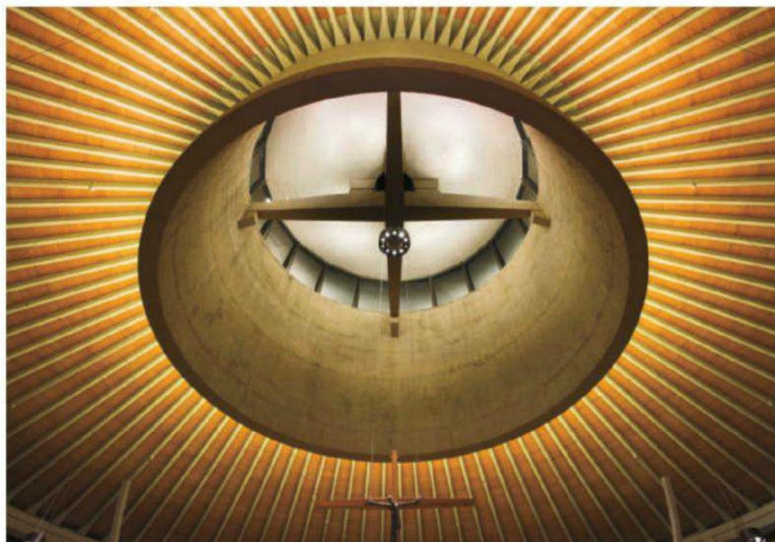
**AS IF SPARKED** by divine intervention, a design team led by Thomas Heatherwick completed and revitalized an important Modernist church by Francis Pollen (1926–87) for a historic Benedictine abbey, illuminating the late British architect's vision with craft and 21st-century technology.

Nestled in the bucolic West Sussex village of Crawley some 42 miles southeast of London, the Church of Our Lady, Help of Christians at Worth Abbey, built between 1964 and 1974, is one of the finest examples of that era's ecclesiastical architecture and listed as a Grade II\* (or "particularly important") building by England's Historic Buildings and Monuments Commission. It is also one of the region's largest churches, at approximately 17,000 square feet, seating up to 900 people in a vast volume that Pollen devised by incorporating bridge-building techniques into his scheme. But the striking sanctuary was never finished, and such essential details as permanent seating integral to the original circular plan were omitted. The lighting, too, was inadequate for the needs of the abbey's active community of 25 monks, the 550 students of the school they run, and the thriving congregation they serve.

Thanks to the recent contributions of generous benefactors, the design-savvy monks—including one former architect—were able to tap Heatherwick to renew and furnish the interior of their church in the round. The British designer and his studio restored the building's reinforced-concrete surfaces, replaced the windows, and improved the acoustics. They surrounded the central altar with exquisitely curved, fixed seating and choir stalls custom-made out of solid black walnut striped with ash. Then they created a distinctive portland-stone pulpit and holy-water stoups informed by Pollen's existing altar and baptismal font.

As improved lighting was crucial to the success of the project, Heatherwick engaged DPA Lighting Design to develop a strategy that would be invisible yet supply multiple layers of illumination. Most would have to be electric, because the only sunlight entering the room filters in through bands of clerestories encircling the perimeter walls and a 40-foot-wide lantern that pierces the conical timber-and-concrete roof above the altar. According to DPA's Gary Campbell, the light was very beautiful, but weak. The challenge, he explains, was to get an ample amount of well-controlled, nonglaring light down to the floor from the substantial height, which would improve light levels for reading. The monastery also requested a flexible, easy-to-use control system that would allow it to create appropriate settings for various services and events.

The first step was to refurbish Pollen's existing single-lamp fixtures—a series of cylindrical pendants and up/down sconces in rustic metal—retrofitting them with dimmable AR111 low-voltage halogen lamps. The DPA team rearranged

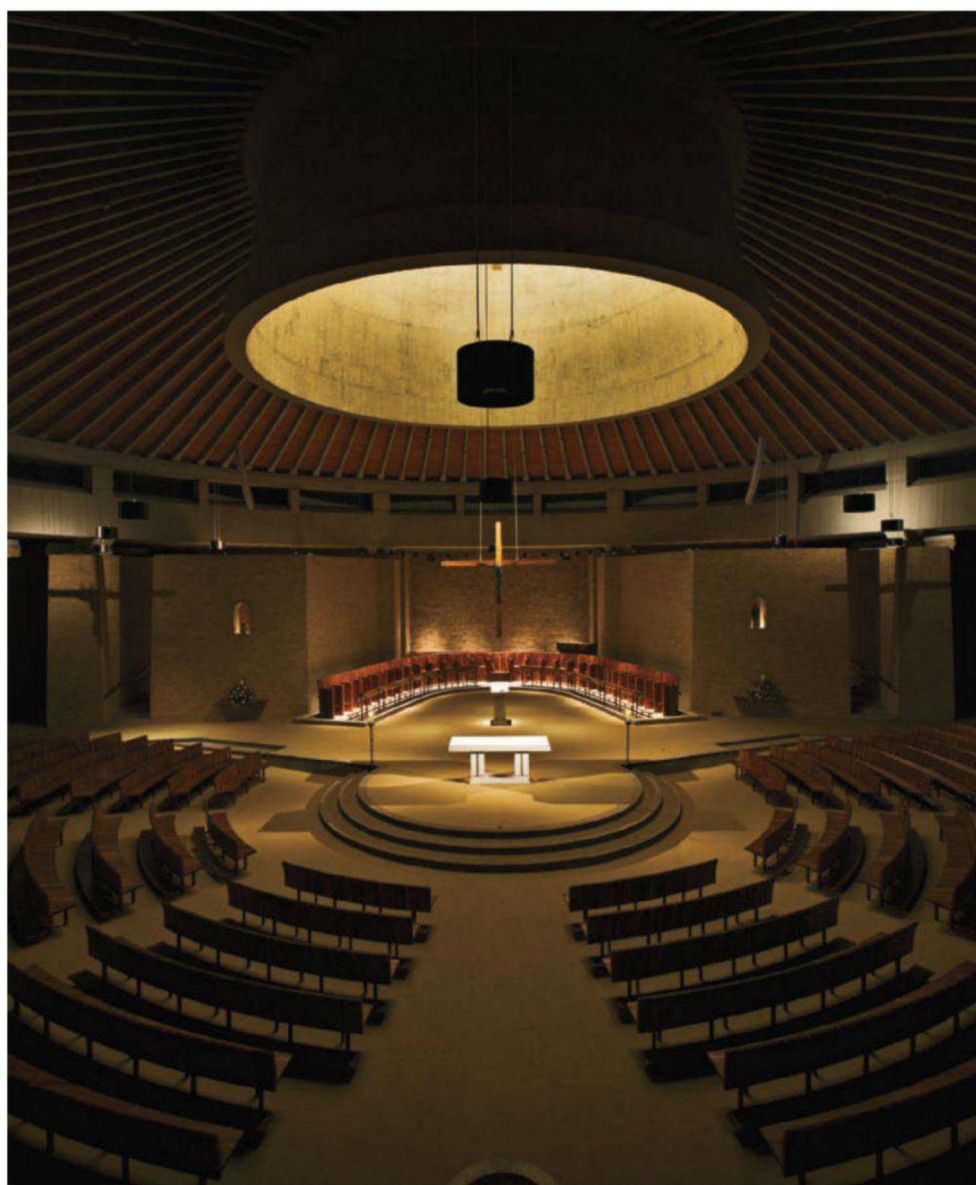
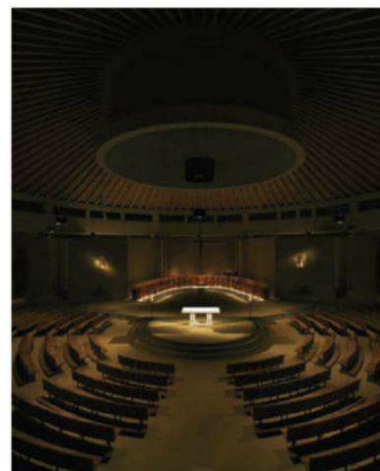




the pendants over the clergy's seats to give them a focused beam, and supplemented the originals with four-lamp replicas suspended over the congregation to provide ambient, task, and emergency lighting (the last supplied by an auxiliary battery-powered LED). Then the team developed a robust 10-lamp version, motorized for maintenance, that hangs from the lantern's core and highlights the lectern and altar—also spotlighted for additional drama from the tops of four perimeter columns. Finally, the lighting designers tucked powerful LEDs on top of the lantern's crossbeams to brighten its walls indirectly, and rimmed its outer base with cold-cathode tubular lighting to wash the ceiling with an even glow. Everything is dimmable, and split up into zones and tasks.

The overall effect is theatrical, due in part to the preset scenes. "The architecture is stunning," says Campbell. "And when you light that, it is incredible—like a stage set." ■

**CELESTIAL SETTINGS** Designed to be built over time, Francis Pollen's church at Worth Abbey was erected between 1964 and 1974 but ultimately completed in 2011 by Thomas Heatherwick and a team that included DPA Lighting Design. Driven by programmable controls, the flexible lighting system allows the monks to create atmospheric scenes that illuminate the lantern and ceiling singly or in tandem (opposite), highlight the altar with an overhead pendant and perimeter spots (below), and use light and shadow for function or meditative effects (right).



#### credits

**ARCHITECT:** Heatherwick Studio – Thomas Heatherwick, principal; Peter Ayres, Fred Manson, project architects

**LIGHTING DESIGNER:** DPA Lighting Design – Gary Campbell, partner in charge

**ENGINEER:** BLR Associates

**CLIENT:** Worth Abbey Monastery

**CONSULTANTS:** Swift Horsman (furniture fabrication); Arup (acoustics)

**GENERAL CONTRACTOR:** CMS Building Services

**SIZE:** 17,000 square feet

**COMPLETION DATE:** August 2011

#### SOURCES

**LIGHTING CONTROLS:** Lutron

**LIGHTING:** Mike Stoane Lighting (pendants, sconces, spotlights); AC/DC (cold cathode); Philips Color Kinetics (LEDs)

**ELECTRIC HOIST:** Raising & Lowering Systems



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CIRCLE 33

## Temple Beth Elohim Wellesley, Massachusetts William Rawn Associates HLB Lighting Design

By Allison Craig

**AWE IS A CONCEPT** central to Judaism, and awe is the feeling you get as you enter Temple Beth Elohim, a Reform synagogue in Wellesley, Massachusetts. Dubbed “the best new house of worship to have been built in the Boston area in decades” by *Boston Globe* architecture critic Robert Campbell, Temple Beth Elohim is an inspiring example of how architecture can articulate spirituality and lighting design can create wonder.

This 42,000-square-foot space is the devotional home to more than 1,000 families. Completed in 2011, it was designed

by William Rawn Associates, with lighting by Horton Lees Brogden Lighting Design (HLB). The most striking feature of the synagogue, whether viewed from the street, the tree-lined courtyard, or the doorway, is its soaring sanctuary. The space features two 36-foot-high window walls, facing north and east. While architecturally stunning, this expansive glass created significant lighting challenges. HLB had to conduct extensive daylighting studies at every hour to figure out how to maintain the desired visual transparency and connection to the outdoors, while ensuring that the congregants do not experience glare and the rabbi doesn't appear in silhouette. It also had to achieve the unusually high foot-candle levels (30 to 35, compared with 15 to 20 in a typical church) necessary for this congregation's participatory religious practice.

The first step was to place a custom maple-wood screen wall in the east-facing window, behind the ark. According to Carrie Hawley, associate design principal at HLB, “We worked with the architects to determine the ideal configuration,

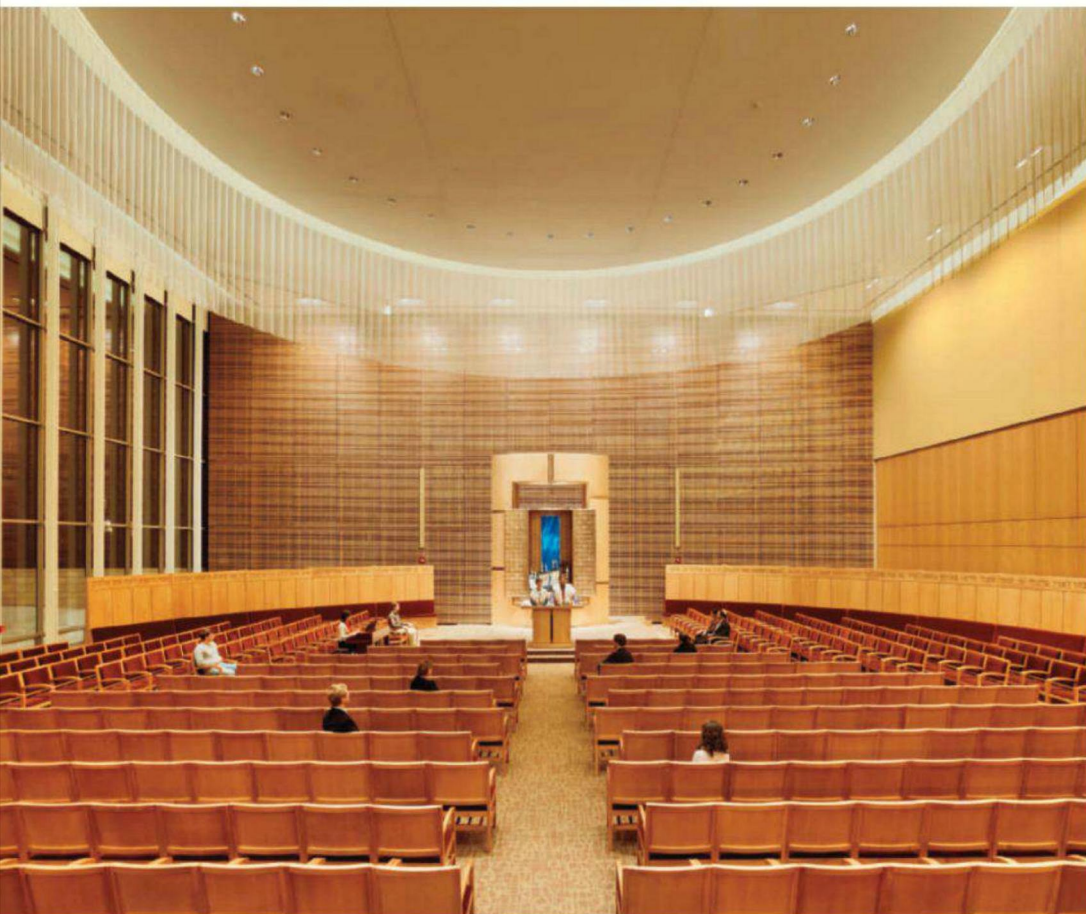
**SPIRITUAL CLARITY** Framed by landscaped grounds and the evening sky, the temple's north-facing window wall reveals a soaring sanctuary dramatically illuminated by a luminous mesh circle of light and a floating ceiling softly delineated by LED cove lighting.



size, spacing, and angles." With the delicacy of a bamboo shade, the screen delivers a subtle, filtered light during the day and solidifies the room as darkness falls. For evening hours, HLB achieved an ethereal glow with a sophisticated layering of lighting techniques. It arranged energy-saving 83-watt, long-life halogen accent lights in a concentric (dim-mable) ring over the congregants. Then it aimed ceramic metal-halide wallwashers at the screen and focused halogen accent lighting on the ark. In a lighting sleight of hand, HLB aimed linear LEDs at the room's focal point, a 47-foot-wide circular mesh cylinder designed by the architects, which suspends 10 feet from the ceiling. Finally, it installed LED cove lighting to give the illusion that the entire ceiling is floating.

"We take advantage of lighting in every form to create different moods, personal and communal," says Judith Cannon, the temple's director of administration and operations. Light sources were chosen for their warm color characteristics, creating a seamless marriage of natural and electric light. During the day, you are hardly aware that there are any fixtures at all. But at night, the glowing circle of light tells passersby that this is a special place. ■

*Allison Craig, a regular contributor to RECORD's sister publication SNAP, writes about architectural products and projects.*



#### credits

**ARCHITECT:** William Rawn Associates – William L. Rawn, design principal in charge; Samuel Lasky, associate design principal

**LIGHTING DESIGNER:** Horton Lees Brogden Lighting Design – Barbara Horton, design principal in charge; Carrie Hawley, associate design principal; Hayden McKay, principal in charge of daylighting

**ENGINEERS:** LeMessurier (structural); Cosentini (m/e/p); Stantec (civil)

**CONSULTANTS:** Dietz & Associates (interior design); Kirkegaard Associates (acoustics)

**GENERAL CONTRACTOR:** Richard White Sons

**COMPLETION DATE:** May 2011

#### SOURCES

**GLAZING:** Oldcastle BuildingEnvelope

**INTERIOR LIGHTING:** Alkco, Bartco, Bega, Bruck, Erco, Focal Point, Intense, Kurt Versen, The Lighting Quotient, Lithonia Lighting, Philips Color Kinetics (ambient, downlights, pendants, task)

**LIGHTING CONTROLS:** Lutron

**NIGHT AND DAY** The architects and lighting designers collaborated to create a custom wood screen for the east-facing window wall behind the ark that delivers a subtle, filtered light during the day (above) and an embracing solidity as darkness falls (left). Flexible, modular seating can be arranged in orthogonal or circular plans to accommodate the congregation's varied participatory services.



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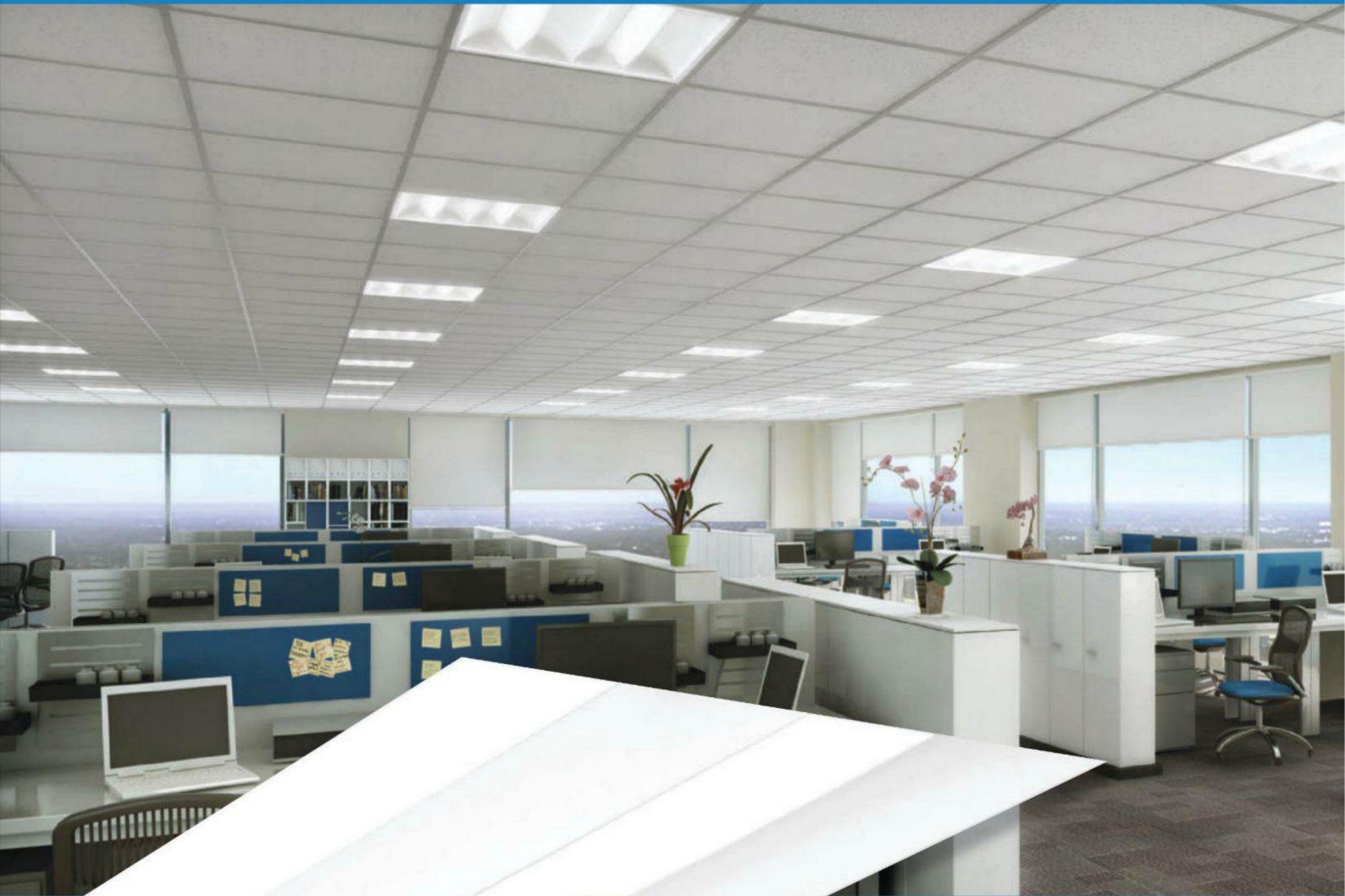
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## Quaker Meeting House Washington, D.C. KieranTimberlake Arup Lighting By Caryl Kinsey Fox

**CREATING** A space that inspires is a weighty responsibility for architects and designers. KieranTimberlake's 2000 master plan for Sidwell Friends School, a Quaker K-12 day school in Washington, D.C., called for updating, uniting, and optimizing an aging urban campus, reflecting the school's desire to become a model of sustainability. As part of its scheme, the Philadelphia-based firm renovated the existing gymnasium, transforming the 1950s structure into a hybrid Arts Center and Meeting House (actually a large room within the building) to be used for the students' weekly worship.

Gleaning from the philosophical and spiritual teachings of the Religious Society of Friends founder George Fox, the architects created a simple diagram that configures the space and materials around a core of silence and light. According to partner Stephen Kieran, this arrangement literally defines the room, so it becomes a magnet that draws everyone around it into its sphere, providing form, order, and meaning where none existed.

Meetings take place in this seemingly simple space, where the architects devised an atmosphere of silence—both aural and visual—by minimizing elements that might bring participants back to the present. To do this they pocketed doors, worked exit signs into door frames, and tucked mechanicals out of view. Then they layered a series of floating white wall and ceiling panels around windows and a deep central skylight. These buffer noise, direct sunlight, and outside distractions, yet still reveal glimpses of nature. During the day, a gentle illumination filters in around the suspended vertical and horizontal planes that screen existing north and

**A QUIET PLACE**  
Inspired by Quaker teachings, the architects created a Meeting House space for Sidwell Friends School, infusing it with silence and light by buffering outside noise and direct sunlight with a series of floating ceiling and wall panels to minimize outside distractions.

south clerestories, and the newly installed skylight, enhancing the warmth of the reclaimed white-oak flooring below—a rich, unfinished surface that continues up the walls and wraps the room.

Working with Arup Lighting, the architects maintained the quality of the sun's glow at night by installing indirect T5 fluorescent tubes. Each electric-lighting gesture can be controlled independently, as needed, to augment varying daylight conditions and specific programmatic requirements.

The designers used similar lighting techniques and suspended ceiling planes in the surrounding hallways, extending the illusion of skylights beyond the immediate Meeting House room. Nearly all the lighting in the public spaces, which includes PAR30 halogen lamps and Biax compact fluorescent channel and track lighting, is hidden from view, spreading the silence out to the campus beyond.

The entire space is lit using 1.9 watts per square foot, with 3,500K T5 high-output fluorescent lamps that achieve 25 to 30 foot-candles. The Arup designers used daylight analysis and lighting-simulation software to verify light levels. They tested multiple configurations, working with KieranTimberlake to make slight adjustments to the architecture in order to maximize the quantity of natural illumination entering the space. The final daylight-autonomy calculations indicate that most of the room achieves greater than 300 lux for over 50 percent of normal operating hours, lessening the need for supplementary electric light. Typically, during the day only cove lights at the east and west walls are necessary.

Given the volume and multiple uses of the space, the designers might have been tempted to introduce a variety of lighting systems. But they purposely kept their interventions spare and simple. The balance of electric light and daylight peeking between the layers not only yields a sense of serenity and calm that encourages contemplation, it reinforces the client's commitment to the environment and its student body. ■

*St. Louis–based architect and lighting designer Caryl Kinsey Fox has practiced both disciplines in New York City and Los Angeles and taught lighting design at SCI-Arc and UC Irvine.*

## credits

**ARCHITECT:** KieranTimberlake  
– Stephen Kieran, James Timberlake, design partners;  
Jason Smith, associate in charge;  
Andrew Evans, project architect

**LIGHTING DESIGNER:** Arup  
Lighting – Brian Stacy, associate

**ENGINEERS:** CVM (structural);  
Bruce E. Brooks & Associates  
(m/e/p); Vika (civil); GeoConcepts  
(geotechnical)

**CONSULTANTS:** K2 Audio  
(acoustic); GreenShape  
(environmental)

**GENERAL CONTRACTOR:**  
Whiting-Turner

**SIZE:** 4,200 square feet

**COMPLETION DATE:** May 2011

### SOURCES

**LIGHTING:** Pinnacle (cove);  
Cooper (downlights)

**CONTROLS:** Philips Strand  
Lighting

**SURFACES:** BASWAphon  
(acoustical plaster); Benjamin  
Moore (low-VOC paint)

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**SERENE BALANCE** The lighting designers worked with KieranTimberlake to devise an architecture that maximizes the desired amount of sunlight entering the room. By day, it is seamlessly supplemented with a controlled, discreetly installed electric-lighting system, as needed.



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## Inspiring Illumination

While a few of these new lighting designs take inspiration from unusual sources, like origami or palm trees, others have a historical connection, including a reproduction of one of the first fixtures designed for the Edison bulb and an energy-saving lighting control that is part of a retrofit for the Empire State Building.

By Rita Catinella Orrell

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### Eclipse

New York-based designer Harry Allen took a cue from the tropical gardens of Brazil for the design of the Eclipse pendant, which has a form and structure recalling the concentric growth rings at the base of palm trees. Available through the Brazilian lighting manufacturer ViaLight Design, the shades are made with an aluminum frame in white, black, blue, yellow, and metallic colors. The fixtures use one 60-watt E26/27 bulb and come in two sizes: 14.76" high x 16.14" wide (shown in blue) and 13.58" high x 11.42" wide (shown in yellow). [vialightdesign.com](http://vialightdesign.com)

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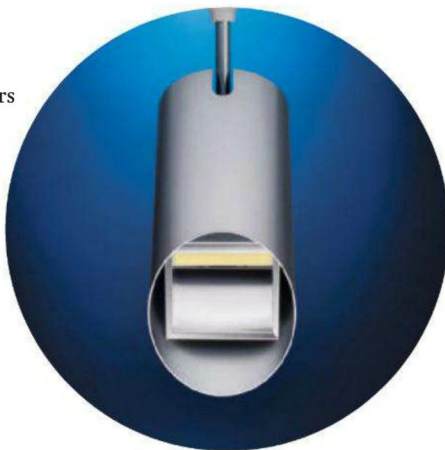
### Flex

Flex is a customizable light-fixture system from 3M Architectural Markets that can be suspended and curved to follow architectural lines and create luminous installations along walls and ceilings. Ideal for retail, health-care, hospitality, and office environments (rendering shown), Flex uses energy-efficient LED sources in 11 slender, lightweight, connectable components that can be mixed and matched. Available in standard or custom finishes, the fixture is currently installed in 3M's Minneapolis showroom, designed by James Mansour.

[3MArchitecturalMarkets.com](http://3MArchitecturalMarkets.com) CIRCLE 213

### LumeLEX 2045 LED Series

This new stem-mounted wallwash fixture is the latest addition to the LumeLEX family of cylinders from Lighting Services Inc. Powered by Xicato XLM Artist Technology, the series features a discreetly hidden driver, making it appear no different from a traditional halogen source. Utilizing a computer-designed, highly specular asymmetric reflector, the LumeLEX 2045 produces 1,100 lumens of a seamless, even wash of light. The fixtures come with a five-year warranty, a Reliability Data sheet, and easily replaceable 50,000-hour LED modules. [lightingservicesinc.com](http://lightingservicesinc.com) CIRCLE 214

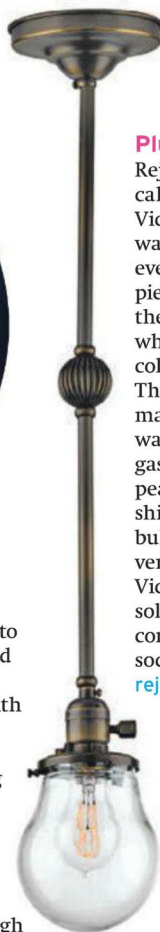


### Origami LED

Peerless Lighting has added an LED version to the Origami line that includes suspended and wall-mount T5-T5HO fluorescents. Designed to be efficient, energy-saving luminaires with a broad distribution of light, Origami LEDs bathe ceilings with smooth gradients of indirect light while uniformly illuminating work planes below. The LED light engine delivers L80 performance for 50,000 hours. When spaced 15' apart on-center in a 60' x 40' open office, Origami achieves a low power density of .76 watts per square foot while delivering 29 foot-candles on a 2.5'-high work surface. [peerlesslighting.com](http://peerlesslighting.com) CIRCLE 216

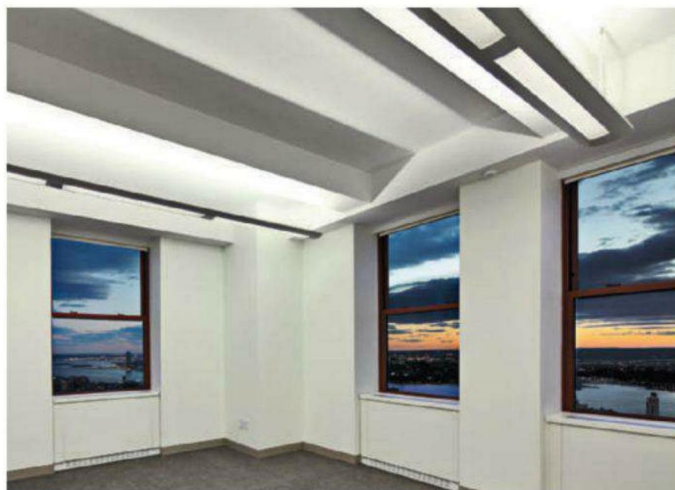
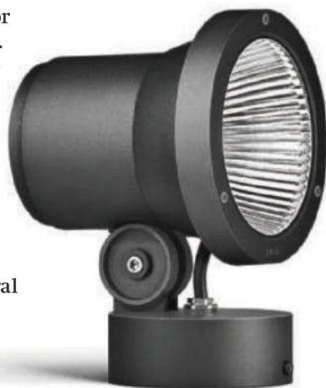
### Plum Pendant

Rejuvenation has created a historically accurate reproduction of a Victorian-style rod pendant that was among the first electric fixtures ever made. The fixture is based on a piece originally manufactured in the 1880s by Sigmund Bergmann, who patented the electric socket and collaborated with Thomas Edison. The down-facing orientation was a major innovation at the time, as it was not previously possible with gas lamps, and the original opaque pear-shaped shade was designed to shield eyes from the "bright" Edison bulbs. Shown here in a clear-shade version with a 60-watt incandescent Victorian-style bulb, Plum is made of solid brass in 13 finishes and can be controlled with a functional turnkey socket or wall switch. [rejuvenation.com](http://rejuvenation.com) CIRCLE 215



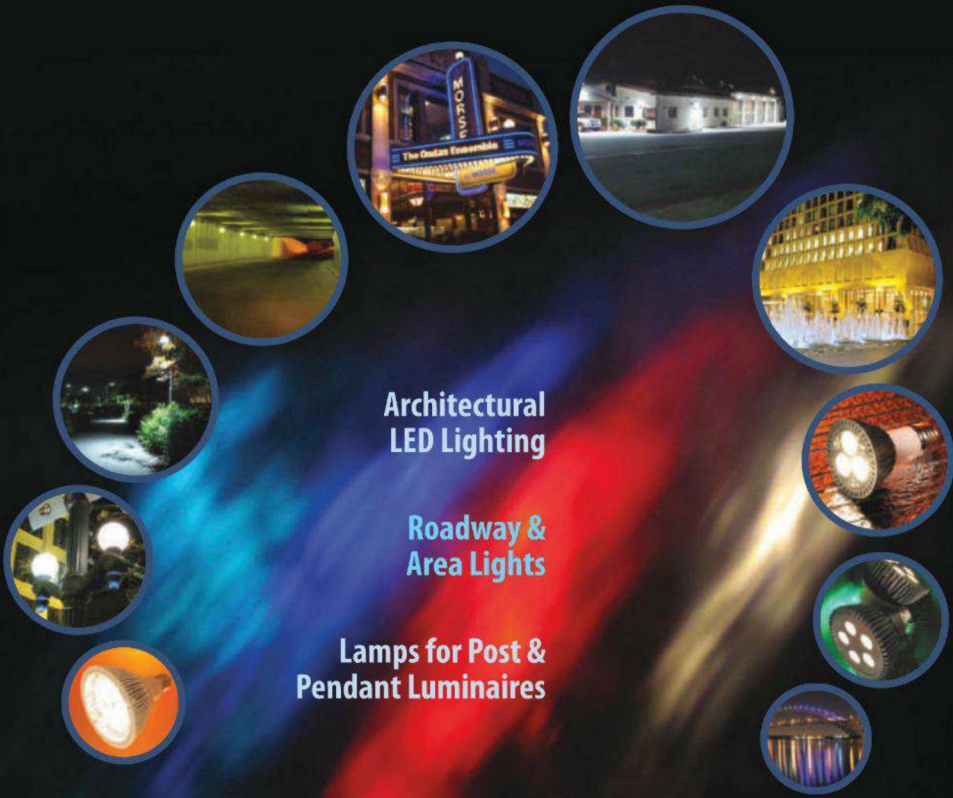
### Compact Floodlights

Bega's new line of compact floodlights offers a wide range of power outputs and beam options and is available for LED, halogen, and HID light sources. The floodlights are ideal for applications such as landscaping, facades, flagpoles, and trees, and feature die-cast aluminum housings and safety glass. A two-piece die-cast aluminum canopy is provided for direct attachment to a standard 4" wiring box or Bega 538 wiring box. The LED units have a color temperature of 4,000K and include an integral 120V-277 electronic LED driver with 0-to-10-volt dimming. The fixture is CSA-certified to U.S. and Canadian standards. [bega-us.com](http://bega-us.com) CIRCLE 217



### Lighting-Control Retrofit

In collaboration with the Empire State Building's property manager, Jones Lang LaSalle, Lutron was selected to provide sustainable lighting-control solutions for prebuilt tenant spaces throughout the New York City landmark. The wireless solution, which includes occupancy/vacancy sensors and daylight dimming controls, allows for an easy retrofit and minimal disruption, and is expected to provide total lighting-energy savings of up to 65% and a payback period of 2.75 years. The Empire State Building is undergoing a building-wide retrofit to improve energy efficiency and financial performance as part of the Clinton Climate Initiative's Building Retrofit program. [lutron.com](http://lutron.com) CIRCLE 218



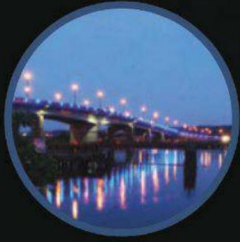
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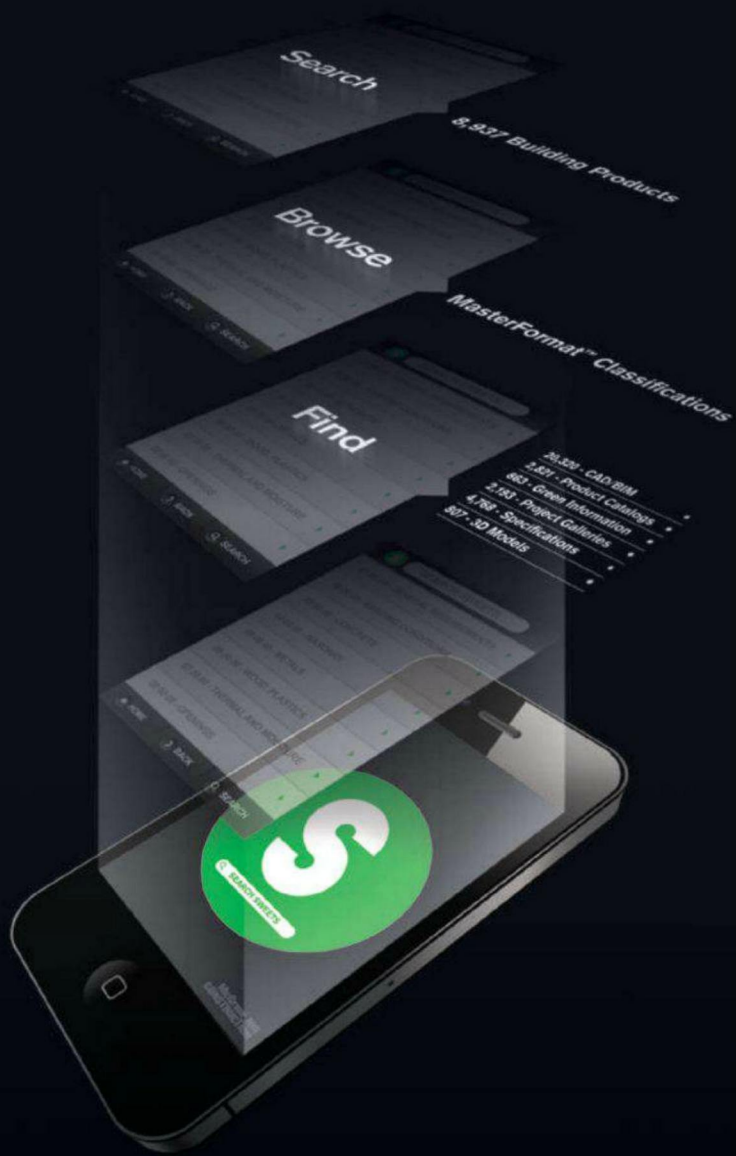
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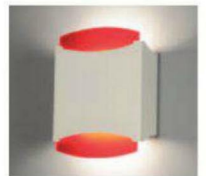
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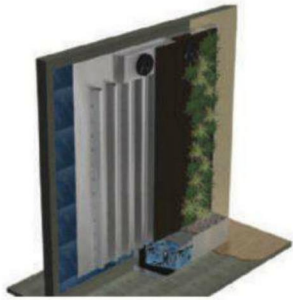
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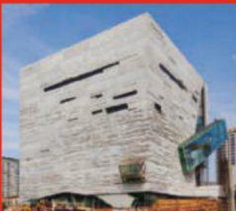
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# Style and Sustainability of Precast Concrete

## New Perot Museum is both aesthetically intriguing and efficient

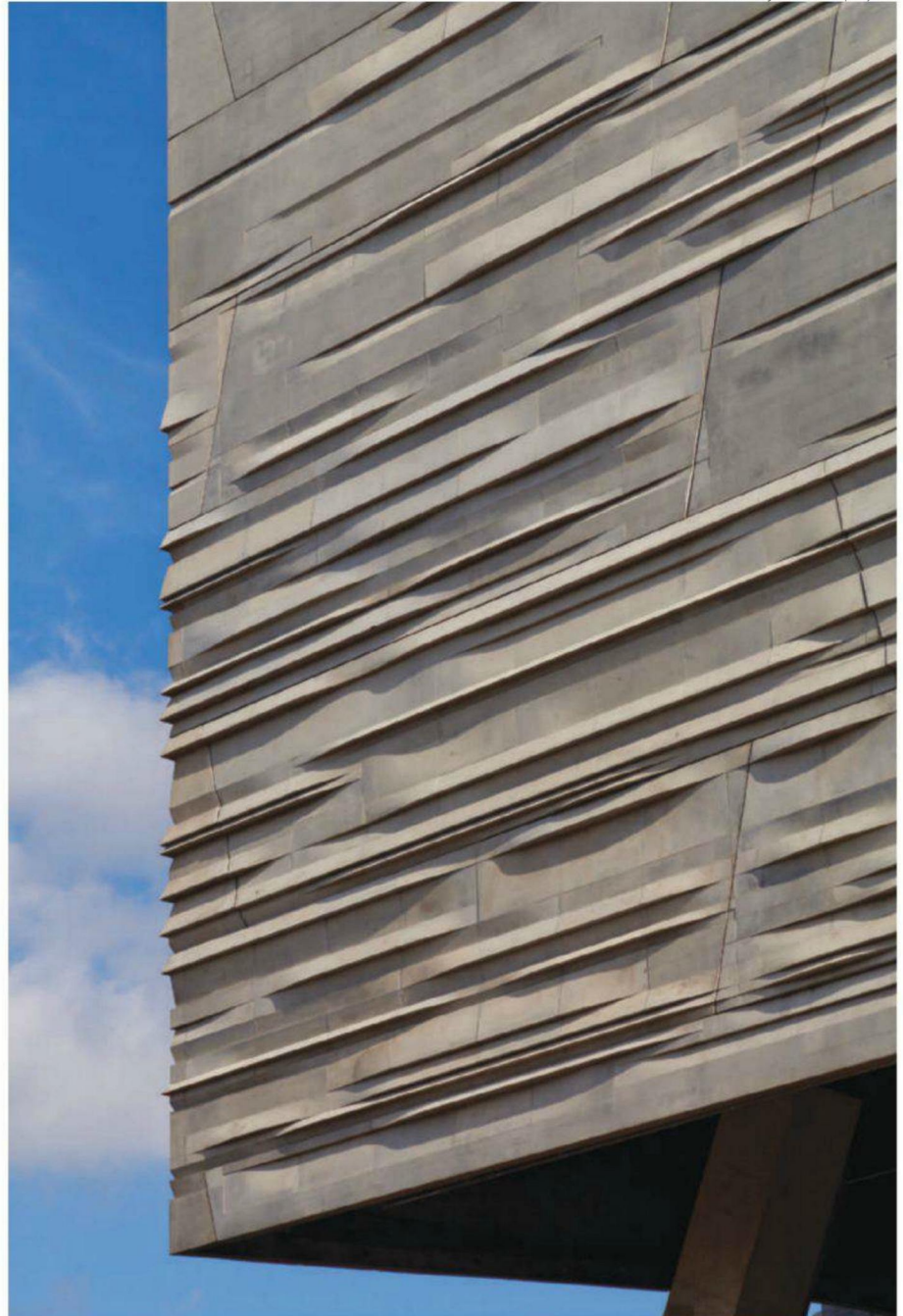
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**P**recast concrete façade cladding systems have been used for significant works of architecture, and a contemporary example is reviewed in this continuing education article. The case study—the Perot Museum of Nature and Science in Dallas—is examined in detail to show how its precast concrete panels can contribute to design excellence, including sustainability, high performance, efficient construction, and advantages for occupant health and safety. Examples of the benefits of precast concrete include durability, low maintenance costs, good life-cycle performance, high thermal mass, acoustical isolation, and resistance to air infiltration and weather.

Choice of cements, aggregates, coloration, and other additives for both performance and aesthetic characteristics is an important part of developing any architectural solution. General guidelines are presented for determining the concrete mix, with attention to the specifications for the new museum.

In many projects utilizing precast, as was the case at the Perot Museum in Dallas, an important attribute of a precast panel mix is to minimize panel or unit weight without

*Photo courtesy of Holcim (US) Inc.*



### CONTINUING EDUCATION



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#### Learning Objectives

After reading this article, you should be able to:

1. Describe the use of precast concrete in terms of building performance, sustainability, and construction benefits.
2. Explain how precast concrete solved numerous design and sustainability considerations for the case study subject, the Perot Museum in Dallas.
3. Discuss the effect of precast concrete on green building certifications and ratings.
4. List the general attributes of cements and concrete mixes, and the selection criteria used for the case study project.

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The precast concrete façade cladding on the new Perot Museum of Nature and Science in Dallas is used to aesthetic advantage by Morphosis Architects, with Pritzker Prize-winning architect Thom Mayne.

Photo courtesy of Holcim (US) Inc.



**Precast concrete façade cladding on the new Perot Museum, affords durability, low maintenance costs, and high thermal mass, among other benefits.**

compromising the durability and sustainability of the cladding. The resulting mix may be compared to ordinary portland cement concrete to determine weight and material savings. This simple consideration will impact the building's green attributes, construction cost, and other variables.

A number of aesthetic benefits are possible with the use of precast concrete façades. Among the visual considerations outlined is the use of integral color throughout the precast slabs. In many typical applications, the use of pigmentation is isolated to an exterior portion and sandwiched against the uncolored grey cement, which typically comprises the interior. Integral color affords some advantages in design expression.

There are other advantages to using precast, according to the architects, engineers, precasters, and concrete manufacturers involved with the Perot Museum project. For example, the opaque concrete shell contributes to a more stable and comfortable indoor environment while also protecting the occupants. It is a fire-resistant enclosure that is also inherently strong and resilient when it comes to hurricanes, tornados, hail and wind-blown projectiles. In general, precast concrete is a good choice for public health, safety, and welfare (HSW) as well as security and life safety, according to PCI, Precast Prestressed Concrete Institute.

Recent developments in concrete technology have improved the material's suitability for green building. Portland cement, a key ingredient in concrete, whether precast or ready mixed, is a significant factor in concrete's environmental footprint. The cement industry as a whole has made significant reductions in emissions over the last three decades. According to the Portland Cement Association (PCA), since the 1970s

the cement industry in the United States has increased its energy efficiency by more than 30 percent, leading to a significant reduction in emissions. In addition, concrete producers routinely use recycled materials, such as fly ash, ground granulated blast-furnace slag, and silica fume or other pozzolans—also known collectively as supplementary cementitious materials, or SCMs—as a component in concrete. This not only may reduce the amount of portland cement in the mix, but can have positive effects on concrete properties.

Although SCMs can be separately added to the concrete mix at the concrete plant, SCMs are

Photo courtesy of Holcim (US) Inc.



**The concrete mixes for the project included up to 51 percent slag in core walls, and 50 percent fly ash in piers, columns, and slabs.**

often used as an ingredient in a *blended cement*. In blended cements, the SCM is proportioned and added at the cement plant prior to delivery to the concrete production facility. In some parts of the world, according to Barry Descheneaux, manager of product support and development for Holcim (US), portland cement may be as little as 25 percent of the type of cement used, while the use of cements containing ground limestone, fly ash or other pozzolans, or blast furnace slag, make up the balance.

In addition, concrete and precast manufacturing have become more efficient. State-of-the-art cement plants reduce emissions of nitrous oxides, and optimized firing processes further minimize emissions of harmful gases. At the precast shops, new production techniques and lean manufacturing processes have made an already sustainable building method even more attractive.

Sustainability was another key project driver for both the architect and the client—the Perot Museum's leadership. The precast cladding system employs fly ash and recycled materials. Its mass and low air-infiltration rates protect the building from the vagaries of sunlight and seasons. Concrete and aggregates tend to be abundant, local materials, according to the Chicago-based Precast/Prestressed Concrete Institute (PCI). Most important, precast concrete panels have a long average service life due to their durable, low-maintenance surfaces, as PCI explains (see sidebar on opposite page).

There were more reasons to use precast concrete for the Perot Museum. To break it down, the building concept, design process, and precast system development and jobsite logistics are detailed in this article. The overview will benefit professionals with limited experience in precast concrete building design and construction administration.

### CREATING AWARENESS OF SCIENCE

In designing the Perot Museum of Nature and Science in Dallas, Pritzker Prize-winning architect Thom Mayne, founding principal of the Culver City, California-based firm Morphosis Architects, sought to “create a facility that inspires awareness of science through an immersive and interactive environment that immediately engages visitors,” as he said when the project was unveiled in 2009 by the Museum of Nature and Science, Dallas. “We rejected the traditional notion of museum architecture as a neutral background for exhibits. Instead, the new building and the surrounding outdoor areas will become an active tool for science education.”

As part of realizing that goal, Mayne chose precast concrete as his primary building

material, which has uniquely allowed him to achieve the style and long-term sustainability he envisioned for the facility.

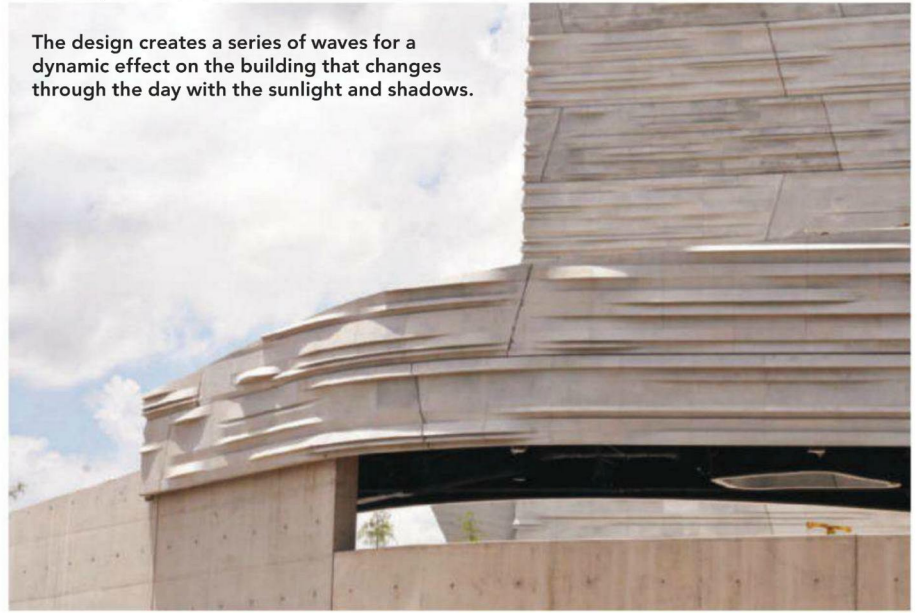
The \$185-million museum, which is expected to open in January 2013, will relocate collections from a facility in nearby Fair Park, a recreational and educational complex that since 2006 has been home to the collections of the Dallas Museum of Natural History, The Science Place, and the Dallas Children's Museum. "It's important for us to be thoughtful about the environmental aspects of the museum," Nicole Small, the museum's CEO, recently told *The Dallas Morning News*. "We are a museum of nature and science. We have to practice what we preach."

With specific environmental goals in mind, the facility was designed by Morphosis with the local architect Good, Fulton & Farrell to include a landscaped roof featuring native flora, a 50,000-gallon rainwater-collection system, and a solar water-heating system. Its construction would also incorporate recycled and locally sourced building materials. Condensation from the building's air-conditioning system will be collected as well, allowing the museum to keep its water bill closer to that of a residence than the typical costs for a 180,000-square-foot public facility.

Still, in conceiving what the Perot Museum has described on its website as "a 'living' example of engineering, sustainability, and technology at work," Mayne, who cofounded Morphosis in 1972, applies the firm's long-held philosophy that the meaning of an

Photo courtesy of Holcim (US) Inc.

The design creates a series of waves for a dynamic effect on the building that changes through the day with the sunlight and shadows.



architectural work can be understood by absorbing the culture for which it was made. With this in mind, the architect eschewed what many would describe as a conventional approach to green design, at least from an aesthetic perspective.

Mayne does not believe that aesthetic uniqueness and building performance have to be mutually exclusive. As he proves with the Perot Museum, a building's design can reflect his vision and that of his client while being

environmentally responsible. There are no rules, as Mayne has illuminated through his work, about what a so-called "green building" should look like, and it's not important that a building announce itself as the result of that intention. Mayne, in other words, prefers to *show* that a building can be visually compelling and environmentally responsible without necessarily having to *tell* people that's the case.

What Mayne and his colleagues came up with for the Perot Museum is a 14-story cube that appears to be suspended over the thoughtfully landscaped grounds that make up the balance of its 4.7-acre site. The building houses 11 permanent exhibition halls and a traveling exhibition space, educational facilities, a theater, museum store, café, and sprawling podium rooftop. The podium roof is designed with landscaping by Dallas-based Talley Associates that blurs the distinction between where the natural environment ends and the building itself begins.

## EVALUATING PRECAST CONCRETE

Precast concrete panels have a long average service life due to their durable, low-maintenance surfaces, according to the Chicago-based Precast/Prestressed Concrete Institute (PCI). That's just one reason—and an important one—that precast was selected for a monumental green building like the Perot Museum of Nature and Science in Dallas. The other reasons to consider precast, says PCI, include:

### ► Fire and natural-disaster resistance.

Precast concrete effectively contains fire within its boundaries and is inherently noncombustible. Concrete also resists wind, hurricanes, projectiles, flooding, and water damage.

### ► Indoor environmental quality (IEQ).

Most concrete has negligible levels of volatile organic compounds (VOCs), and it can be used as a finish surface as well as a structure without coatings or sealants.

### ► Heat-island mitigation.

Typically light colored, reflective precast surfaces help minimize solar heat absorption, reducing the urban heat-island effect.

### ► Abundant, locally sourced materials.

Local, naturally occurring sand and stone comprise about 85% of all concrete. Shipping and transportation energy are typically reduced using precast.

### ► Noise resistance.

Concrete provides good noise reduction performance for better indoor acoustics.

### ► Energy performance and thermal mass.

Concrete enclosures are beneficial for reducing heating and cooling loads in a building, which can allow the downsizing of HVAC systems.

### ► Durability and resilience.

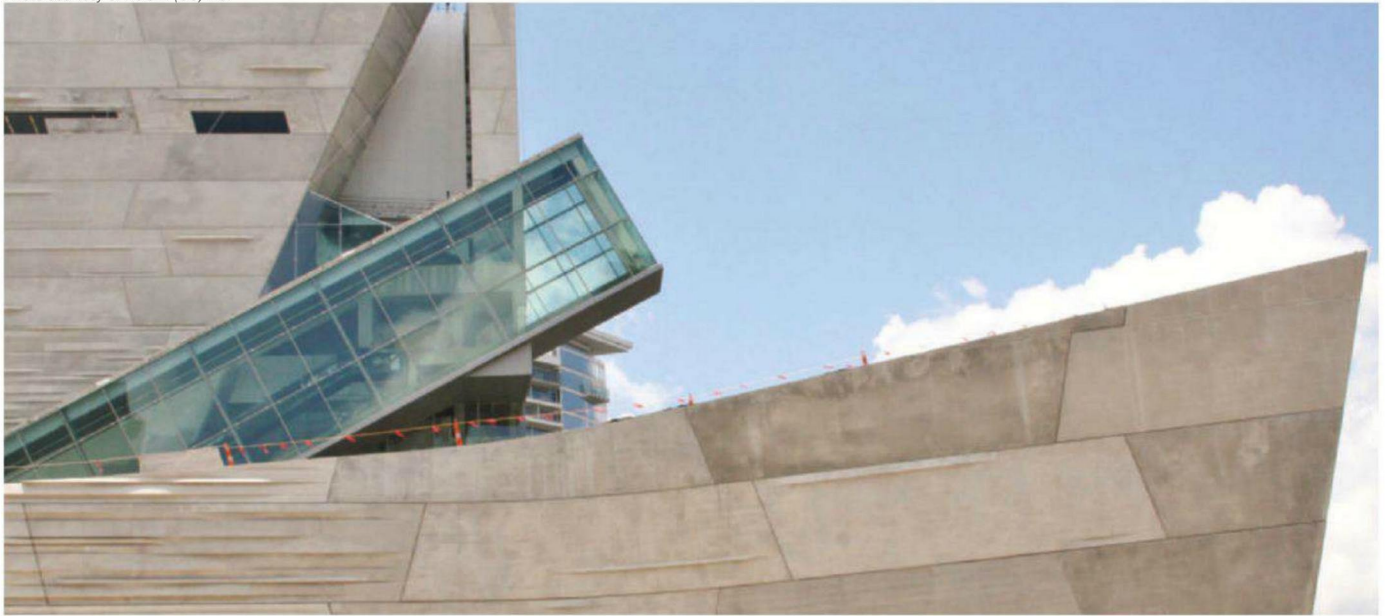
Precast concrete building structures and façade cladding tend to have a very long service life. With little maintenance, precast panels are resilient and durable, often outliving the very buildings they enclose.

## SEEMINGLY KINETIC EXTERIOR

The line between structure and space is audaciously delineated by a 150-foot, glass-enclosed shaft, in which a 54-foot escalator travels at an angle along the building's exterior, opening the museum to its surroundings and inviting those beyond the facility's walls inside. It is a connective feature of which Mayne is particularly proud.

The aesthetically punctuating escalator shaft draws attention to the building's seemingly kinetic concrete exterior. The design intent, according to museum officials, was to "create a series of waves that gives a dynamic effect on the building that changes minute-to-minute through

Photo courtesy of Holcim (US) Inc.



The line between structure and space is audaciously delineated by a 150-foot, glass-enclosed shaft, in which a 54-foot escalator travels at an angle along the building's exterior—a signature feature by the architect Thom Mayne.

the day with the sunlight and shadows.” The texturing is denser at the bottom of the cube and slowly fades away as the cladding moves upwards. According to the museum, “This pattern was done intentionally to create a perception that the building dissolves into the sky.”

The museum's exterior is made up of more than 650 precast concrete panels that were fabricated in Hillsboro, Texas, by the Gate Precast Company, a large precast provider with headquarters in Jacksonville, Florida. The panels make up a number of elements, including the vertical portions of the site's large plinth, the 14-story cubelike tower, and the exterior of the building's memorable atrium.

The construction of the building enclosure was no simple feat; it was the result of what Christopher Wolfe, of the project's general contractor, Balfour Beatty Construction, told *Engineering News-Record* was “the most difficult and challenging precast job I've ever seen.” The design of the concrete panels—which average about 8 feet by 30 feet in size with thicknesses of up to 9-1/2 inches—resulted in weights of as much as 8 tons each. The panel profiles are intricate and carefully organized to achieve Mayne's design effect; this demanded close coordination among the architect, engineers, the general contractor, the concrete supplier, and Gate Precast's craftsmen, who brought that aspect of the project to fruition.

The resulting building façades, which play with available light and shadows, resemble a massive, completed puzzle whose pieces are as distinct from one another as they are equal parts of a larger composition. To achieve the undulating effect Mayne wanted the building exterior to have, the panels had to be uniform in color and composition but different, to varying degrees, in their non-pigmented, striated outer texture.

Gate Precast was able to achieve all the specifications and design intent. After the project was complete, the company was lauded for its work by PCI, earning the institute's design award in the “Best Government and Public Buildings” category as well as a Sidney Freedman Craftsmanship Award, which recognizes “excellence in manufacturing” of precast building components.

Mayne's use of precast concrete also allows the Perot Museum to present a building that is as much a part of the natural landscape as a complementary element of it. The building's design has a sense of movement, lending the museum a part of its desired *living* quality—if not evoking a sense of time passing. That is, the Perot Museum is less an interruption of the natural, surrounding landscape and more a continuance and development of it, with its planted surfaces and water collection.

Likewise, the museum's mission to educate and inform younger generations about the

natural world and their place within it is actually served by the structure itself. Mayne's design presents a number of valuable lessons from the building's aesthetic design to its efficiency-focused construction—a lesson in savings that begins with its precast concrete visage.

#### FROM DESIGN TO CONSTRUCTION

To benefit the project's coordination and schedule, the concrete subcontractor Gate Precast was called in early to assist with design development and advise on construction approaches. Building information modeling (BIM) would be beneficial to ensuring a faster and more accurate fabrication phase, by using the BIM model for mold shaping and speeding the coordination of panel design and installation.

In *Engineering News-Record*, Gate Precast's president Dean Gwin said, “We couldn't have done this job without BIM,” with all the related trades “sharing in the 3D modeling.” For its part, the consulting engineer Buro Happold used BIM to simulate engineering elements, integrate design elements, analyze costs, and detect clashes. For the façade work, Gate Precast modeled more than 100,000 square feet of precast cladding in total, which was integrated into the structure's final 3D model.

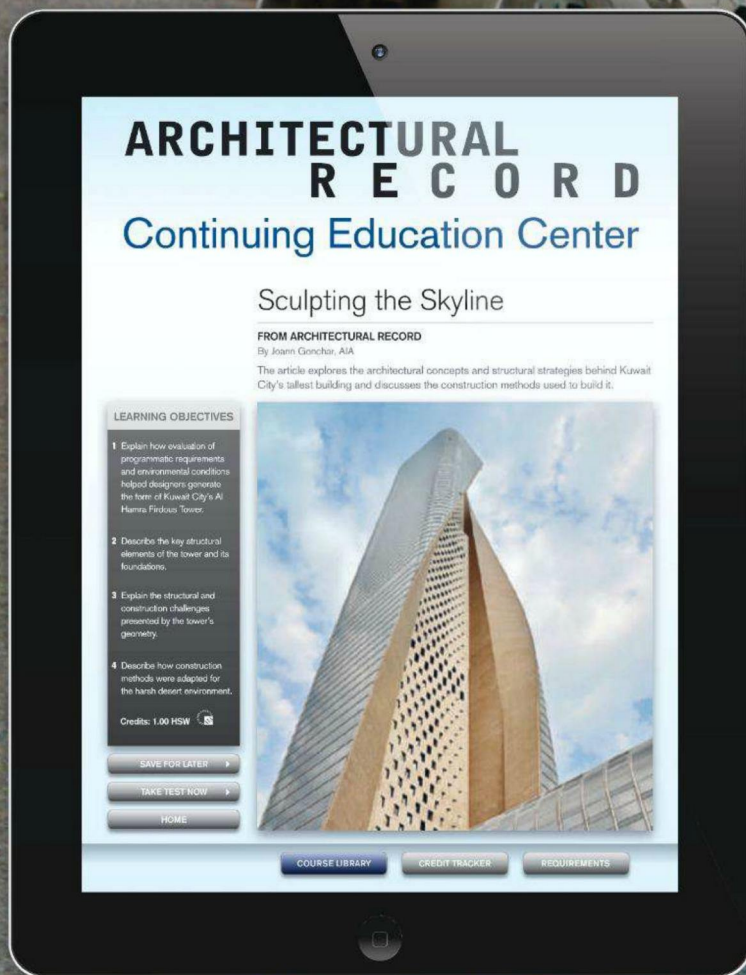
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CEILING & RAIL SYSTEMS

# Replacing the Fluorescent Lamp with Linear LED Luminaires

The drive for energy efficiency and new componentry delivers viable LED solutions

Sponsored by Selux | *By James Brigagliano, LC, IESNA*

**D**esign professionals are well aware that in the hierarchy of energy-efficient lighting, LED (light-emitting diode) systems are superior to compact fluorescent systems and are far superior to the incandescent lamp. They also know that LED technology will go a long way to help counteract our expanding carbon footprint. But they may not know that within the last year, many new linear LED luminaires have come on the market that now represent a viable alternative to the traditional linear fluorescent fixture.

According to the U.S. Department of Energy (DOE), which has adopted a comprehensive strategy to accelerate the LED market, LED lighting is expected to represent 36 percent of luminaire sales for the general illumination market by 2020, which translates into energy savings of 19 percent. The replacement of traditional fluorescent lighting with linear LED luminaires (the complete lighting unit rather than the lamp alone) will significantly contribute to those reductions.

## THE FLUORESCENT LAMP

Since it appeared on the market in the late 1930s and spread rapidly during World War II as wartime manufacturing demanded better lighting, the fluorescent lamp has been the mainstay of commercial and industrial lighting. Both T12 and T8 lamps remain common in existing buildings, but due to recent federal efficiency standards, almost all new commercial construction uses T8 or T5 linear fluorescent lamps.

The light produced by a fluorescent tube is caused by an electric current conducted through mercury and inert gases. This allows the phosphor coating on the glass tube to emit light. Fluorescent lamps require a ballast to regulate operating current and provide a high start-up voltage. Electronic ballasts outperform electromagnetic ballasts by operating at a very high frequency that eliminates flicker and noise. Electronic ballasts also are more energy-efficient. Special ballasts are needed to allow dimming of fluorescent lamps. Improvements in technology have resulted in fluorescent lamps with color temperature and color rendition that are comparable to incandescent lamps.



Linear LED luminaires light Marquez Hall, the new state-of-the-art teaching and research facility at the Colorado School of Mines, Golden, Colorado.

*Photo by Kenneth Wiese, courtesy of Selux*



## GLOSSARY AND LIGHTING METRICS

**CCT (correlated color temperature):** a measure of the color appearance of a white light source. CCT is measured on the Kelvin absolute temperature scale (K). White lighting products are most commonly available from 2,700K (warm white) to 5,000K (cool white). Cool light is preferred for visual tasks because it produces higher contrast than warm light. Warm light is preferred for living spaces because it is more flattering to skin tones and clothing. A color temperature of 2,700–3,600K is generally recommended for most indoor general and task lighting applications.

**CRI (color rendering index):** a measure of how a light source renders colors of objects, compared to a “perfect” reference light source. Color rendition is generally considered to be a more important lighting quality than color temperature. Most objects are not a single color, but a combination of many colors. Light sources that are deficient in certain colors may change the apparent color of an object. The Color Rendering Index (CRI) is a 1–100 scale that measures a light source’s ability to render colors the same way sunlight does. The top value of the CRI scale (100) is based on illumination by a 100-watt incandescent light bulb.

**Electroluminescence:** Light is generated directly when electrons recombine with holes, in the process of emitting photons.

**LED:** light-emitting diode. LEDs are small light sources that become illuminated by the movement of electrons through a semiconductor material. LEDs can be integrated into light fixtures to provide white and colored light.

**LED light engine:** comprises the driver (powers and regulates the power supply and other electronics), LEDs, optics, and heat sink/mounting.

**Life performance curve:** a curve that presents the variation of a particular characteristic of a

light source (such as luminous flux, intensity, etc.) throughout the life of the source. Also called lumen maintenance curve.

**Lumen:** The International System of Units (SI) unit of luminous flux is a measurement of light. The total amount of light emitted by a light source, without regard to directionality, is given in lumens (lm). As reference, a 100-watt incandescent lamp emits about 1,600 lumens.

**Lumen depreciation:** the decrease in lumen output that occurs as a lamp is operated. LED useful life is typically based on the number of operating hours until the LED is emitting 70 percent of its initial light output (L70).

**Lumen maintenance:** the percentage of initial light output produced by a light source at some percentage of rated useful life.

**Luminaire:** the complete lighting unit (LED light engine and housing) ready to plug in.

**Luminous efficacy:** or efficacy of energy consumption is the total luminous flux emitted by the light source divided by the lamp wattage; expressed in lumens per watt (lm/W). DOE long-term research and development goals calls for white-light LEDs producing 160 lumens per watt in cost-effective, market-ready systems by 2025. If a luminaire efficacy value is not included in a manufacturer’s data sheet, it may be calculated by dividing the product’s total light output (lumens) by the input power (watts) from the same photometric test. The result is the product’s efficacy in lm/W.

**Efficiency vs. efficacy:** The term “efficacy” is normally used where the input and output units differ (lumens and watts). The term “efficiency” usually is dimensionless. For example, lighting fixture efficiency is the ratio of the total lumens exiting the fixture to the total lumens produced by the light source.

**SSL:** solid-state lighting; umbrella term for semiconductors used to convert electricity into light.

Fluorescent lamps use about 25 percent of the energy used by incandescent lamps to provide the same amount of illumination (efficacy of 30–110 lumens per watt). They also last about 10 times longer (7,000–24,000 hours). Lower energy costs typically offset the higher initial cost of the lamp that requires the additional cost of a ballast. Because they contain mercury, many

fluorescent lamps are classified as hazardous waste. The United States Environmental Protection Agency recommends that fluorescent lamps are segregated from general waste for recycling or safe disposal.

There are two general types of fluorescent lamps: compact fluorescent lamps (CFLs) and fluorescent tubes.

### CFLs

CFLs combine the energy efficiency of fluorescent lighting with the convenience and popularity of the incandescent lamp shape. They can replace incandescent lamps that are roughly 3–4 times their wattage, saving up to 75 percent of the initial lighting energy. Although CFLs cost 3–10 times more than comparable incandescent lamps, they last about 10 times as long (10,000 hours).

### Fluorescent Tubes

More energy efficient than CFLs, fluorescent tube lamps—the second most popular type of lamp—are usually identified as T12 or T8 (12/8 or 8/8 of an inch tube diameter, respectively). They are installed in a dedicated fixture with a built-in ballast. The two most common types are 40-watt, 4-foot lamps, and 75-watt, 8-foot lamps. Tubular fluorescent fixtures and lamps are preferred for ambient lighting in large indoor areas because their low brightness creates less direct glare than incandescent lamps.

**Fluorescent tube construction.** A fluorescent lamp tube is filled with a gas containing low-pressure mercury vapor and argon, xenon, neon, or krypton. The inner surface of the lamp is coated with a fluorescent (and often slightly phosphorescent) coating made of varying blends of metallic and rare-earth phosphor salts. The lamp’s electrodes are typically made of coiled tungsten and usually referred to as cathodes because of their prime function of emitting electrons. For this, they are coated with a mixture of barium, strontium

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### Learning Objectives

After reading this article, you should be able to:

1. Discuss the performance, energy efficiency, and life-cycle characteristics of LED lighting systems.
2. Identify the reasons why LED systems require new testing procedures.
3. Summarize the sustainability programs and LED developments that are accelerating the introduction of new luminaire products.
4. Compare efficacy and other performance features of linear LED luminaires with linear fluorescent luminaires.

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Photo courtesy of Hyexposure Photography



Linear LED luminaires provide soft lighting for Boston University Rich Hall residence in Boston, Massachusetts.

and calcium oxides chosen to have a low thermionic emission temperature.

#### LED TECHNOLOGY

Unlike incandescent and fluorescent lamps, LEDs are not inherently white light sources. Instead, LED is a semiconductor light source. When a light-emitting diode is switched on, electrons are able to recombine with electron holes within the device, releasing energy in the form of photons. This effect is called electroluminescence and the color of the light (corresponding to the energy of the photon) is determined by the energy gap of the semiconductor. An LED is often small in area (less than 1 square millimeter), and integrated optical components may be used to shape its radiation pattern.

LEDs emit nearly monochromatic light, making them highly efficient for colored light applications such as traffic lights and signage. However, to be used as a general light source, white light is needed.

White light can be achieved with LEDs in two main ways: phosphor conversion, in which a phosphor is used on or near the LED to emit white light; and RGB (red, green, and blue) systems, in which light from multiple monochromatic LEDs (red, green, and blue) are mixed, resulting in white light.

#### Directional Light

One of the defining features of LEDs is that they emit light in a specific direction. Since directional lighting reduces the need for

reflectors and diffusers that can trap light, well-designed LED fixtures can deliver light efficiently to the intended location. In contrast, fluorescent and “bulb”-shaped incandescent lamps emit light in all directions where much of the light produced is lost within the fixture, reabsorbed by the lamp, or escapes from the fixture in a direction that is not useful. For many fixture types, including recessed downlights, troffers, and undercabinet fixtures, it is not uncommon for 40 to 50 percent of the total light output of fluorescent and incandescent lamps to be lost before it exits the fixture.

#### Extended Lifetime

The rated lifetime of LED products is at least comparable to other high-efficacy lighting products, if not better, and for many specific product types, LEDs have the highest rated lifetime. This attribute can be especially important where access is difficult or where maintenance costs are high. In fact, several U.S. Department of Energy GATEWAY demonstrations have revealed that maintenance savings, as opposed to energy savings, are the primary factor in determining the payback period for an LED product.

#### LED MARKET

A perfect storm of state and federal government attention to energy-saving LEDs plus industry investment in LED technology is delivering an abundance of products that

enter the market about every four to six months. ANSI/ASHRAE 90.1-2010, Title 24 2010 California Building Standards & Codes, LEED® requirements and the DOE are all shaping the LED market. ANSI/ASHRAE 90.1-2010 is pushing increasingly strict energy code models with goals to have market-viable net-zero buildings by 2030.

Lighting programs such as ENERGY STAR, a joint program of the U.S. Environmental Protection Agency and the DOE, and DesignLights™ Consortium, a collaboration of utility companies and regional energy efficiency organizations, are offering rebate programs. Also related is the DOE's LED Lighting Facts® program which showcases LED products performance by reviewing third-party testing and supplying an approved label indicating performance. Commercially available LED Product Evaluation and Reporting (CALiPER) program, provided by the DOE, is a useful resource that shares case studies and extensive testing results.

But the quality and energy efficiency of LED products still varies widely as LED technology continues to evolve and luminaire manufacturers negotiate the learning curve of integrating LEDs into their products. To keep up to date with LED technology developments, design professionals are urged to track the many organizations supporting LED technology.

#### Successful LED Applications

Some LED products have performed well. These include a wide range of replacement lamps, as well as integrated light fixtures, such as portable desk/task lights, under-cabinet lights, recessed can downlights, track heads, and outdoor fixtures for street and area lighting.

**Recessed LED downlights.** One of the earliest applications of solid-state lighting for general illumination, LED recessed can downlights are now widely available in a range of sizes and lumen packages, offering a viable alternative to incandescent and compact fluorescent (CFL) products. As the technology has advanced, LED downlights have in many cases become superior to conventional downlights in terms of energy efficiency. This has led to the increasing choice of LED lamps and LED downlight retrofit units as replacements for omnidirectional lamps.

As of May 2012, more than 350 recessed LED downlight products were ENERGY STAR qualified, and more than 590 LED downlights were listed by LED LightingFacts, the majority of which exceeded the minimum 42 lm/W luminous efficacy required for ENERGY STAR qualification.

**Under-cabinet lighting.** Increasingly specified by design professionals, low-profile, energy-efficient, long-lasting, under-cabinet LED fixtures offer new possibilities for creating specific lighting effects and providing pure light to kitchen work areas.

**Solar landscape/marker lights.** With long-lasting LED lamps (up to 10 times longer than MR16 lamps) and zero running expenses, solar landscape/marker lights are becoming the choice of convenience for supporters of green technology.

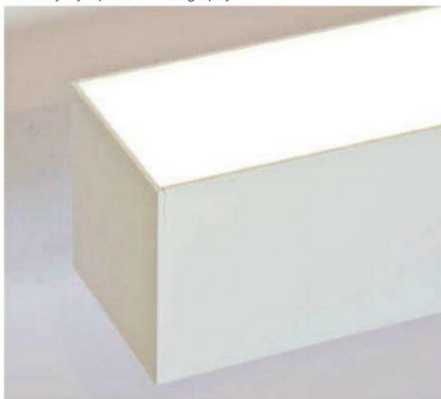
**RGB color-changing applications.** With the growing availability of digital controllers, RGB color-changing and dimming LED technology is used in a wide range of applications from ballrooms and luxury apartments to bridges and restaurants.

### LED Luminaire Construction

An LED luminaire, or integrated LED package, starts with a tiny chip (most commonly about one square millimeter) comprised of layers of semi-conducting material. LED packages may contain just one chip or multiple chips. The package is mounted on heat-conducting material called a “heat sink” and is usually enclosed in a lens. LED luminaires require a heat sink because LEDs do not emit heat as infrared radiation; the heat must be removed from the device by conduction or convection or “heat sinking.” Without adequate heat sinking or ventilation, the device temperature will rise, resulting in lower light output. Because LEDs are sensitive to thermal and electrical conditions, they must be carefully integrated into lighting products. In fact, thermal management is arguably the most important aspect of successful LED system design.

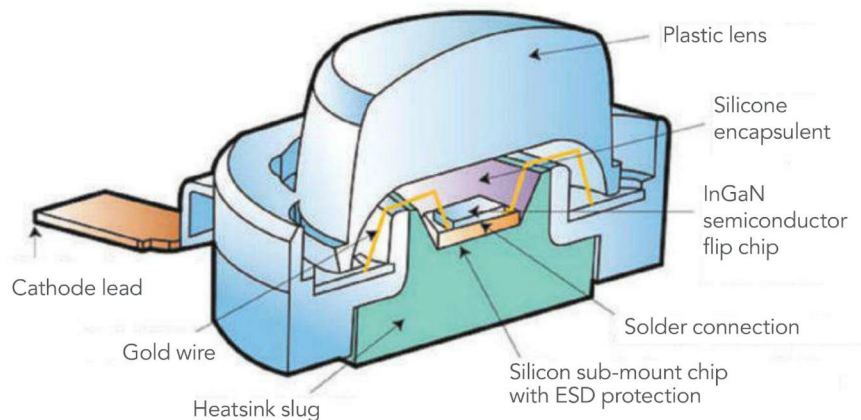
The resulting device, typically around 7 to 9 mm on a side, can be used separately or in arrays. LED devices are mounted on a circuit

*Photo by Hyexposure Photography*



**Example of uniform lens brightness from edge to edge in an LED luminaire**

*Source: www.otherworldlight.com/resources.asp*



**Components of a typical light-emitting diode (LED)**

board, which can be programmed to include lighting controls such as dimming, light sensing, and pre-set timing. The circuit board is mounted on another heat sink to manage the heat from all the LEDs in the array. The system is then encased in a lighting fixture or architectural structure and is termed a “luminaire.”

**New developments.** Without new components, materials and design updates, new performance levels of LEDs could not be realized.

The use of low-copper aluminum extrusions, castings with stainless steel hardware, and quality powder coat finishes are allowing luminaires to maintain their appearance at L70 (70 percent of its initial light output) and beyond. Captive screws, replaceable LED light engines, age-resistant gasket systems, and tool-less access are critical, while potential issues such as galvanic corrosion, lens yellowing, and expansion/contraction are being addressed during product design. LED drivers should have life-hour values similar to the LEDs they power.

Leading luminaire manufacturers use only reliable LEDs with LM-80 test data (see sidebar “Test Method Quick Reference” in the online version of this article) and pay special attention to maintaining the proper junction temperature of the LED. One manufacturer designs for a balance of power, heat sinking, and possible ambient temperatures by using a heat chamber for testing luminaires at elevated temperatures of 50°C or more.

Optics is an area where manufacturers can vary greatly. Some manufacturers invest in optics with maximum efficiency while others trade off some efficiency for increased visual comfort. One manufacturer has each of its LED luminaires undergo an extensive visual performance critique process arguing that

visual comfort can improve your ability to see well.

The end result of minimal glare is achieved through critical viewing angles and, in some cases, an LED source that is completely unseen. LEDs have allowed manufacturers to achieve uniform lens luminance and color for linear luminaires never possible with similar fluorescent systems.

Manufacturers have updated their light engines so that new generations are providing a confident 36,000- to 60,000-hour life with minimal lumen depreciation based on TM-21 calculation results. (See TM-21 explanation in sidebar “Test Method Quick Reference” online.) Good LED light engine designs can be easily interchanged via plug-in terminal connectors. They are also delivering CRIs of 80+ and standard color temperatures of 3,000K, 3,500K, and 4,000K. One winner of The Next Generation Luminaires™ (NGL) Solid-State Lighting (SSL) Design Indoor Competition was commended on its product’s “continuous lines of light, which provide superior performance, excellent luminance uniformity, and flexibility,” and on the integral driver “available in different housings, with multiple mounting and dimming options.”

### LED Life-Cycle Assessment

Studies by the DOE updated in August 2012, found that the negative environmental impacts of LED lamps at present are less than those for incandescent lighting products, but by 2017 they will be significantly less than for all other lighting products.

Part 2 Life-Cycle Assessment of Energy and Environmental Impacts of LED Lighting<sup>1</sup> examined five life-cycle stages: raw materials, manufacturing, transportation to point of sale, energy-in-use of the product, and end-of-life/disposal/recycling. It also examined the manufacturing process for a white-light

Photo by Steven Vaughan Photography, Dallas



Continuous-run linear LED luminaires were specified in custom lengths for the Chapwood Capital Investments office in Dallas, Texas.

LED product to understand the impacts of the manufacturing process. It then compared the manufacturing process with that of other lighting products.

The study found that energy-in-use is the dominant negative environmental impact, and that LEDs and CFLs are similar in energy consumption. But by 2017, the prospective negative environmental impacts of the improved LED lamp will be significantly less than incandescent, about 70 percent lower than CFLs, and approximately 50 percent lower than current 2012 LED solutions. The spider web charts spell out 15 environmental impacts in four sectors.

### Testing Standards

The use of LEDs as a general light source has forced changes in test procedures used to measure lighting performance.

Traditional photometry methods use a “relative photometry method,” where lighting energy efficiency was developed separately for lamp ratings and for fixture efficiency. A lamp rating indicates how much light (in lumens) the lamp will produce. A fixture efficiency, which is an appropriate measure for fixtures that have interchangeable lamps, indicates the proportion of rated lamp lumens actually emitted by the fixture.

In contrast, LEDs have a complex relationship between the LED light sources and the luminaire components, where manufacturers design LEDs as a unit. The performance of each unit is unique and is a function of the design and the manner in which the LEDs are integrated into the package or luminaire. LED luminaires, therefore, cannot be compared to other lighting systems,

which separate lamp performance and fixture performance.

The efficiency of an omnidirectional fluorescent luminaire, for example, is measured according to relative photometry methods, i.e., lumens emitted by the lamp plus the performance of the fixture in directing “usable” light. Its efficiency is greatly limited by the fixture components (e.g., lenses, reflectors, or louvers), orientation of the lamp, and size of the fixture. But in the case of directional LED linear luminaires, where all the light is emitted in the intended direction, performance is improved because of less wasted light.

In order to evaluate LED products, the Illuminating Engineering Society of North America (IES) published LM-79-08, *Approved Method for the Electrical and Photometric Measurements of Solid-State Lighting Products*. LM-79 is a product testing method based on absolute photometry, which characterizes a luminaire as a whole and acknowledges its unique

Photo by Hxposure Photography



Evenly spaced LEDs contribute to a uniform appearance.

thermal, optical, and electrical properties (see sidebar “Test Method Quick Reference” online). Its performance data provides a means for design professionals to evaluate different LED luminaires.

Of more interest to manufacturers, IES LM-80-08: IES, *Approved Method for Measuring Lumen Maintenance of LED Light Sources*, describes the measurement of lumen maintenance—the amount of light output maintained over time—for LED packages used in luminaires.

### Theoretical Limits of LED Technology

In regard to luminous efficacy (lumens produced per watts consumed), current proven performance in labs has delivered over 280 lm/W. Researchers have indicated a theoretical limit for white LEDs to be somewhere around 300 lm/W at the device level. LED devices with an efficacy of 300 lm/W will result in luminaires with the potential to deliver 240 lm/W or more, by far the most efficacious practical light source available for general lighting. This potential is certainly exciting and has developers of LEDs racing to reach this limit with major advances about every year.

### LINEAR LED LUMINAIRES VERSUS LINEAR FLUORESCENT LUMINAIRES

While there has been considerable DOE-driven literature on LED replacement lamps for CFL and linear fluorescent fixtures, there has been relatively little addressing linear LED luminaires as replacements for linear fluorescent lighting. However, the IES LM-79-08 photometric reports and manufacturer data sheets of the many newly introduced LED luminaires should provide design professionals with a helpful basis for evaluating products.

### Length of Life

Unlike other light sources, LEDs usually don’t “burn out”—instead, they get progressively dimmer over time (a process called lumen depreciation primarily caused by heat generated at the LED junction). LED useful life is typically based on the number of operating hours until the LED is emitting 70 percent of its initial light output (L70). Good-quality white LEDs in well-designed fixtures are expected to have a useful life of over 60,000 hours. High-quality linear fluorescent tubes (T8 and T5) using rare earth phosphors will lose only about 5 percent of initial lumens at 20,000 hours of operation. The life of a typical linear fluorescent tube ranges from 7,000 to 24,000 hours while the best linear fluorescent lamps can last more than 30,000 hours depending on the type of ballast used and amount of on/off cycles.

See endnote in the online version of this article.

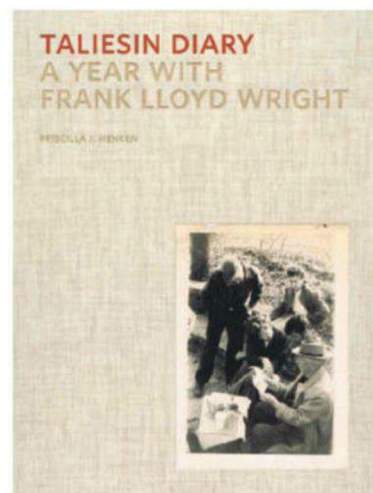
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# Taliesin Diary: A Year with Frank Lloyd Wright

Priscilla J. Henken (Author), Sarah Leavitt (Editor)



Photographs by David Henken

In 1942, New Yorker Priscilla Henken kept a diary to document her year in Wisconsin as part of the Taliesin Fellowship. Published for the first time and illustrated with photographs, *Taliesin Diary* is a lively description of day-to-day life on the communal working farm of one of America's most important architects, Frank Lloyd Wright. The diary is supplemented by annotations and contextual essays written by National Building Museum staff.

Purchase this book, co-published with W. W. Norton, now at the National Building Museum Shop or online at [go.nbm.org/Taliesin](http://go.nbm.org/Taliesin). Your Museum Shop purchases support the National Building Museum's exhibitions and programs.

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- CAD/BIM •
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Photo by K. K. Law



The University of British Columbia Earth Sciences Building is a five-story wood structure that uses CLT, glulam, and LSL. Architect: Perkins+Will Canada Architects Co.

# Mass Timber and Wood Framing

New and traditional approaches reduce cost and meet code for mid-rise construction

Sponsored by naturally:wood

**M**id-rise construction is becoming increasingly popular as a means of boosting densification, containing urban sprawl, and respecting infrastructure limits while maintaining neighborhood charm and community appeal. Multi-family construction in particular has grown, increasing 46 percent between 2009 and 2011. This year, the sector is expected to continue to advance, rising 23 percent over 2011.<sup>1</sup>

Wood has a key role to play in mid-rise construction. It has proven to be more affordable than concrete or steel, and has a lower environmental footprint than either material. Architects for Stadhaus, a nine-story wood apartment building in England, found that compared to concrete, a wood building offered cost savings of more than 15 percent,<sup>2</sup> and that 186 tons of carbon were sequestered within its structure.<sup>3</sup>

Codes now allow wood as a structural material in five- and six-story wood-frame structures, in most U.S. states and throughout Canada. Traditional wood-frame construction

is a proven solution for current mid-rise structures up to six stories, and mass timber is a possible solution for even taller buildings. Both are being used to achieve durable, code-compliant, economical mid-rise developments that add vibrancy at a human scale.

This article will provide a high-level comparative overview of the systems themselves. Wood-frame construction systems including balloon, platform, and semi-balloon framing will be discussed as will mass timber solutions including cross-laminated timber (CLT), glue-laminated timber (glulam), and laminated strand lumber (LSL). Case studies will showcase how architects are using these systems to full advantage either through code-compliant situations for additional stories or by turning to alternative solutions—methods of construction that are not included in the building code per se, but can be used to meet the intent of code—to build taller, smarter, and more efficiently with wood.

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### Learning Objectives

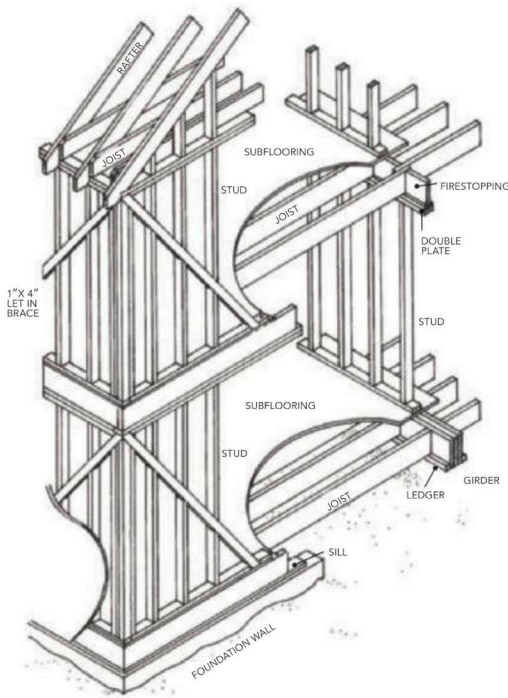
After reading this article, you should be able to:

1. Discuss the ways in which wood contributes as a structural building material in mid-rise construction.
2. Distinguish between platform, balloon, and semi-balloon framing.
3. Explain the potential of modern mass timber systems.
4. Cite examples of various approaches to wood-frame mid-rise construction.

To receive AIA/CES credit, you are required to read the entire article and pass the test. Go to [ce.architecturalrecord.com](http://ce.architecturalrecord.com) for complete text and to take the test for free.

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Image courtesy of American Wood Council



Platform framing uses shorter lengths of lumber for the studs, generally 2x4s spaced 16 inches on center.

### TRADITIONAL WOOD-FRAME CONSTRUCTION

For centuries in North America, the dominant method of building homes and low-rise apartments has been wood frame construction, which has shown strength, longevity, and stability. Mid-rise light wood-frame structures are widely considered to be cost effective, due to relatively low material costs, reduced construction time, availability of resources and labor.<sup>4</sup> The development of prefabricated component systems increases the strength and affordability of wood frame construction. Also, when built according to building codes and industry standards, wood-frame structures can provide hurricane and seismic resistance.

Wood-frame construction entails the use of wood-framing members, typically dimensional lumber, I-joists, or prefabricated wood trusses, spaced relatively close, and used with sheathing or decking to create a structure that can withstand loads. Modern wood framing essentially includes three types: balloon, platform and semi-balloon framing.

### Balloon Framing

With long lumber lengths, vertical load-bearing framing studs run continuously from foun-

ation to roof. Intermediate horizontal floor joists are nailed to the sides of the vertical studs and bear on a ledger. The ledger is notched into the stud. Typically this system is more common in two-story buildings due to the stud length availability. However, a variation of this method could be used in increments of two stories. The advantage to this is that it would eliminate the shrinkage that may occur from the floor joists.

### Platform Framing

Over time, platform framing replaced balloon framing as the dominant framing method. Platform framing uses shorter lengths of lumber for the studs, generally 2x4s spaced 16 inches on center. The walls are typically framed with a sill or sole plate, studs and two top plates, then floor joists bear on the top plates. Platform framing does not require hangers, while semi-balloon framing does as described below.

At each story, joists are covered by subflooring providing a platform, or work surface, on which walls and partitions are easily erected. The benefits of platform framing include the fact that walls can be constructed on the ground and less effort is involved in lifting them into place than in balloon framing. Notching of the stud is not required, and after one story is constructed, the framers can utilize it to construct the next story. Platform framing also accommodates various prefabricated methods.

### Semi-Balloon Framing

Semi-balloon framing is a cross between balloon framing and platform framing. Where balloon framing has a continuous stud from foundation to roof, semi-balloon framing does not. Balloon framing does not require hangers, whereas semi-balloon framing does.

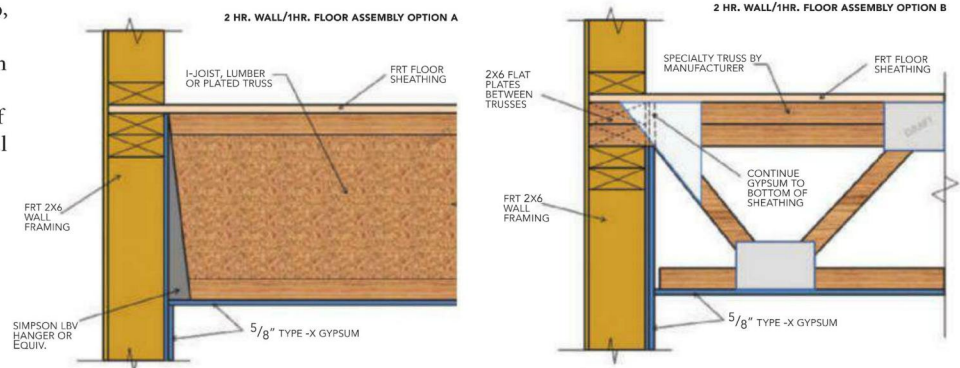
While platform framing is more dominant overall, modern semi-balloon framing, in which the floor joist hangs from the double

top plates, is more common in buildings that are five stories and up, and is ideally suited to certain circumstances. According to Michelle Kam-Biron, P.E., S.E., senior technical director, lead for mid-rise construction for WoodWorks, "In the U.S., where most states follow the International Building Code, semi-balloon framing is often used as an alternative to platform framing in structures where fire requirements or shrinkage may be a challenge." Type III construction requires non-combustible exterior walls but there is an exception in the code that allows for fire-retardant treated wood (FRTW). "Designers will sometimes utilize semi-balloon construction, hanging the joist off the top plates and eliminating the penetration of the exterior wall building envelope," Kam-Biron says.

### MASS TIMBER PRODUCTS AND SYSTEMS

Advancements in wood technology, systems and products, together with performance-based building codes have fueled interest in building with mass timber in mid-rise construction and even taller buildings. Engineered wood products offer the architectural community alternate materials and systems with comparable or better performance and environmental attributes than other construction materials. Canadian architect Michael Green, in fact, sees mass timber—CLT, parallel strand lumber (PSL), and LVL—playing a major role in buildings up to 30 stories. Performance-based building codes are accommodating the use of such new technology. While some of this new generation of wood products are not referred to specifically in the building code, architects can propose them as an alternative solution. As an example, buildings that were previously permitted only to be of non-combustible construction, can now be built of wood, provided it is sufficiently demonstrated that the structure provides equivalent fire safety.

Photo courtesy of US WoodWorks



(LEFT) Semi-balloon framing is more common in buildings five stories and higher; (RIGHT) it is often used as an alternative to platform framing where fire requirements or shrinkage may be a challenge.



Differentiated from dimensional lumber by having minimum dimensions required by the building code, modern mass timber<sup>6</sup> refers to a family of products including sawn stress-grade lumber, timber tongue and groove decking, glulam, and CLT—that offer advantages in terms of increased strength, and also have quickened the construction process and enabled the use of wood products as solid walls, floors, elevator shafts, and columns to construct an entire building. Modern heavy timber products are particularly suited to mid-rise/multi-family housing, schools, large-span recreation centers, and supermarkets—buildings that must stand up to extreme loads caused by strong winds, heavy snow loads, and earthquakes.

CLT is one type of new mass timber assembly that is comparable in strength to steel and concrete,<sup>7</sup> but weighs less. A CLT panel has at least three glued layers of boards placed in orthogonally alternating orientation to the neighboring layers. In special configurations, consecutive layers may be placed in the same direction, giving a double layer to obtain specific structural capacities. Modern CLT exemplar include the eight-story H8 in Bad Aibling, Germany, which was completed in three weeks. Experts maintain that the structural performance of CLT makes it possible in situations where wood has never been used before.<sup>8</sup> In North America CLT solutions are emerging in mid-rise buildings, setting records for versatility and speed.

Image courtesy of FPInnovations



Panel sizes vary by manufacturer. CLT is currently available in North America with dimensions up to 19-1/2 inches thick, 18 feet wide and 98 feet long.

### CASE STUDIES ON TRADITIONAL AND INNOVATIVE WOOD SYSTEMS

The following case studies illustrate a variety of ways in which architects approach wood-frame mid-rise construction utilizing both traditional and new methods to maximize functionality. These examples cover a wide array of conditions and challenges, including cost, climate, seismic activity, and adherence to safety codes.

Photo courtesy of Misra Architect Ltd.



<b>Name</b>	Skyline Condominiums
<b>Location</b>	Vancouver Island, B.C.
<b>Architecture</b>	Misra Architect Ltd.
<b>Construction</b>	Kang & Gill Construction Ltd.
<b>Structural Engineering</b>	JSH Engineering Ltd.
<b>Completion</b>	November 2012

Designers used balloon framing to prevent shrinkage on this Vancouver Island development.

### 1 BALLOON FRAMING AS A MEANS TO REDUCE SHRINKAGE

Located on the southern tip of Vancouver Island, the six-story Skyline Condominiums enjoy an idyllic location and postcard views.

Designers used balloon framing to reduce the potential for shrinkage. “Normally, the wood member shrinks approximately 3/8 of an inch per floor for 12 percent moisture in the wood. To avoid that, we used plywood, joist hangers for the joists, and balloon framing,” says Pradip Misra, principal, Misra Architect Ltd. Because wood shrinks to a greater degree across the grain than parallel to grain, it’s the horizontal members, such as the sills and joists than can be problematic, rather than the posts and studs. “The joists are hung from the side of the bearing walls. This eliminates the floor shrinkage in the total building shrinkage,” says Steve Hoel, P.Eng., Struct.Eng., principal, JSH Engineering Ltd.

Skyline’s location is prone to humidity, seismic activity, and wind. This resulted in more than a few design challenges. Buildings in this area are required by code to withstand the most severe earthquake loads in Western Canada, and there is always a tendency to build with either steel or concrete. However, the design team and the owners went with wood. Wood-frame structures, which have numerous nailed joints,

have more load paths and are inherently more ductile than those with a rigid connection—which make them more flexible and allows them to dissipate energy when subjected to the sudden loads of an earthquake. “The mass of the building also contributes,” says Sukh Johal, technical advisor for WoodWORKS!BC. “Wood buildings are lightweight, but perform well structurally.” Since forces in an earthquake are proportional to the weight of a structure, wood-frame buildings that are properly designed and constructed perform exceptionally well. Misra says that mechanical options were also a factor in seismic design, notably “hold-downs,” known as continuous tie rod systems or 1-inch diameter steel bars that extend from the concrete slab to the upper floors. “This is a self-adjusting system to keep all floors intact in the event of seismic forces.”

Wood also offered advantages in terms of cost. Developers, who opted for a six-story structure in response to the increased height allowed in B.C., compared the costs of concrete, steel, and wood in an extensive study. “A concrete-and-steel superstructure ran 20 to 25 percent more than wood, and a structured steel superstructure 12 to 15 percent more than wood,” says Biki Kang of Kang & Gill Construction Ltd. “Wood was found to be the most economical choice.”

Photo courtesy of Tien Sher Group of Companies



CASE  
STUDY  
2

<b>Name</b>	Quattro 3
<b>Location</b>	Surrey, B.C.
<b>Architecture</b>	Patrick Cotter
<b>Construction</b>	Tien Sher Group of Companies
<b>Structural Engineering</b>	Thomas Leung
<b>Completion</b>	2012

Photo by Matt Todd Photography, courtesy of WoodWorks



<b>Name</b>	Marselle Condominiums
<b>Location</b>	Seattle, WA
<b>Architecture</b>	PB Architects
<b>Construction</b>	Norcon, NW, Inc.
<b>Structural Engineering</b>	Yu & Trochalakis, PLLC
<b>Completion</b>	2009

## 2 PLATFORM WOOD CONSTRUCTION BRINGS AFFORDABLE URBAN APPEAL

The Quattro 3 condominium opened in September 2012, the first multi-family six-story building in Metro Vancouver, built from wood. The project used platform framing to increase affordability and occupant comfort. Featuring 164 units from studios to two-bedrooms and one floor of commercial space, Quattro 3 is part of a larger planned community that will include up to 1,900 homes.

While experts say that mid-rise wood frame construction is too new to B.C. to make a definitive statement about the cost competitiveness of wood, what can be said is that based on projects under construction in 2011 the above-grade cost of wood mid-rise construction will reduce costs by ten percent vs. steel or concrete construction. “There’s always a difference between concrete and wood in terms of affordability,” says Charan Sethi, president and CEO of the Tien Sher Group of Companies, developers of Quattro 3. “In the Surrey market, concrete units sell for \$50 to \$75 per square foot more than comparable wood units.” Sethi feels the mid-rise wood building benefits from lower per-unit land costs and construction costs that can then be passed along to the consumer. “We’re always looking for ways of bringing affordability to the working class market,” Sethi says.

Sustainability, locally sourced materials, and ease of construction were other factors that drew Sethi to wood. Sethi says, “Construction was completed by our experienced framing crew and on-site staff. The process was efficient.”

Occupant comfort was a prime concern. Noise transmission is a performance challenge

in any multi-family building and in wood construction there are several solutions to mitigate sound transmission, including greater mass, increased stiffness, sound-absorbing insulation, resilient metal channels, and structural discontinuity between noise and occupant. At Quattro, 1.5-inch lightweight concrete topping between floors was used for additional soundproofing and robust insulated double 2-inch-x-6-inch framed party wall construction was employed to minimize vibration and sound transfer between homes.

Fire experts maintain that six-story wood-frame buildings are as safe as any other form of buildings. “For a sprinklered occupied building, there is absolutely no safety issue,” Sethi says. According to Len Garis, Surrey’s fire chief and president of the Fire Chiefs’ Association of B.C., “the fire safety of people living in six-story wood-frame buildings should be equal to the safety in any other building.” Garis was quoted as saying, “These buildings are fully sprinklered and our research suggests to us that in a sprinklered building, a fire is likely to never leave the room of origin, has historically never left the floor of origin in a building. Where the sprinkler system needed to operate to put the fire out, it put the fire out.”

Quattro 3 makes an ideal introduction to mid-rise wood buildings in Metro Vancouver not only in terms of affordability, but in occupant comfort and safety as well.

## 3 SEATTLE HYBRID: WOOD PLATFORM FRAMING AND A CONCRETE PODIUM

The Marselle is a hybrid wood and concrete structure consisting of five stories of wood-platform framing plus a wood mezzanine and

a six-story concrete podium, of which, two stories are above ground. The combination of “five and one-half over two” made Marselle the tallest modern wood-frame structure in Seattle.

Marselle’s main distinction lies in the way wood framing was used to maximize the value of the finished space. Two key code requirements allowed that to happen.

The City of Seattle’s 2003 Building Code (SBC), under which the Marselle was built, was based on the 2003 International Building Code (IBC). Under the 2003 IBC, mezzanines were limited to 33 percent of the floor area beneath. However, SBC allowed five stories of wood construction over two stories of Type I construction plus 50 percent for a mezzanine. Mezzanine levels are not considered floors. Under the SBC, Type V-A construction allowed a fully sprinklered 70-foot maximum height for five stories while Type III-A allowed a fully sprinklered 85-foot maximum height for five stories. Zoning regulations allowed a maximum height of 85 feet. Therefore, the design team took advantage of Type III-A construction by adding a mezzanine level on top of the allowed five-story structure, to fill in the building envelope to the 85-foot maximum zoning height allowed.

The other criteria concerned construction type. According to architect Michael Shreve with PB Architects, “under the 2003 SBC, section 504.2, the allowable height for buildings of Type III-A construction in Group R-2 could be increased to five floors of wood-frame construction above two stories of Type I concrete construction and an 85-foot maximum height. The two floors of concrete construction were required to be Type I construction with



CASE  
STUDY  
**3**

Photo courtesy of UBC



CASE  
STUDY  
**4**

<b>Name</b>	Centre for Interactive Research on Sustainability (CIRS), University of British Columbia
<b>Location</b>	Vancouver, B.C.
<b>Architecture</b>	Perkins+Will Canada Architects Co.
<b>Construction</b>	Heatherbrae Builders
<b>Structural Engineering</b>	Fast+Epp Structural Engineers
<b>Completion</b>	2011

CONTINUING EDUCATION

a three-hour horizontal fire rating separating the wood construction from the concrete construction.”

“Once built, the top level units would have water views of Seattle’s Lake Union,” explained structural engineer Panos Trochalakis, P.E., S.E., principal with Yu & Trochalakis, PLLC. “For obvious reasons, the developer wanted to take advantage of that.” The extra half-story mezzanine added about \$250,000 to the construction cost of the building, but the architect and builder estimated that the added height and space increased the value of the complex by \$1 million and afforded revenue-generating views on the top floors.

Attention was devoted to maximizing the strength and durability of the wood members, with architects designing for potential shrinkage. As is typical with wood-framed podium structures, Marselle’s contractors used a continuous rod tie-down system with a shrinkage compensation device to limit deflection and avoid wall separation due to wood shrinkage under wind and seismic forces. They also included an expansion joint in the cladding; were careful to specify proper panel spacing in the exterior wall sheathing; and included a provision in the mechanical system to allow for movement.

The use of wood also had a positive impact on schedule and budget factors, with pre-paneled walls enabling a speed of construction that made a big difference. The panels, which ranged from 4 to 20 feet long, were pre-assembled by a

local framer in an off-site warehouse, and then quickly and easily lifted into place at the job site by crane. “If you can install the walls on a building the size of Marselle in less than two weeks per floor, then you lower construction costs significantly,” Trochalakis says. “Lower construction costs were the number one reason to use wood. Wood-frame construction is virtually impossible to beat in terms of cost.”<sup>10</sup>

**4** **MASS TIMBER FOR A SIMPLIFIED DESIGN AND GREATER STRUCTURAL CAPACITY**  
Billed as the most innovative high-performance building in North America, the Centre for Interactive Research on Sustainability (CIRS) at the University of British Columbia is expected to be the university’s first LEED® Platinum building, and is on track to receive Living Building Challenge recognition. The building was envisioned as a new baseline in sustainable high-performance buildings, and incorporated regenerative design—an emerging alternative to current green design practices that seeks not merely to reduce harmful environmental impacts, but to actually improve both the natural environment and the lives of their human inhabitants. Mass timber played an important part in achieving these goals. CIRS features a simple structural design, comprised of a combination of glulam members, dimensional lumber, plywood, and a minimal amount of concrete. The moment frame structure was designed to create an open, column-free

floor plate for flexibility of use and interior arrangements, and to allow for large openings in the walls that maximize daylight and views. The members’ size and solidity make the structure non-combustible heavy timber construction under British Columbia Building Code—a designation that simplifies the building design.

In order to reinforce external charring in case of fire, designers sized all members slightly larger than required. A building-wide sprinkler system and on-site water supply and water pump were also incorporated to enable the heavy timber wood structure to meet the requirements for non-combustible construction required by code.

Designers opted to size the structure to support a live load of 100 pounds per square foot (4.7 kilonewtons/square meter), double the requirements of the British Columbia Building Code, to achieve an increased capacity that allows for additional equipment and future changes in use. Structural members were larger where larger loads required more support, notably in the auditorium where beams and columns were sized to handle both a long span over the seating and the load of the green roof. “From a structural point of view, the modern engineered materials... have increased the strength of wood so that they have a much greater structural capacity,” says Paul Fast, managing partner, Fast+Epp.

See endnotes in the online version of this article.

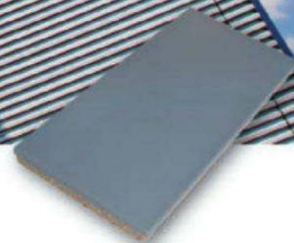
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**CIRCLE 86**

# Concrete Masonry in Green Buildings

Specifying CMU as part of a naturally sustainable design

Sponsored by Oldcastle® Architectural | By Peter J. Arsenault, FAIA, NCARB, LEED AP

At the Banner MD Anderson Cancer Center in Gilbert, Arizona, CMU construction combined strong aesthetic appearance, structural support, and green building attributes.



Photo courtesy of Oldcastle® Architectural

Concrete masonry units (CMUs) are well known by architects, contractors, and owners because of their enduring history over thousands of years, demonstrating proven performance in many building types around the world. From a design standpoint, they provide flexibility, variety, and code compliance within a range of standardized and modularized shapes and sizes. From a construction standpoint, they are commonly available and installed by local masons using established construction techniques. From an owner's perspective, they provide affordable, durable, and safe facilities with comparatively low maintenance. But beyond all of this, their inherent characteristics and properties also contribute substantially to green and sustainable design. As we will explore further, they do this in multiple ways due to their inherently green nature.

## CMU OVERVIEW

Architects have commonly specified CMUs for a variety of specific, traditional reasons recognizing that they can provide both structure and aesthetics in a single manufactured product. As a building material, modular manufactured CMUs provide construction assemblies that are durable and readily resistant to abuse,

making it an ideal choice for commercial, institutional, and industrial applications. In designing a building requiring versatility, the variety of finishes, styles, and textures of CMUs offers a considerable design palette of choices to create successfully designed interior and exterior spaces. Conversely, while different units may appear to look the same on the outside, inside they can vary in weight, detailing, and reinforcing to suit a load bearing structural condition or be simply designed for lightweight non-load bearing partitions. The modular sizes of any of these hollow or solid units contribute to their overall economy and efficiency in design and construction. Since these sizes are typically larger than clay masonry units, they can be installed in less time and with less labor than smaller units and prove to be generally very cost effective overall. In applications where fire codes are a prevailing design priority, CMU walls provide a readily documentable level of fire resistance for extended time periods. In fact, in many cases, actual results of fires have shown that interior furnishings and materials may have burned completely while CMU-enclosed areas remain standing and in many cases can be readily cleaned and re-used. As a result, they have demonstrated their ongoing structural

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CREDENTIAL MAINTENANCE

### Learning Objectives

After reading this article, you should be able to:

1. Identify and recognize the traditional attributes and features of concrete masonry unit (CMU) construction.
2. Assess the strengths and limitations of CMUs for use in green building design including inherent green building characteristics.
3. Investigate and compare different strategies to increase green building performance using CMU construction.
4. Explore the types of innovative design applications and positive life-cycle attributes of CMU construction.

To receive credit, you are required to read the entire article and pass the test. Go to [ce.architecturalrecord.com](http://ce.architecturalrecord.com) for complete text and to take the test for free.

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Photos courtesy of Oldcastle® Architectural



Demonstrating the resilience of CMU, the West Street Building by Cass Gilbert was reopened in 2005 after being damaged by the World Trade Center collapse and a five-day fire in 2001.

integrity even under the duress of fires, storms, floods, and other disasters.

Beyond the traditional reasons to use CMUs, architects and owners seeking to design green and sustainable buildings have begun to discover and realize that all of these inherent attributes of concrete masonry attest to its true long-term sustainability. That is, it holds up well over time providing a very durable and resilient building that is easy to care for and maintain. And in most cases, it offers very positive life-cycle qualities related to cost and environmental impact.

Green building design is based on a variety of principles particularly related to the products used in construction. CMUs have gained attention in recent years for being very consistent with these green principles including its qualities of:

is extracted. Further, recycled content is not only possible, but quite common, thus avoiding further extraction.

**User comfort.** High levels of acoustic, thermal and visual comfort are achievable using CMUs in interior and exterior spaces.

**Energy reduction.** CMU walls can be readily insulated and in many cases can contribute to additional thermal mass in a building which will reduce temperature swings, lower HVAC usage, and save on energy costs.

**Noise transmission control.** CMU walls typically achieve favorable sound transmission class (STC) ratings and help separate quiet areas from noisier areas.

## The modular nature of concrete masonry is actually quite optimal for dense sites that are short on space but high on pedestrian or vehicular traffic.

**Use of natural materials.** CMUs are manufactured around the world from sand, aggregate, and Portland cement, all of which are common and natural materials.

**Low environmental impact.** The materials that go into a CMU can be obtained using processes and procedures that respect the environment and restore areas where material

These inherent characteristics of CMUs have been described as making them “naturally green” in that they have already been doing for centuries the things that we are paying more attention to in building design today. Most notably, the green building movement in this country has given rise to quantifiable rating systems that seek to establish specific levels of achievement in the creation and performance of

green buildings. The best known of these green building rating systems has been developed by the U.S. Green Building Council and known as the LEED® rating system. This is actually a family of ratings that apply to different building situations (e.g. new or existing buildings, core and shell, interiors) and in some cases building types (schools, healthcare, retail, homes, etc.). All of the LEED rating systems have been subject to ongoing changes and updates since their inception, but the basic categories of defining green buildings have remained the same across the different versions over time. With that in mind, we’ll look at the contributions that CMU can make in each of these green building categories.

### SUSTAINABLE SITES USING CMUs

The focus of this category of green building design is on enhancing the positive aspects of a building site while minimizing the negative impacts that adding a building can have on that site and the surrounding area. Generally, there are three areas that concrete masonry can help achieve this overall goal for sustainable sites:

#### Development Density

Providing denser buildings with smaller footprints has been demonstrated to be an important part of sustainable and walkable communities. The fire resistance capability of concrete masonry directly enables greater building density by meeting fire code requirements for separation of spaces. Further, the structural attributes of CMUs allow for vertical building design that can help minimize building footprints. In particular the modular aspect of concrete masonry lends itself to working well within small or irregular shaped building lots as easily as larger ones. In terms of optimizing the most appropriate use of a site, it is worth noting that segmented retaining walls (SRW) made of concrete masonry has the potential to allow for the utilization of sites previously considered to be unsuitable due to slope or irregular terrain. In all, creating denser clusters of buildings can be coupled with a high ratio of open space that promotes biodiversity and effective environmental site design.

#### Community Connectivity

The modular nature of concrete masonry is actually quite optimal for dense sites that are short on space but high on pedestrian or vehicular traffic. The use of concrete masonry pavers of different types and styles introduces a design element that helps weave a particular building or series of buildings into the community fabric it is located within. This can be an attractive and effective way to create pedestrian access between the project site and neighborhood buildings and services.

## Stormwater Management

In the interest of reducing disruption to natural hydrology patterns and minimizing the potential for pollution due to stormwater runoff, permeable paving has emerged as a very effective strategy. CMU pavers that are non-pervious and allow stormwater to permeate between them are not only effective in this regard, they provide an attractive aesthetic with a variety of colors and textures compared to monolithic paving choices such as asphalt or concrete. By properly specifying and designing with CMU site pavers, green building objectives can be met by reducing impervious ground covering thus increasing on-site infiltration and reducing stormwater runoff. From a general design standpoint, this approach can also increase the usable space on a site while requiring very little maintenance. For more detailed information on this strategy, designers can consult the National Concrete Masonry Association (NCMA) technical bulletin titled “NCMA TEK 11-11: Permeable Pavements for Commercial Parking Lots.” Open grid paving systems are also recognized as reducing heat island effects and can thus provide this additional benefit as described further below.

## Heat Island Reduction, Non-Roof

Developed areas are known to have higher air temperatures than non-developed areas due in large part to the presence of dark-colored surfaces that produce heat when the sun shines on them. This phenomenon is referred to as a “heat island” and can notably affect the localized microclimate, producing an unwanted warming effect on people and buildings. As such, strategies to reduce this generated heat focus on either shading dark surfaces or providing hardscape surfaces that reflect rather than absorb sunlight to keep temperatures cooler. The unit of measurement for a material to be effective in reducing the heat island effect is the solar reflectance index (SRI). Based on a scale of 1 to 100 per standard ASTM procedures, a score of 0 would apply to a standard black surface (highly non-reflective) while a score of 100 would apply to a white surface (very reflective). The green building standard is to achieve a minimum SRI of 29 across hardscape materials. Happily, typical new gray CMU pavers have been tested at an SRI of 35 thus exceeding the minimum benchmark by over 20 percent.

By using a combination of these CMU-based strategies in sustainable site design, designers can readily achieve a substantial number of points under the LEED rating system toward an overall green building certification level.

## ENERGY AND ATMOSPHERE CONTRIBUTIONS FROM CMUs

Optimizing energy performance is what most people think of when they think green buildings. In all cases, the LEED rating system now requires some minimum performance levels to be achieved and offers the greatest number of potential points under this critical category. Using CMUs as part of an overall building envelope and construction strategy can contribute to over half of the available points here, but more importantly can dramatically reduce energy costs and the carbon footprint associated with a building in various ways.

### Optimize Energy Performance through Continuous Insulation

The place where architects spend a lot of time addressing energy conservation is in the building envelope and specifically in how to effectively insulate the envelope from thermal heat loss or unwanted heat gain. It has become increasingly recognized in energy codes and standards as well as in LEED that insulation is most effective at achieving thermal performance results when it is truly continuous and not interrupted by framing or structural members thus avoiding energy-draining thermal bridges. Stud space insulation installed only between studs or other structural members dramatically decreases the effective insulation R-values of walls well below the intended design level. Conversely, it has been common for CMU cavity wall construction to place insulation between the layers or wythes

*Photos courtesy of Oldcastle® Architectural*



Permeable CMU site pavers allow stormwater to penetrate into the soil, thus avoiding unwanted run off, reducing pollution, and reducing the heat island effect.

of masonry such that the insulation is truly continuous and uninterrupted by any other structural members. This means that the full value of the insulation is available without compromise other than needed fasteners and intended openings, which of course need to be properly detailed. Further, the amount of insulation installed can vary based on a particular building's needs and the climate it is located in thus seeking to optimize the performance of the wall. And since this is such a common practice, different modular products and insulation approaches are available. Some innovative approaches have even gone beyond the common cavity wall approach creating multi-part CMU systems that include an inner and outer CMU module with a middle piece of rigid insulation, which stops thermal breaks and contributes to overall energy performance.

### Optimize Energy Performance through Thermal Mass

Buildings have become increasingly lighter in weight over the past 100 years, which means that the amount of pure mass in them is reduced compared to prior eras. In the process a significant thermal benefit was lost which is now being realized and incorporated again into green buildings. The physics of returning mass to a building allows the space to be thermally tempered; thermal mass slows the rate of temperature swings in a space creating a slower thermal lag. One of the easiest and most common ways of adding this thermal mass to a building is by using CMUs, but it must be located inside of

the insulation layer to be truly effective for energy and comfort performance. The basic premise is simple. The thermal mass absorbs heat from the surrounding area when it is warm and re-radiates it back out thus cooling afterwards. Typically this means that the mass is absorbing heat during the daytime, helping to keep a space from overheating, and radiating at night, helping to keep a space appropriately warm. If you have ever walked into a masonry church or monument during the summertime you have likely felt the pleasant temperature difference immediately and then realized that there is likely no air conditioning at play. This natural ability for masonry to absorb and store heat produces multiple benefits to the owners and occupants of a building including:

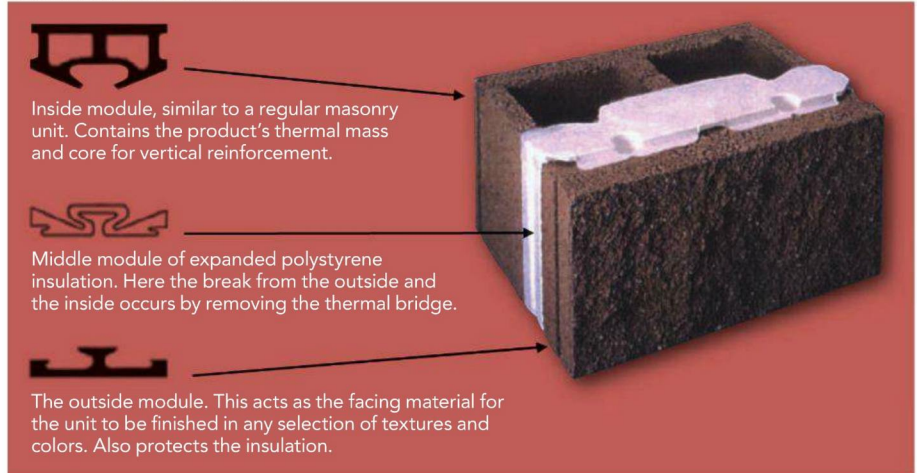
- ▶ Peak heating and cooling loads can be reduced since the high and low temperatures of the space are moderated and temperature variations are reduced.
- ▶ Peak heating and cooling loads can be shifted to non-peak hours saving the owner on peak electricity rates and saving the utility company on overall peak energy supply requirements.
- ▶ The size of HVAC systems can be reduced since the high and low temperature points that the systems need to perform to can likely be trimmed—hence less heating and cooling capacity is needed.
- ▶ Building energy codes have come to recognize the energy benefits of thermal mass with prescriptive credit and trade-offs that can be garnered to show code compliance that might otherwise be unavailable.

Images courtesy of Oldcastle® Architectural



Typical cavity wall concrete masonry construction with continuous rigid insulation

Images courtesy of Oldcastle® Architectural



**Some innovative CMU products provide multi-part units with a full thermal break avoiding thermal bridging.**

It is important to recognize that there is a misconception that designing a building with added thermal mass will always use less energy and reduce energy costs overall. No one can realistically make that claim since there are many other variables that go into the design of a building and the systems that serve it. Therefore, it is important to look at the whole picture and perform computerized energy modeling if needed to see the potential energy savings for any given design. Nonetheless, adding thermal mass to a building does very often create all of the benefits stated above including the very real savings in

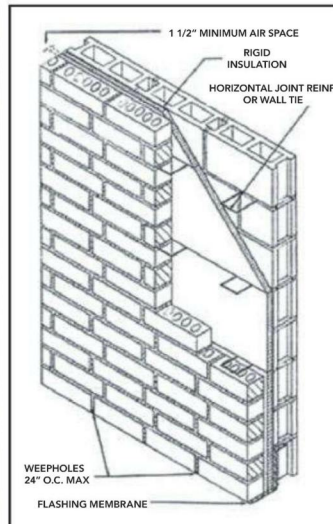
many cases of buying energy during off peak hours. And maybe even more important to users, it is rather consistent in increasing occupant comfort. If the space is perceived as comfortable, then there is less likelihood to change the thermostat settings to a more energy-consuming level.

**Passive Solar Design**

As we saw in the heat island example, solar energy works. Specifically when sunlight strikes a darker surface, it turns to heat as anyone who has ever walked barefoot in summer on asphalt paving can attest. It does this without the need for any mechanical equipment or outside energy, hence the use of the word "passive." In green buildings, the key is to capture that available solar heat and use it to the benefit of the building occupants. LEED recognizes the use of on-site renewable energy such as passive solar based on calculating the percentage of annual energy costs that are offset by this on-site energy. Points are awarded for as little as a 1 percent contribution with up to 7 points available for a 13 percent contribution to the annual energy needs of a building. Beyond LEED, the U.S. Department of Energy (DOE) estimates that energy cost reductions in the 30 to 50 percent range are possible using a combination of energy conservation and passive solar strategies.

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# PLAY WORK BUILD

A new exhibition at the National Building Museum opening on November 18, 2012



Create the tallest towers, the most ridiculous shapes, the truly impossible structures. Children and adults alike are encouraged to put their skills to the test and let their imaginations run wild with blocks—small, big, and virtual—in this new exhibition that also features a selection of architectural and construction toys from the Museum's collection.

*PLAY WORK BUILD* was developed in partnership with Imagination Playground and designed by Rockwell Group.



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Good workplace lighting must provide the necessary amount of light, while protecting the visual environment from glare and remaining within the allowable energy footprint.

# A Guide for Specifying Commercial Lighting

Selecting effective and efficient fixtures for productive workspaces

Sponsored by Prudential Lighting | By Jeanette Fitzgerald Pitts

**A**s you prepare to read this article either in a magazine or online on your computer screen, take a quick survey of the lighting in the immediate area. Look up at the overhead fixture, referred to by many in the lighting design community as a luminaire. Is it aesthetically pleasing or does it seem to have been designed to be ignored? More importantly, does the fixture put the right amount of light in the right locations? Do you have enough light to be able to read comfortably or are your eyes straining to make out the words or squinting to block out an overly bright overhead light? Is the fixture causing an irritating and eye-fatiguing glare on the screen? Good lighting is necessary for creating a functional and productive workspace. Poor lighting often provides the setting for sore eyes.

Until recently, creating a good lighting environment was a challenge in compromise. It was almost impossible to find a fixture that looked good, could put the necessary amount of light on the work surface, in a way that was efficient and fit within the client's budget. Too often designers were unknowingly forced to

choose between a functional space, an efficient space, and a budget-friendly space. They selected highly efficient or inexpensive fixtures that created poor lighting environments, because the fixtures were unable to provide light where it was needed, at the recommended levels, or in a uniform fashion. The efficient and effective fixtures were prohibitively expensive, requiring significant cost trimming in other areas to stay within the project's budget.

The good news is that today compromise for good lighting is no longer necessary. Technological advancements in light sources and fixture design now offer the specification community the rare opportunity to select aesthetically pleasing lighting fixtures that provide the right light, with greater energy efficiency, in a way that actually saves money in materials and maintenance. The secret is knowing what to look for in a fixture.

## PRODUCTIVE WORKSPACES AND GOOD LIGHTING

The most basic design goals in an office or commercial setting are to create a place where

work can be accomplished, communication can occur, and business can be conducted. Light is instrumental in creating that productive environment. The inextricable relationship between lighting and productivity is due to the fact that people use their eyes to interpret and interact with the world around them, and the human eye requires light.

In short, the cornea bends rays of light, reflected by the object of interest, through the pupil, which is the dark, round opening in the middle of the colored iris. The light is focused onto the retina in the back of the eye. Photoreceptor cells in the retina transform the light into an electrical impulse that is sent through the optic nerve to the brain. Without the appropriate amount of light, a person's ability to perform a visual task, such as reading email, reviewing a spreadsheet or watching a slide presentation, is compromised and they must spend time and energy adjusting, both consciously and unconsciously, to see the materials better. This immediately diminishes their productive time and efforts to create, analyze or respond.

## Provide the Right Amount of Light in the Right Location

In order to select fixtures that will provide an appropriate visual environment and productive workspace, start by identifying the visual tasks that will be performed in the area and the amount of light necessary for a person to perform them. The Illuminating Engineering Society of North America (IESNA) has developed recommendations, highly regarded throughout the industry, that outline optimal light levels for performing various visual tasks or the amount of light best suited to specific types of space. The IESNA 9th Edition Handbook recommends that lighting systems in office buildings be designed to maintain 400 lux (40 footcandles) at the working level in a single office, 400 lux (40 footcandles) at the working level in open-plan offices, and 300 lux (30 footcandles) at the working level in a conference room. It is interesting to note that these recommended light levels assume that the majority of office work is computer based. When paper-based reading tasks were the primary office function, recommended light levels ranged between 750 and 1,000 lux (75-100 footcandles) at the working level.

As was alluded to in the wording of the IESNA recommendations, to create an optimal visual environment, fixtures must do more than provide the recommended amount of light, they must provide it at the working level, also referred to as the work plane. In the office setting, the IESNA recommendations identify the work plane as being roughly 2.5 feet high, generally regarded as a typical desk height. In corridors, stairwells, and restrooms, denoted by the IESNA as circulation areas, the optimal light levels must be maintained on the floor, enabling occupants to move safely through the spaces.

### The Importance of the Optical System

It is the optical system within a fixture that takes the light emitted by the lamp and distributes it into the interior space. The design of the optical system determines if the fixture has the control to spread a pleasant, uniform light into the specific areas it is needed or if the light leaves the fixture in a more haphazard manner, invariably ending up in places that it

Photo courtesy of Prudential Lighting



The IESNA recommends that an open-plan office maintain 400 lux (40 footcandles) at the working level.

is and is not wanted with varying degrees of uniformity.

There are three components that work together to form the optical system in even the most basic light fixture. They are: the lamp, the lens, and the reflector (also referred to as the fixture housing). The lamp emits the light. The lens is the material that the light passes through as it enters into the interior environment. As the lamp emits light, not all of the light immediately passes straight through the lens. Fluorescent lamps, for example, emit light of the same intensity in a full 360 degrees around the lamp. Even if the lens was of a sufficient size and design to catch and transmit the light emitted from 180 degrees of the lamp, the remaining 50 percent of the light emitted by the lamp is not aimed directly at the lens. The reflector is the enclosure around the lamp that reflects any remaining light back out through the lens.

A rudimentary optical system may consist of no more than a lamp in a metal box that

has been painted white, so that it reflects light, instead of absorbing it, and a basic lens, which is essentially a generic piece of clear prismatic acrylic or glass that protects the lamp from accumulating dust. This is the type of optical system often found in the traditional recessed, lensed, troffer luminaires commonly installed throughout office buildings and other commercial facilities.

Unfortunately, the simple design of these types of optical systems severely limits both the efficiency of the fixture and its ability to control the placement of the light it provides. Poor efficiency is the result of poor internal light management. These basic metal box fixtures are typically not designed to direct the reflected light out of the box as quickly as possible and, instead, allow the light to bounce randomly around inside the fixture, losing energy and intensity with every extra reflection. Poor light placement is the result of the rudimentary reflector and basic lens having no ability to direct the light into the areas it is needed and instead allowing light rays to scatter indiscriminately into the interior space or concentrate on one particular area, causing a visual hot spot or glare.

### Prevent Glare

Glare is perhaps one of the biggest stumbling blocks for achieving a productive workspace. Glare occurs when a light source, or the

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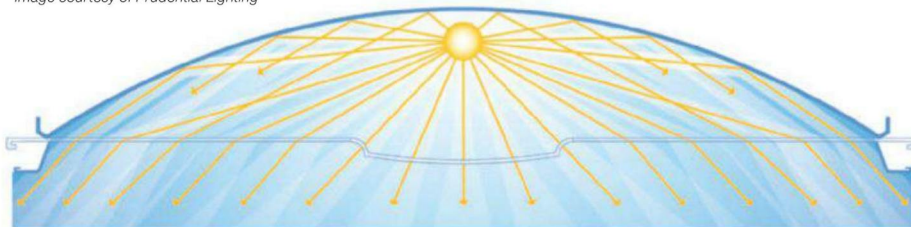
After reading this article, you should be able to:

1. Identify the light necessary to perform various visual tasks, as recommended by the IESNA.
2. Explain how optical systems in fixtures affect the efficiency and light distribution of the fixture.
3. Use a photometric report to predict how a lighting fixture will distribute light in a space and identify potential glare concerns.
4. Explore the impact of greater fixture spacing criteria on the overall energy footprint of the lighting system and ongoing system maintenance.

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Image courtesy of Prudential Lighting



The lamp, the lens, and the reflector work together to form the optical system in a light fixture.

Image courtesy of Prudential Lighting



**More deliberate reflector design and advanced lens materials enable optical systems to offer better fixture efficiency and light control.**

reflection of a light source, is significantly brighter (generally more than three times brighter) than the ambient area surrounding it, causing visual discomfort.

The visual discomfort is the result of the human eye's inability to adapt appropriately to the extreme contrast in the light intensities within its field of vision. Adaptation is a chemical process that takes place on the surface of the retina, regulating the eye's sensitivity to light. In bright environments, this sensitivity decreases because more visual stimulus is available. In darker settings, sensitivities increase.

The change in sensitivity is uniform across the eye, leaving few options to compensate for hot spots and areas of irregularity. When the eye's sensitivity to light decreases to accommodate the brightest object in view, the surrounding areas become too lowly lit to be seen clearly. When the eye's sensitivity to light increases to interpret the dimmer surroundings, the intensity of the brighter object becomes glaring and uncomfortable.

Accommodation is the physiological response that compensates for shortcomings in adaptation. Accommodation is the muscular process that limits the amount of light entering the eye by constricting the pupil and squinting. People can also accommodate their visual environments by lowering their heads and furrowing their brows. This is often an unconscious, automatic response, like blinking when the eyes are dry.

In an office space, an employee could be subjected to glare for several hours nearly every day. Physically unable to adapt to glaring conditions, employees spend their days accommodating the visual environment with involuntary contractions of the pupil, squinting, changing the position of their head, and furrowing their brows. Repetitive use of these accommodation tactics can lead to stress injuries and muscle fatigue that manifest in the forms of eye strain, headaches, and computer vision syndrome. These problems are uncomfortable, fatiguing, and contribute to decreased productivity in the workplace.

Over the years, two common responses for combating glare in the commercial environment

emerged. Less reflective, matte computer screens replaced their glossy predecessors in droves and fixture manufacturers added a pattern or opacity to the lens that more actively diffused the light and better obscured the lamp, in an attempt to eliminate glare-causing hot spots. Unfortunately, neither of these solutions did anything to improve the energy efficiency of the lighting system or to better project light into the areas where it was needed.

Today, rising energy costs and the public's renewed love affair with glossy screens have given specifiers a need for a new response to combat pesky glare. An ideal solution would simultaneously prevent glare, improve the efficiency of the light environment, and place the IESNA-recommended amount of light at the working level. Sophisticated optical systems, and the lighting fixtures that employ them, are the solution that allows a commercial environment to reinstate the vibrant glossy screens on a

computer, tablet or smart phone, without sacrificing productivity to glare, and improving the overall efficiency of the lighting system.

It is with more deliberate reflector design and advancements in lens materials and technology that optical systems are now able to offer better fixture efficiency and light control. Reflectors, in more advanced optical systems, are precision built to reflect light from the lamp through the lens more effectively, minimizing the light energy wasted as the light bounces around within the fixture. Lenses have advanced from lamp dust jackets to powerful optical components. For example, a refractive lens is a lens that has been engineered with refractive prisms inside of it. These refractive prisms bend and distribute the light in a dramatically more controlled manner than the dumb or diffuse lenses previously used, making it possible to achieve IESNA-recommended light levels on the work plane and, at the same time, prevent the presence of unwanted or potentially glare-causing light elsewhere.

#### READING PHOTOMETRIC REPORTS

While manufacturers can provide a copious amount of information on the specific lamp type, reflector, and lens material contained within a fixture, understanding how the components work together to distribute light requires additional information. Specifiers can use photometric reports to predict how a lighting fixture will perform in a space.

Photometric reports summarize and graphically illustrate how a fixture distributes light with a candela chart and in a polar graph called a candela distribution curve. Looking at these reports, a specifier can quickly compare the distribution patterns of multiple fixtures and determine which fixture seems best equipped to meet the illumination needs of the space. Designers can also use these reports to deduce whether or not a fixture has the potential to produce glare or unwanted striations.

#### The Candela Chart

The candela chart is an at-a-glance summary of the light intensities (measured in candelas) distributed by a fixture into specific areas of the surrounding space. The candela chart organizes the candela values in terms of the horizontal and vertical coordinates of their location around the fixture. The horizontal coordinate refers to a unique viewing position, called a horizontal viewing angle, which exists along an imaginary circle around the horizontal axis of the fixture. The vertical coordinate refers to various heights, or vertical angles, along a vertical plane located at each unique horizontal viewing position.

Imagine a hanging, 2-by-4 linear direct/indirect troffer fixture. Visualize the horizontal axis of the fixture, running through the fixture

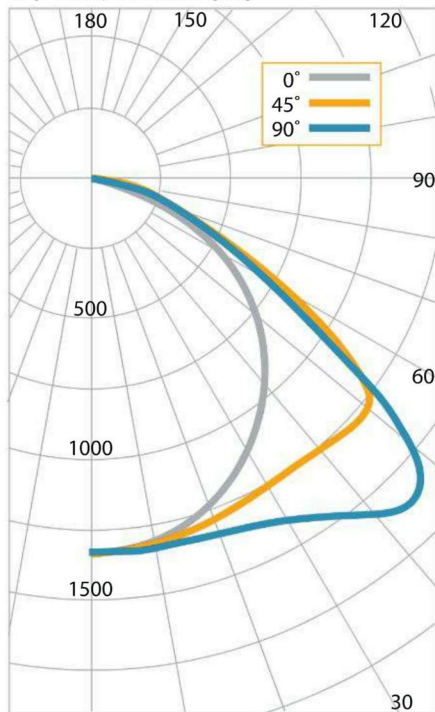
INTENSITY (CANDLEPOWER) SUMMARY						
ANGLE	Horizontal Viewing Angles					Output Lumens
	0	22.5	45	67.5	90	
0	1330	1330	1330	1330	1330	
5	1318	1319	1329	1336	1334	128
10	1301	1305	1321	1335	1335	
15	1273	1282	1308	1332	1337	369
20	1232	1248	1289	1332	1345	
25	1181	1206	1271	1344	1368	589
30	1116	1152	1258	1369	1405	
35	1040	1093	1253	1410	1466	787
40	954	1033	1259	1483	1565	
45	858	976	1277	1549	1618	964
50	756	920	1275	1467	1483	
55	650	853	1130	1124	1079	875
60	543	745	808	738	707	
65	436	557	533	500	488	516
70	327	374	354	347	342	
75	215	239	230	239	235	250
80	118	137	141	148	144	
85	45	59	65	64	61	69
90	0	0	0	0	0	

**This candela chart displays the light intensities of complete vertical planes as measured from five distinct horizontal viewing locations.**

end-to-end. Now draw an imaginary circle around the horizontal axis of the fixture, so that one end of the fixture rests at 0 degrees and the other end rests at 180 degrees. Now imagine a person walking around the fixture on the imaginary circle. Every few steps, the person stops to admire the fixture. The location where they stop to view the fixture is an example of a horizontal viewing angle. A candela chart will typically contain between three and five unique horizontal viewing positions on that circle, denoted as angle measurements. Five horizontal viewing angles commonly seen in a candela chart are 0, 22.5, 45, 67.5, and 90 degrees.

Now, imagine a ladder at each of the five horizontal viewing angles on the circle, so there are five ladders on the imaginary circle. Each ladder represents a vertical axis and it is positioned so that the fixture is in the center of the ladder, with rungs extending in equal distances above and below. The bottom of the ladder denotes 0 degrees on the vertical axis, the top of the ladder is 180 degrees on the vertical axis, and the center of the lighting fixture should be at 90 degrees. There can be as few rungs or as many rungs on the ladder as necessary, depending upon the level of

Image courtesy of Prudential Lighting



The candela distribution curve illustrates that this fixture distributes light in a batwing pattern.

detail contained in the candela chart. Some candela charts will step up the vertical axis in 5-degree increments, others in 2.5-degree increments, and so on. The vertical viewing angles referenced in the candela chart refer to the various rungs on the ladder placed at each unique viewing position. All of the measurements taken from one ladder, or vertical axis, represent the vertical plane at that specific horizontal viewing angle.

If the fixture emitted a perfectly symmetrical pattern of light in all directions, the entire lighting distribution pattern could be detailed from one vertical plane of measurements taken at one horizontal viewing position. However, most fixtures do not emit a symmetrical pattern of light in all directions, so more measurements need to be taken, which accounts for why most candela charts contain between three and five horizontal viewing angles and the measurements from their associated vertical planes.

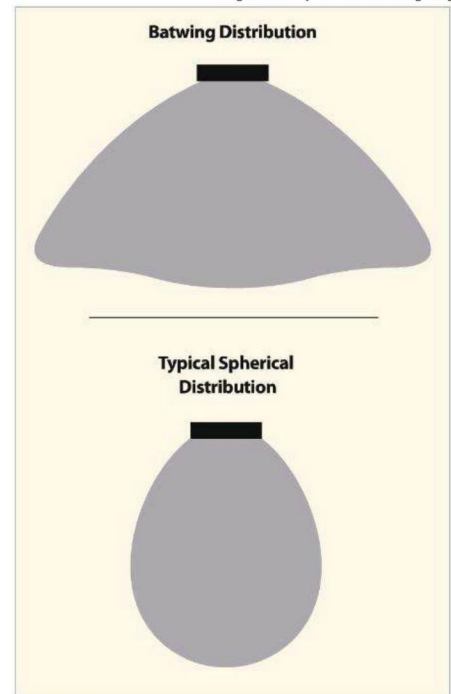
The candela chart displays the horizontal viewing angles across the top as the column headings and the vertical viewing angles (in increments between 0 and 180 degrees) as the row headings. For example, look at the candela chart shown on the opposite page. The unique horizontal viewing angles (0, 22.5, 45, 67.5, 90) are charted across the top as the column headings. The viewing angles, staggered in 5-degree increments between 0 and 90 degrees, are the row headings. The various candela measurements taken along the vertical plane at each unique horizontal position are contained within the chart.

Commercial fixtures today commonly distribute light in either a spherical pattern or a batwing pattern. A spherical pattern of light resembles a ball stuck to the fixture and the batwing pattern of light resembles a bat, with wings spread, going headfirst into the fixture. It is by plotting the information captured on the candela chart into a candela distribution curve that the pattern of light emitted by the fixture is realized.

### The Candela Distribution Curve

The measurements from the candela chart are plotted onto a polar graph to create a candela distribution curve. The candela distribution curve graphically illustrates the lighting distribution pattern of the fixture. This circular (or semi-circular) graph places the light source at the center and maps the various light intensities (in candelas) in incremental steps up the vertical plane (0-180 degrees) for a single horizontal viewing angle. The plots for multiple horizontal viewing angles can be laid over one

Image courtesy of Prudential Lighting



Batwing pattern and spherical pattern as observed at a 90° horizontal viewing angle

another onto one distribution curve to better illustrate changes in the direction and intensity of light output that a person would experience as they walked around the fixture from one horizontal viewing angle to another.

Look at the candela distribution curve shown at left. This one polar graph contains three vertical viewing planes taken from three horizontal viewing positions (0, 45, and 90 degrees). Notice that the graph illustrating the vertical viewing plane at 90 degrees has a distinct batwing shape.

### A Few Quick-Read Characteristics

There are a few important characteristics about the lighting fixture and how the lighting fixture will perform in a space that are quickly revealed by referencing the candela distribution curve. It can be an easy way to compare the lighting distribution of multiple fixtures of interest. First, the distribution curve will illustrate if the fixture is direct (emits light only between 0 and 90 degrees on a vertical axis), indirect (emits light only between 90 and 180 degrees on a vertical axis), or direct/indirect which emits light both above and below the fixture (0 to 180 degrees on the vertical plane).

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# Indoor Air Biofilters Deliver Clean Air Naturally

Biological systems function to improve air quality while providing beautiful form

Sponsored by Nedlaw Living Walls Inc. | By Peter J. Arsenault, FAIA, NCARB, LEED AP, and Alan Darlington, PhD

It is commonly noted that people currently spend 80 to 90 percent of their time indoors. That means we are breathing indoor air and, as a result, indoor air quality (IAQ) has been the focus of numerous studies, standards, and programs that seek to create healthy indoor environments. Common approaches to achieving better IAQ results, particularly in green building design, include careful selection of materials used and increasing ventilation rates. Over the last decade or two, there is also another option that is emerging, namely the use of a plant-based indoor air biofilter. This completely biological (i.e. natural) method of maintaining the quality of indoor air has become recognized as an exceptionally functional and very aesthetic system that can truly enhance indoor environments in many ways.

## PRINCIPLES BEHIND INDOOR AIR BIOFILTRATION

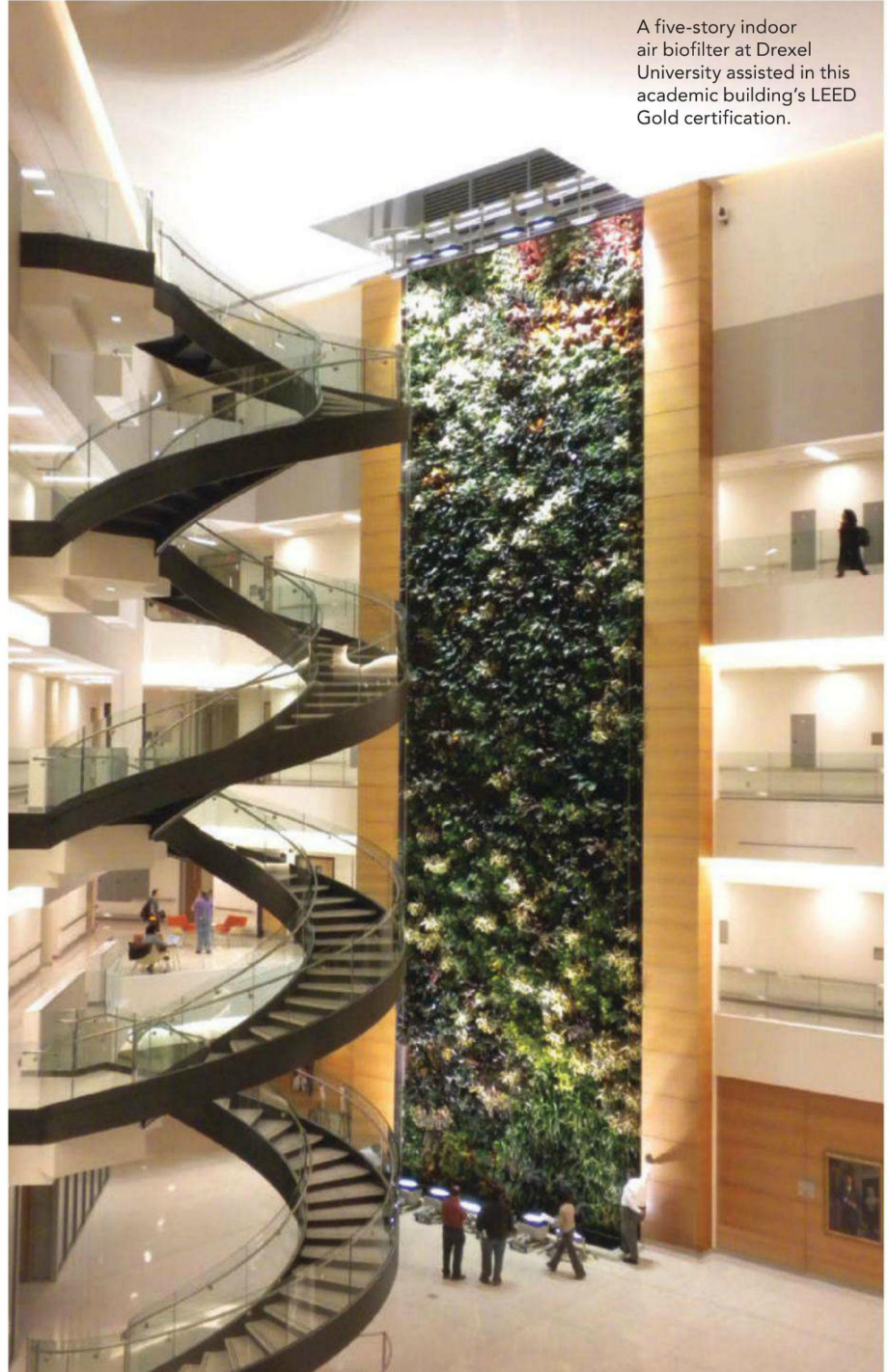
The science behind indoor air biofilters had its start back in 1994 at the Controlled Environment Systems research facility at the University of Guelph in Ontario, Canada. Early research was funded by the Ontario Center of Excellence (OCE) and by the European and Canadian Space agencies. The group gained worldwide recognition for their use of biological systems to improve indoor air quality. Some of the principles that were identified and developed since then are discussed below.

### The Nature of Contaminants

Indoor air can be contaminated by any number of things thus reducing its quality and beneficial aspects. For purposes of our discussion, a contaminant is simply defined as anything in the air that we breathe that is detrimental to our health or well-being. It could be determined to be downright harmful due to its inherent make-up as a hazardous substance. Or it could be an otherwise common substance that is a concern due to its level of concentration in the air which exceeds the ability of a human body to deal with it. Hence a contaminant can take several forms.

One of the most common contaminants to be addressed is volatile organic compounds (VOCs). In simplest terms, these are defined as carbon-, oxygen-, and hydrogen-containing compounds that are present as gases under normal atmospheric conditions—in other words

*Photo courtesy of Nedlaw Living Walls Inc.*

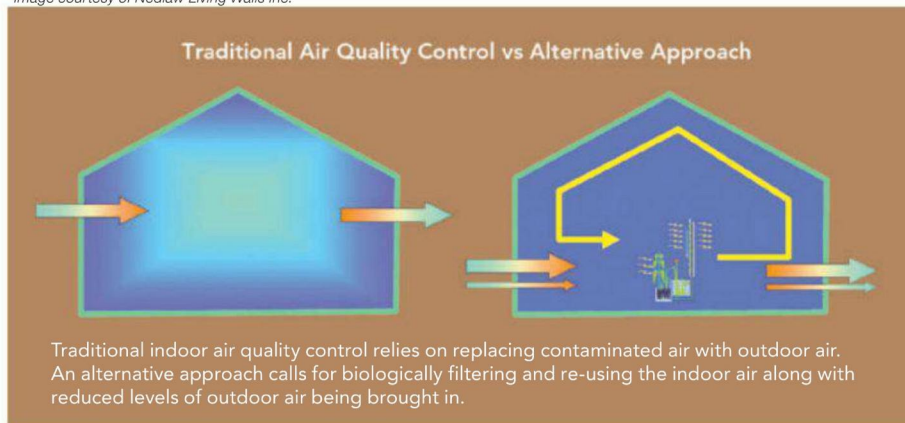


A five-story indoor air biofilter at Drexel University assisted in this academic building's LEED Gold certification.

are released as a gas from a liquid or solid. The U.S. Environmental Protection Agency (EPA) differentiates between those that are a concern and those which aren't. Naturally occurring compounds found in the environment such as metallic carbides or carbonates, and ammonium carbonate don't typically react, so they aren't included in the EPA's definition. A large number of others have been deemed to have negligible effects and as such aren't regulated. Many regulated VOCs are included on EPA's list because of the potential harm they can do to people at certain concentration levels. They are of particular relevance since they are used in literally thousands of manufactured products that go into the construction or operation of buildings. When these products emit VOCs into the air once installed inside a building, they can cause concentrations that are 5 to 10 times higher than would be found outside of the building. The common VOC-containing building products include things like paints, paint strippers, adhesives, wood preservatives, composite board stock, furniture, flooring, etc. It is common to restrict the use of materials containing VOCs by specifying "low VOC" and occasionally "no VOC" products may be available, but it is more likely that some VOC-containing products will make their way into virtually any building. Once a building is occupied then it becomes the operations that use aerosol sprays, cleansers, disinfectants, moth repellents, air fresheners, stored fuels, automotive products, or dry-cleaned clothing that can become contributing sources of VOCs. Other contributors can also include printers, photocopiers, paper products, computers, and the people themselves (perfumes, deodorants, and our natural scent). The impact of activities on IAQ is so great that buildings constructed with low-VOC material will eventually have the same IAQ as a typical construction.

One VOC that is a particular concern is formaldehyde which is a naturally occurring combination of hydrogen, oxygen, and carbon, but found to be irritating or even toxic to people. It is well known as a preservative in medical laboratories, as an embalming fluid, and as a sterilizer. Its primary use is in the production of resins and as a chemical intermediate for other products. Urea-formaldehyde (UF) and phenol formaldehyde (PF) resins are used in buildings as part of foam insulations and adhesives used for wall and floor finishes. In short, its use is very widespread in the construction industry and is also used in some paper products ([www.cpsc.gov/cpscpub/pubs/725.pdf](http://www.cpsc.gov/cpscpub/pubs/725.pdf)). As a result, green building standards and organizations focused on healthy indoor environments all tend to specifically address limiting the use of formaldehyde in addition to VOCs in general.

Image courtesy of Nedlaw Living Walls Inc.



Moving beyond VOCs, other contaminants include concentrations of particulate matter (i.e. dust) or detrimental gases such as carbon monoxide in the air. High concentrations of particulates cause irritation in human airways and can cause a wide range of respiratory ailments as a result. The presence of high concentrations of non-VOC gases can be toxic or even fatal in severe cases since the air could become starved of oxygen.

The traditional approach to remediating both the presence and the concentration of contaminants inside buildings is to exhaust out the contaminated air and replace it with outside air that is presumably fresher and cleaner. Historically, this was done by natural ventilation (operable windows, doors, or louvers) and many green building designs are looking to this option again. More common, however, is the use of HVAC equipment to move and treat the air in a building. Fans exhaust the indoor air out on one end, while drawing in and conditioning outdoor air on the other to distribute it throughout the building. Inserting air particle filters of one type or another into this process has been common for a long time, but the types and sophistication of those filters have increased in recent years to address indoor air quality concerns from contaminants. Of course, the cost of those filters has often increased as well. The purpose of the filters is to remove primarily particulate contaminants that are brought in from the outside, but also to help clean any air of particles that is re-circulated indoors. Building codes and standards promulgated by ASHRAE and others call for copious amounts of ventilation air to keep the occupants of a building healthy, even while sometimes jeopardizing the ability to optimize energy performance.

The U.S. Green Building Council's LEED® rating system even includes a provision for a construction indoor air quality management plan before occupancy that includes the option of "flushing out" the building with thousands of square feet of air for every square foot of

space—a process that can take days or even weeks and temporarily drive up an energy bill notably. The LEED® rating system and other green building standards also call for a reduction in the presence of VOCs in building materials to begin with which is appropriate for construction and renovation projects where this can be specified and controlled. Nonetheless, since VOCs can come from so many other sources and can concentrate in indoor spaces at high levels, ventilation and filtration will likely always remain appropriate for contaminant removal.

### Removing Contaminants with Natural Processes

Just as ventilation can be realized through either mechanical or natural means, it is now possible to realize highly effective air filtration

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### Learning Objectives

After reading this article, you should be able to:

1. Summarize and explain the principles of indoor air biofiltration that affect indoor air quality.
2. Analyze and compare the different basic components of an indoor air biofilter system.
3. Theorize and predict the impact of a biofilter on indoor air quality in buildings.
4. Specify and conceptually design an appropriate indoor air biofilter into a building to optimize performance.

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Tiny microbes on the roots of plants use VOCs and other contaminants as a food source and break them down into harmless compounds.

through natural processes that can be coupled with mechanical systems. The scientists at the University of Guelph and others since then have advanced the indoor air biofilter as a way to filter and clean indoor air naturally by installing a properly designed system based on plant-scapes inside the building. These systems employ a vertical hydroponic green wall (i.e. soil free and water based) containing a range of plants chosen specifically for use in the system. As a living air filter, it removes common indoor contaminants and improves the quality of the air. Indoor air is actively drawn through the green wall of plants, activating highly specialized, natural, biological processes to break down pollutants into their benign components of water and carbon dioxide. Clean, cool air is then distributed throughout the space by the mechanical ventilation system.

The indoor air biofilter system works by employing technology that is an adaptation of two separate industrial processes:

**Biofiltration.** In this process, a contaminated air or water stream is passed through a biologically active substrate where beneficial microbes use the pollutants—such as VOCs—as their food source. Nothing accumulates within the biofiltration system, however, since microbes

degrade the contaminants into their benign constituents of carbon dioxide (CO<sub>2</sub>) and water.

**Phytoremediation.** This process has traditionally used green plants to facilitate the recovery of contaminated soils, a process typically used to clean-up contaminated brownfield sites. Using this same fundamental technology, plants can be indirectly involved in cleaning up contaminated indoor air by assisting in the growth and effectiveness of the beneficial microbes and creating the environment where they can thrive.

Using these processes, the indoor air biofilter can be thought of as a system of exposed plants that are integrated within a building and appear as a vertical hydroponic wall. Behind the scenes, a pump constantly circulates water from a reservoir at the base to the top of the wall. The water then flows down the wall through a porous synthetic root medium in which the plants are rooted. Air from the occupied space is actively drawn through the plant wall by either the HVAC system or onboard fans and then returned to the occupied space. As the dirty air from the space comes in contact with the growing (rooting) media, contaminants move into the water phase where they are broken down by the beneficial microbes growing on the roots and other surfaces in the growing media.

It is important to make a distinction here. The indoor air biofilter works because of the combination of all parts of the system described. Potted plants in a space are not capable of achieving the same or even similar results. The reason is because the removal of air contaminants is accomplished not by the leafy parts of the plants but by microbes that exist on the roots. In potted plants, the roots are obviously contained in soil which has little or no exposure to the air. Further, the pot itself is impermeable meaning that air will not flow through the sides of the pot. Even if it did, it would not likely be able to flow through the soil so it would never reach the roots or the microbes that could do the job of cleaning the air. Therefore, while potted plants may absorb some small amount of carbon dioxide and replace it with oxygen through photosynthesis, they will have little other impact

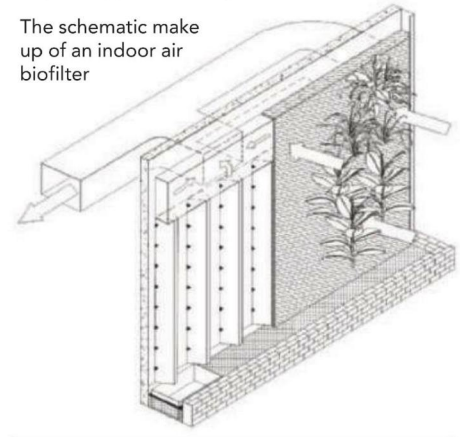
on indoor air quality. And they will certainly not filter out contaminants.

### Green Benefits of Indoor Air Biofilters

Indoor air biofilters provide a full range of contributions toward greening a building. In addition to improving the aesthetics and the physical environments of the facilities in which they are installed, they also help building owners improve the quality of the air for the occupants.

The first contribution is the ability of an indoor air filter to break down VOCs through the biofiltration process. In controlled laboratory studies, these systems have been shown to remove up to 90 percent of VOCs in a single pass. Real world testing in actual buildings shows some expected variation from ideal laboratory conditions, but they have still been measured at impressively high VOC removal rates. The process for determining

Image courtesy of Nedlaw Living Walls Inc.



The schematic make up of an indoor air biofilter

this actual performance involves using sensors to measure the presence of VOCs in the ambient air that is entering a biofilter and similarly measuring the air that is exhausted from the biofilter. Testing using this process was undertaken at a dozen different locations representing different building types in both summer and winter conditions. The results of ongoing sampling showed that the levels of VOCs measured in the indoor ambient air could vary widely throughout the day and between buildings. As that air passed through the 12 indoor air biofilters tested, they were all found to remove VOCs but the rate of removal ranged from a full 100 percent removal down to less than 50 percent in some cases. The average removal rate across all 12 systems was about 85 percent overall with a typical 20 percent variation. Equally important, the testing found that air leaving the biofilter was not significantly different from outside “fresh” air when comparing the ambient parts per billion

## UNIVERSITY OF GUELPH HUMBER

Built: May 2004

Architects: Diamond and Schmitt Architects

Address: 207 Humber College Boulevard, Toronto, Ontario

The biofilter measures 10 m wide and 16 m high for a total area of approximately 160 m<sup>2</sup>.

The largest single indoor air biofilter constructed at the time, it is fully integrated into the building air handling system and capable of delivering 40,000 CFM. It is supplied with natural light and supplemented with architectural lighting, and contributed towards the building receiving a 2005 award of excellence from the Royal Architecture Institute of Canada.



Photos courtesy of Nedlaw Living Walls Inc.



Indoor air biofilters can be readily integrated into a variety of vertical wall locations within a building.

(ppb) of VOCs in each. In essence, the indoor air biofilter was found to be transforming the indoor air to the quality of fresh outdoor air in terms of VOC content.

Indoor air biofilters also contribute to removal of particulate matter in the air. Commonly this is the role of filtration in HVAC systems which may use High-Efficiency Particulate Air (HEPA) filters rated to capture different sizes of airborne particles. They do nothing however, to control the gaseous chemicals in the air such as VOCs since they are specifically designed to trap particles. As these particles are collected, the filters get dirty and clog and need to be cleaned or replaced periodically, creating an ongoing maintenance and disposal requirement. By contrast, an indoor air biofilter uses the extensive surface of the plant material to significantly reduce airborne dust particles in addition to reducing chemical contaminants. This means that the system works very effectively as a total air “pre-filter” before the processed air enters or returns to the HVAC system. Dust particles collected in the biofilter are then washed away by the flowing water cascading down as part of the hydroponic process. This natural method of getting rid of

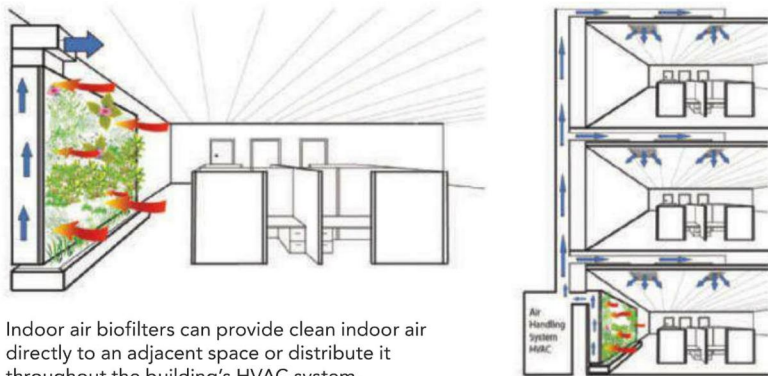
contaminants means that the disposal issues are virtually eliminated.

The presence of an indoor air biofilter also creates an improved work environment that incorporates green plantings and the associated lighting that goes along with those plantings. Essentially, this brings the psychological benefits of nature to the indoor environment. Numerous studies have shown that people may first respond emotionally to this benefit, but scientific evidence supports real physical and psychological benefits from buildings that incorporate natural features and plant life. Buildings with biophilic-inspired elements have been demonstrated to provide psychological benefits to their occupants in a variety of ways. Studies show that workers in offices with views to nature tend to feel less frustrated, more patient, report higher levels of overall satisfaction and well-being, and are therefore more productive employees. These benefits coupled with the indoor air quality improvements lead to decreases in common office ailments (e.g., less fatigue and fewer headaches, sore throats, coughs, and dry skin issues), decreases in employee absenteeism, and typically increased employee productivity. One of the more difficult human resource

challenges is actually not “absenteeism” but termed “presenteeism,” which is lost productivity as people mentally “check out.” An improved workplace with a varied environment and sensory stimulus allows for people to be happier, more relaxed, and stay “tuned in” longer. Since the cost of employees is a major line item in most companies’ budgets, recognizing the correlation between indoor environmental quality, absenteeism, illness, and worker productivity is important. Some estimates put worker salaries at 35 to 40 percent of the typical company’s budget such that even small investments in employee health, productivity, or employee retention can have enormous impacts on the overall profitability of the company.

Of course every green building is also concerned with the energy used to run the various building systems and here an indoor air biofilter can contribute significantly as well. Recent studies indicate biofilters are typically constructed to deliver 50 liters of “virtual outside air” per square meter of biofilter per second. This cleaned air can be integrated into the building in one of two ways. The first mode of operation is to keep ventilation rates the same and use the biofiltered air to augment what is being brought in from outside. Under this scenario, the occupants will enjoy a substantially higher IAQ since 30 percent reductions in airborne pollutants are expected, increasing the wellbeing of the occupants. There will be a small nominal increase in energy since the HVAC system will run normally while lights and water pumps associated with the biofilter will also need to run. The preferred, energy-efficient alternative mode of operation is to use the biofiltered air to actually replace the need for bringing in the full amount of outside air. Here, the building operator reduces the amount of outside air while the occupants do not experience any change in IAQ. This reduction in the amount of outside air brought into the space could reduce the capital costs (smaller HVAC units required) and/or operating costs (conditioning of smaller volumes of outside air)

Image courtesy of Nedlaw Living Walls Inc.



Indoor air biofilters can provide clean indoor air directly to an adjacent space or distribute it throughout the building’s HVAC system.

of the building. Both scenarios have pros and cons of course that need to be looked at for each specific building, but it is also possible that they need not be mutually exclusive—controls could allow for either scenario to operate based on need and occupancy of the building.

Although conceptually a simple system, the successful implementation of an indoor air biofilter requires integration of a range of design issues. Nonetheless, the flexibility of the various components enables a range of aesthetic outcomes.

### INTEGRATING AN INDOOR AIR BIOFILTER INTO A BUILDING

As described thus far, the use of an indoor air biofilter involves the creation of a wall of hydroponic plants with circulating water and air that is integrated into the various other systems of a building such as the structure, HVAC and electrical systems. The place to start is by first assessing where and how large an area to make available for the indoor air biofilter. Typically, this means that a vertical wall area in an open area of the building needs to be available such as in an atrium or open stairway area. It could also be the wall of a gathering place, lobby, a central area, or a passageway. This vertical wall approach provides the maximum possible green space with minimum use of floor space. The vertical wall itself serves as the basic structural support for the components of the system and will need to be confirmed that can accommodate the additional load. Typically,

an indoor air biofilter will add approximately 11 to 16 pounds of dead load per square foot of green surface area. Allowing for this additional load should be readily accommodated in most building designs.

Once the location and loading are accounted for, the next area to integrate with is the HVAC system. Two different approaches are possible here. First, the indoor air biofilter can be constructed with internal or onboard air handling fans that can be used to draw air through the biofilter then release that cleaned air directly back into space that it is serving. This makes it a fairly closed system that serves the immediate surrounding space but not the rest of the building, although it is certainly possible to duplicate this approach multiple times throughout a building. Air flow generated by the building HVAC system would not likely be impacted by this first approach, although supply and return grilles would need to be located to complement, not compete with the biofilter fans. The second approach is to connect the biofilter directly to the HVAC system. In this case the HVAC fans draw the indoor air through the biofilter and distribute the cleaned air throughout the building.

When looking at the HVAC integration, it is important to consider both the quality of clean air generated and the quantity of air treated. Quality speaks to the efficiency and effectiveness of the indoor air biofilter removing contaminants as discussed previously. The quantity of air comes into play when

### WESST CORP.

Built: January 2009

Architects: Diamond and Schmitt Architects

Address: Albuquerque, New Mexico  
This LEED Silver building was among the first indoor air biofilters constructed in the United States. A great project that incorporates great natural light emitted through the glass fronting exterior wall.

determining what rate clean air can be delivered either to a contained area or to a full HVAC system. This is captured as a clean air delivery rate (CADR) which is calculated as the removal efficiency (expressed as a percentage) multiplied by the velocity of the air flowing through the system usually measured in cubic feet per minute (cfm). Hence, if a biofilter is working at 85 percent efficiency, then it will produce 85 cfm of clean air for every 100 cfm of air brought into the system. Note that this means the output of clean air is not limited by the biology of the system rather it is limited only by the amount of air flow into biofilters. Within typical operating conditions, the more air that goes in, the greater the quantity of clean air that goes out.

Since this is a hydroponic (water-based) system, a good quality water supply is needed. The typical approach is for a catch basin or reservoir to be included at the base of the biofilter to hold a small reserve of water. This water is then pumped from this basin up to the top of the system and flows down through the biofilter to nourish the plants that are hosting the beneficial microbes. Note that if this basin is kept filled with water and in some cases stone, then it could reach over 130 pounds per square foot of floor area which will need to be accommodated. The basin will need occasional maintenance, so a drain must be provided for that purpose or simply for the purpose of regulating the water level in the basin. Note that depending on the quality of the water provided, there may be some occasional salt build up in the basin or the rest of the system that will require periodic draining and cleaning.

Continues at [ce.architecturalrecord.com](http://ce.architecturalrecord.com)

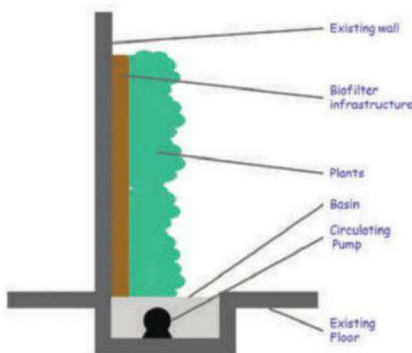
**Peter J. Arsenault, FAIA, NCARB, LEED AP**, practices, consults, and writes about sustainable design and practice solutions nationwide.

**Alan Darlington, PhD**, is a researcher in addition to being the founder and president of Nedlaw Living Walls.

Images courtesy of Nedlaw Living Walls Inc.



A biofilter mounted directly on the wall can be constructed in a variety of sizes and in a variety of locations.



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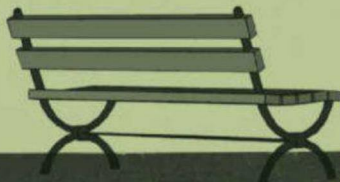
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MANAGE  
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DeepRoot

# Design Options for Greening Urban Environments

## Green infrastructure versus grey infrastructure

Sponsored by Bison Innovative Products, DeepRoot Green Infrastructure, greenscreen®, Invisible Structures, Inc., and IRONSMITH, INC. | By Elena M. Pascarella, PLA, ASLA

**W**ith each new project, architects, landscape architects, engineers, and other design professionals are being asked to provide solutions that are sustainable, meet criteria for low-impact development (LID), and provide holistic environments that enhance the social, psychological, and economic aspects of a community as well as the living systems of the earth. As designers, our ability to turn existing man-made or “grey” infrastructure into “green” infrastructure can assist in achieving these holistic goals.

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#### Learning Objectives

After reading this article, you should be able to:

1. Recognize the benefits of urban green spaces in reducing energy consumption by mitigating the heat island effect and enhancing the health and well-being of people within the urban environment.
2. Identify design solutions that can help to sustain and recapture urban landscapes and bridge the interface between the built, man-made (“grey” infrastructure) and “green” environment.
3. Discuss some of the techniques that enable expansion of green space above and around buildings, capture rain and stormwater at the point source and improve water quality, and enhance the urban environment for plants, wildlife, and people.
4. Describe which LEED® and Sustainable Sites Initiative credits may be obtained through the use of green walls, green roofs, structural soil systems, and suspended pavement systems to achieve increased urban green space, better management of stormwater, increased reduction of heat island effect, and improvements in urban ecosystems.

To receive AIA/CES credit, you are required to read the entire article and pass the test. Go to [ce.architecturalrecord.com](http://ce.architecturalrecord.com) for complete text and to take the test for free.

AIA/CES COURSE #K1211F



At 5c Studios in Tempe, Arizona, green façade systems or green walls provide a building-site interface to improve urban air quality and building energy efficiency.

The Center for Green Infrastructure Design (CGID)<sup>1</sup> defines green infrastructure as “an interconnected network of natural and social systems that provide a diverse range of environmental, cultural, recreational, psychological, public health, and economic benefits.” The CGID states that “green infrastructure conserves environmental values and functions, sustains clean air and water, promotes a sustainable economic regional framework, and contributes to the health and quality of life for our residents.”

The new International Green Construction Code (IgCC) as well as LEED® and SITES™ criteria provides a framework of standards that focus on achieving green infrastructure for projects.

The IgCC code establishes minimum green requirements for both new and existing buildings and includes sustainability measures for the entire construction project and its site starting with the design and going through construction to the certificate of occupancy and project commissioning. The new code is looking to address the built environment from a holistic perspective, making buildings more efficient, reducing waste, and creating positive impacts on health, safety, and community welfare.

The LEED for Neighborhood Development (ND) criteria will expand the LEED criteria beyond the building envelope and the immediate site and will provide criteria for sustainable neighborhoods. LEED ND categories of Neighborhood Pattern and Design and Green Infrastructure and Buildings provide credits in areas that stress heat island reduction, tree-lined and shaded streets, building energy efficiency, building water efficiency, stormwater management, and recycled content in infrastructure.

The guidelines and benchmarks for The Sustainable Sites Initiative or SITES™ present nine categories with standards for protecting and restoring hydrology, soil and vegetation, repairing damaged ecosystems and resources, minimizing the effects of construction, and supporting and maintaining sustainability.

These new codes and criteria provide a framework for designers as they work to achieve green environments. However, urban areas present many challenges towards the creation of a green environment. This article will highlight some recent innovations that help achieve and sustain green infrastructure within the framework of man-made (grey) infrastructure and will review current trends and materials that help to recapture and enhance urban green space, enhance urban arboriculture, enhance water quality and reduce stormwater runoff, achieve energy efficiency, and overall, integrate sustainable design solutions for bridging the



Modular decking on the green roof of the Visionaire Condominium in New York City meets LEED credit in Materials and Resources.

## THE VISIONAIRE, NYC

The Visionaire is New York City's first LEED Platinum-certified condominium project. This project used a modular decking system for their roof patio and as access to their green roof plantings. The Visionaire features a green roof covering 70 percent of the rooftop. The decks on the Visionaire used FSC Massaranduba Tiles and thus qualified for LEED credits. The pedestals have recycled content and thus provided a credit through Materials and Resources.

This project also qualified for a tax credit through a 2008 New York City bill (A.11226)

that allowed building owners in New York City who install green rooftops to receive a property tax credit. Under this law, building owners in New York City who install green roofs on at least 50 percent of available rooftop space can apply for a one-year property tax credit of up to \$100,000.

These modular decking systems protect and extend the life of costly roofing and waterproofing systems, and reduce heat and cold penetration into the building so they provide a means of reducing energy and the related costs.

building-site (grey-green) interface.

Sustainable green infrastructure begins with providing appropriate conditions for the growth and maintenance of vegetation. It is essential that planting areas provide sufficient room for plant growth and provide a planting medium that is loose, friable, and containing sufficient organic matter so that soil can retain porosity for air circulation and water absorption. Sustainable urban green space can be attained through a number of innovations that provide plantable soils, pervious and flexible pavement systems, urban tree protection, vertical planting frames, and flexible surfaces for roof insulation.

### RECAPTURING AND ENHANCING URBAN GREEN SPACE

According to the U.S. Forest Service Urban and Community Forestry Report, June 2010, *Sustaining America's Urban Trees and Forests: Forests on the Edge*, "...tree cover in urban areas of the conterminous United States is estimated

at 35.1 percent (20.9 million ac). As urban areas expand, the amount of urban forest will increase and urban forests will become increasingly critical to sustaining environmental quality and human well-being in urban areas. Careful planning and management will be crucial to maintain and enhance urban forest benefits."

Mature urban forests provide innumerable benefits to a community. They reduce and slow stormwater runoff; serve as habitat for birds, mammals, and insects; reduce energy consumption; mitigate extreme temperature fluctuations; reduce heat island effects; enhance air quality; remediate contaminated soils; help to moderate climate change; and provide attractive, healthy living environments for people. However, urban trees rarely live to their mature age due to the challenges of survival in the urban environment. These challenges include compacted soils, poor hydrology, and constraints to trunk expansion and root growth from urban infrastructure.

Photo courtesy of Bison Innovative Products

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Exteriors: Urban Gray to Green CEU in this issue



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### Providing Better Soil Structure for Urban Forests

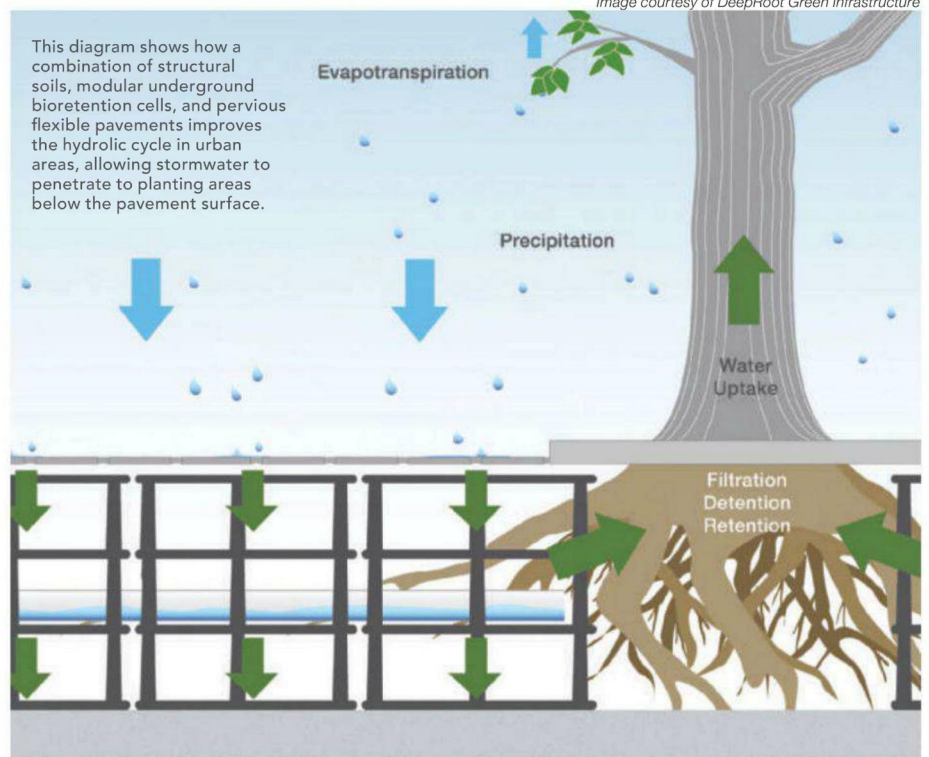
Structural soils are one means of providing urban trees with the medium essential to proper growth and sustainable long-term viability. A study conducted at the Urban Horticulture Institute at Cornell University (N. Bassuck, J. Grabosky, P. Trowbridge, J. Urban) introduced structural soils as a medium for integrating trees into pavement. Structural soils are designed to meet or exceed pavement design standards so that pavement compaction levels can be achieved while the soil remains sufficiently “porous” for root growth and stormwater penetration. Structural soils also provide a continuous base course under pavements for tree root growth.

### Expanding Plantable and Structural Soil Areas

However, structural soils—which are 80 percent rock and only 20 percent soil—in and of themselves are not sufficient in sustaining urban trees. At the 2011 Greenbuild conference, James Urban, FASLA, a contributor to the Cornell University study stated, “structural soils, which combine broken up rock and soil, have issues so urban tree planters came up with a new idea: suspended pavements.” Suspended pavements are constructed with either custom concrete systems or modular products like underground bioretention cells. Modular underground bioretention cells support the pavement while allowing plantable soil as well as underground irrigation systems to be installed below pavement. These cells contain the soil volume that nurtures trees and also slows and treats water before it is piped out. Leda Marritz, ISA-certified arborist for DeepRoot Green Infrastructure, states that modular underground bioretention cells may be used in urban environments such as streets, plazas, parking lots, green roofs, and more in order to expand urban tree plantings and manage stormwater on-site. (See case studies online for more information.)

### REDUCING URBAN HEAT ISLANDS AND STORMWATER RUNOFF

Paved urban environments present challenges with the management of stormwater and the excessive heat that emanates from these pavements. Urban pavements are traditionally non-pervious rigid materials. Flexible pavements are defined by AASHTO (American Association of State, Highway and Transportation Officials) as being one of four standard pavement surfaces. By AASHTO definition: “Flexible pavements in general consist of an asphalt-bound surface course or layer on top of unbound base and sub base granular layers over the subgrade soil. In some



cases, the sub base and/or base layers may be absent (e.g., full-depth asphalt pavements); while in others the base and/or sub base layers may be stabilized using cementitious or bituminous admixtures. Drainage layers may also be provided to remove water quickly from the pavement structure.”

Although newer porous asphalt and concrete pavements are by design sufficiently permeable so that water can penetrate through, their inherent density and their subsurface design and compaction requirements, which provide a suitable surface for vehicular traffic, do not allow for the installation of structural soils underneath.

### Pervious Flexible Pavements

A pervious flexible paving system can provide another design solution in addition to suspended pavements for enhancing green space and transitioning from grey to green infrastructure. Pervious flexible paving systems can utilize either sand with seed/sod/ groundcovers or gravel as filler materials. Both options provide benefits toward filtering and mitigating stormwater runoff and enhancing site ecology. Unlike standard gravel pavement surfaces, a gravel pervious flexible pavement system has added stability and prevents gravel migration as the gravel is contained by the grid paver system. It is dust free, easy to install, and very low maintenance.

Dustin Glist, media and information director for Invisible Structures, Inc., cites the following benefits of pervious flexible paving systems:

- ▶ Reduced site disturbance
- ▶ Enhanced stormwater management
- ▶ Reduced heat island effect
- ▶ Reduced water use through water efficient landscaping
- ▶ Erosion and sediment control
- ▶ Enhanced safety as a result of emergency access to tight urban areas
- ▶ Enhanced urban green space

The primary applications for grass/lawn pervious flexible pavements include residential drives and parking areas, pedestrian traffic zones, utility access areas, fire/emergency access areas, and parking lots. Some examples of this include the parking lot at the West Farms Mall in West Hartford, Connecticut; the parking lot at Reliant Stadium, Houston, Texas; road shoulder reinforcement in Calgary, Alberta, Canada; and fire/emergency access lanes at the Koll Center in Irvine, California.

The Koll Center used 6,000 square feet of grass pervious flexible pavement system to create a porous fire lane around the building. The grass pervious flexible pavement system is located on the south end of the building and within a parking lot. Koll Center is a complex of buildings centered around a beautifully designed outdoor fountain and pedestrian mall.

Image courtesy of DeepRoot Green Infrastructure

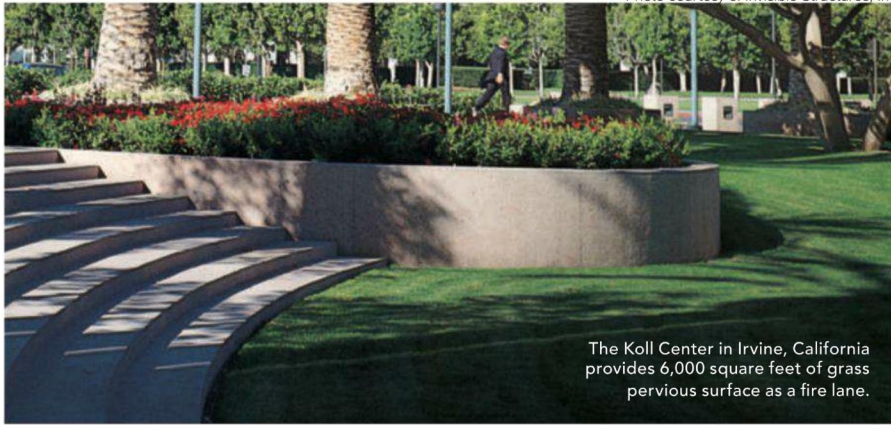


Photo courtesy of Invisible Structures, Inc.

The Koll Center in Irvine, California provides 6,000 square feet of grass pervious surface as a fire lane.

### Pervious Flexible Pavement System Standards

A grass pervious flexible pavement system is best used for light to moderate vehicular use and to reinforce turf. It helps to filter and treat stormwater pollution, reduce heat island effect, and enhance tree growth in parking areas. Since porous pavers drain more rapidly than regular pavers, more water must be applied during the first year after initial seeding to ensure a solid stand of grass. Chemicals cannot be used to remove snow from a grass pervious flexible pavement as these chemicals will degrade the grass and can rapidly leach into the ground water. As with any type of porous pavement, there are also slope restrictions with the use of pervious flexible pavement systems, which include the following:

- ▶ 5 percent maximum slope for fire lanes
- ▶ 8 percent maximum slope for parking areas
- ▶ 15-20 percent slopes for trails and walkways

Pervious flexible paving systems that involve the development of a lawn/grass help to recharge groundwater, reduce stormwater runoff volume, capture suspended solids, clean hydrocarbon drips and pollutants, and protect the grass root zone from compaction so a healthy lawn can be maintained.

A gravel pervious flexible pavement system can be used for parking aisles and bays, ADA and multiple use trails, service and access drives, fire lanes, driveways, RV parking, boat and truck storage, boat ramps, and high-use pedestrian areas. A gravel pervious flexible pavement system has unlimited use in lower-speed vehicular traffic. It can also be used for ADA multiple use trails. The benefits include providing a pervious load-bearing surface, reducing heat island effect, and filtration and treatment of stormwater.

Both grass and gravel systems are made from high-density polyethylene and from second-generation post-industrial recycled products. This material also has a UV protective coating to prevent breakdown from exposure to the elements. Both grass and gravel systems also meet industry standards to support the compressive strength and weight of heavy vehicles such as fire trucks.

### RESTORING URBAN ARBORICULTURE

The Society of Municipal Arborists (SMA) has a slogan that reads “Green Communities are Smart Communities—That’s Why Trees!” The SMA provides resources and studies relating to the many ways that trees improve the environment. In urban areas, trees assist in traffic calming along streets, reduce energy through shading, mitigate drainage and flooding problems through stormwater management, and improve quality of life and health through reduction in pollutants and aesthetic enhancement. Urban reforestation would help to achieve many of the above-mentioned goals and attain LEED® and SITES™ credits for certifications.

In a 2002 report, David J. Nowak of the USDA Forest Service summarized the energy effects of trees on buildings. “Trees reduce building energy use by lowering temperatures and shading buildings during the summer and blocking winds in winter. However, they also can increase energy use by shading buildings in winter, and may increase or decrease energy use by blocking summer breezes. Thus, proper tree placement near a building is critical to achieve maximum building energy conservation benefits.”

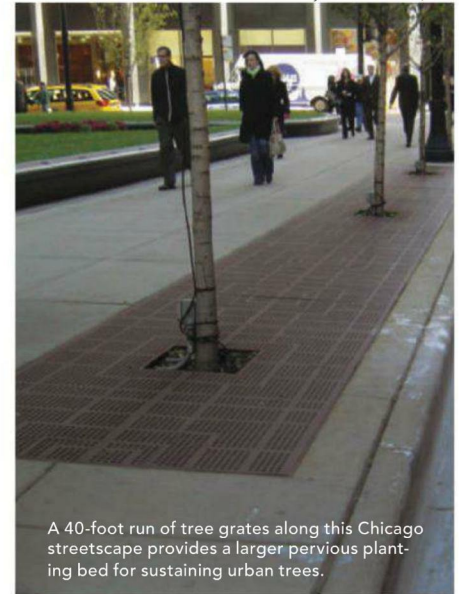
Although urban forests provide many benefits to the health and welfare of urban communities, there are many challenges to

proper placement and installation of trees within the urban infrastructure. Structural soils, modular underground bioretention cells, suspended pavements, and pervious flexible pavement systems are all options for providing sustainable planting environments for trees and lawn areas with the man-made infrastructure. Providing the appropriate volume and planting medium for trees is not the only consideration. Tree placement on sidewalks must also consider universal accessibility and safety for pedestrians.

### Integrating Trees into the Urban Landscape

Tree grates have been used for many years to help integrate trees into the urban hardscape. Tree grates provide surface exposure to air and water that trees require and provide a walkable surface for pedestrians. Tree grates also keep areas around trees free of litter and animal waste so they provide a sanitary benefit as well. Tree grates come in a range of sizes, colors, and grate patterns. In Chicago, for example, a square steel tree grate with small 1/2-inch square openings set in a grid pattern was selected to create a 40-foot run of individual tree grates that provided an extended street tree planting area. By providing extensive tree planting along the street edge, this installation greatly reduced the urban heat island effect within this urban area.

Photo courtesy of IRONSMITH, INC.



A 40-foot run of tree grates along this Chicago streetscape provides a larger pervious planting bed for sustaining urban trees.

See endnotes in the online version of this article.

▶ Continues at [ce.architecturalrecord.com](http://ce.architecturalrecord.com)

### Paver-Grate™

Suspended pavement system allows installation of unit pavers over tree planting area and greatly reduces weeds and trash accumulation.



tree grates



trench grates



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### Paver Grate System

Paver-Grate™ is a unique solution to continuing unit pavers over tree plantings or other sub grade elements. The system allows increased pedestrian area and a seamless design look allowing greater room for trees and pedestrians.

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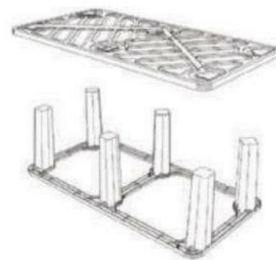


### Porous Paving

Grasspave<sup>2</sup>, from Invisible Structures, Inc., is an industry leader in porous paving. Grasspave<sup>2</sup> is a beautiful way to reinforce turf for parking lots, driveways, access roads, and firelanes. Grasspave<sup>2</sup> is environmentally friendly and provides a natural filtration system for automobile and parking-lot runoff.

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## DeepRoot Green Infrastructure

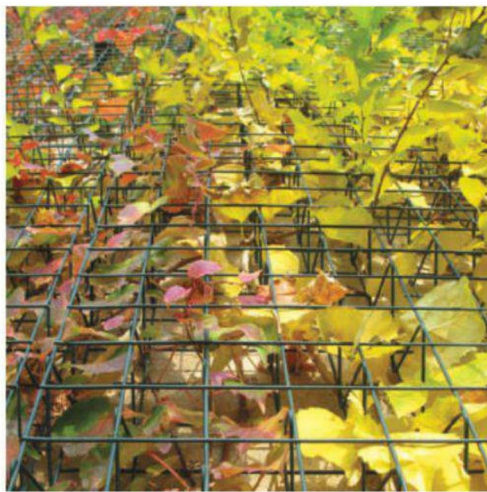


### Modular Tree & Stormwater Management System

The Silva Cell is a modular suspended pavement system that uses soil volumes to support large tree growth and provide powerful on-site stormwater management through absorption, evapotranspiration, and interception.

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***Considerations for Advanced Green Facade Design***

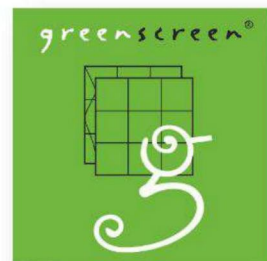
Topics discussed include: integrated design teams, green policy initiatives, shading benefits and building energy efficiency research, specifications, system selection, plants, soils, maintenance, lifecycle, LEED® and SITES™ credit contributions, case studies and client expectations....

**Continuing Education credit through AIA, USGBC, and ASLA.**

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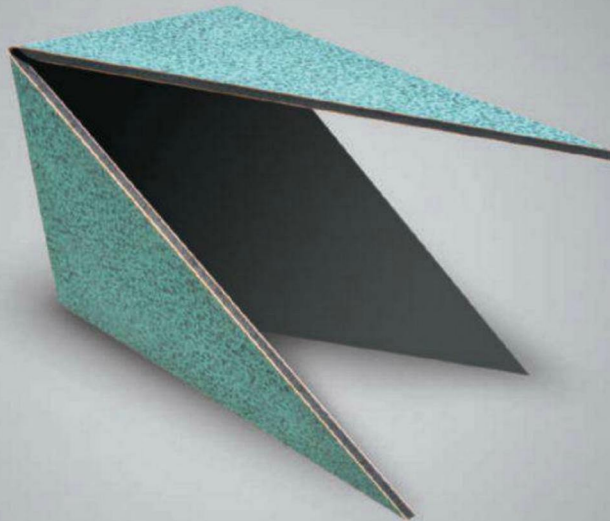
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ALPOLIC Natural Metals deliver the elements you need to make your unique vision real. ALPOLIC Copper, which is also available in a post patina finish, adds beauty and depth to any building façade. Other ALPOLIC metals – Stainless Steel, Titanium, Zinc – project an image of high-tech sophistication like nothing else. For both interior and exterior applications, the Natural Metals Series is part of the largest offering of Aluminum and Metal Composites on the market today and, like all ALPOLIC ACM and MCM cladding materials, it's as outstanding in performance and value as it is in appearance. **For more information please visit us at [www.alpolic-northamerica.com/naturalmetals-series](http://www.alpolic-northamerica.com/naturalmetals-series).**

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MATERIALS

MITSUBISHI PLASTICS COMPOSITES AMERICA, INC.



# Innovative Metal Solutions for the Built Environment

High-performance metal products achieve sustainable, cost-effective results

Sponsored by Alcoa Architectural Products, ALPOLIC Materials, CENTRIA, Chicago Metallic, and Metl-Span | *By Barbara A. Nadel, FAIA*

**F**rom exterior building envelope walls and roofing to interior ceiling systems, metal offers a variety of innovative products, composites, and sustainable design solutions suitable for any climate and building type. Extensive building industry research has led to exciting new products and advanced proven technologies that define building industry standards.

The word metal is derived from the Ancient Greek metallon, and the Latin metallum, for “mine, quarry, mineral.” Metal is an element, compound, or alloy that is a good conductor of electricity and heat. As building components, metals offer many desirable qualities, especially in combination with other building components. Metals are usually malleable, formable, and can be hammered or pressed permanently out of shape without breaking or cracking. They are durable, ductile, shiny, and therefore reflect most incident light. Metals provide insulation, are highly recyclable, and sustainable. Metals are compatible with paints and coatings, and available in finishes and colors to meet any design requirement.

## CONTINUING EDUCATION



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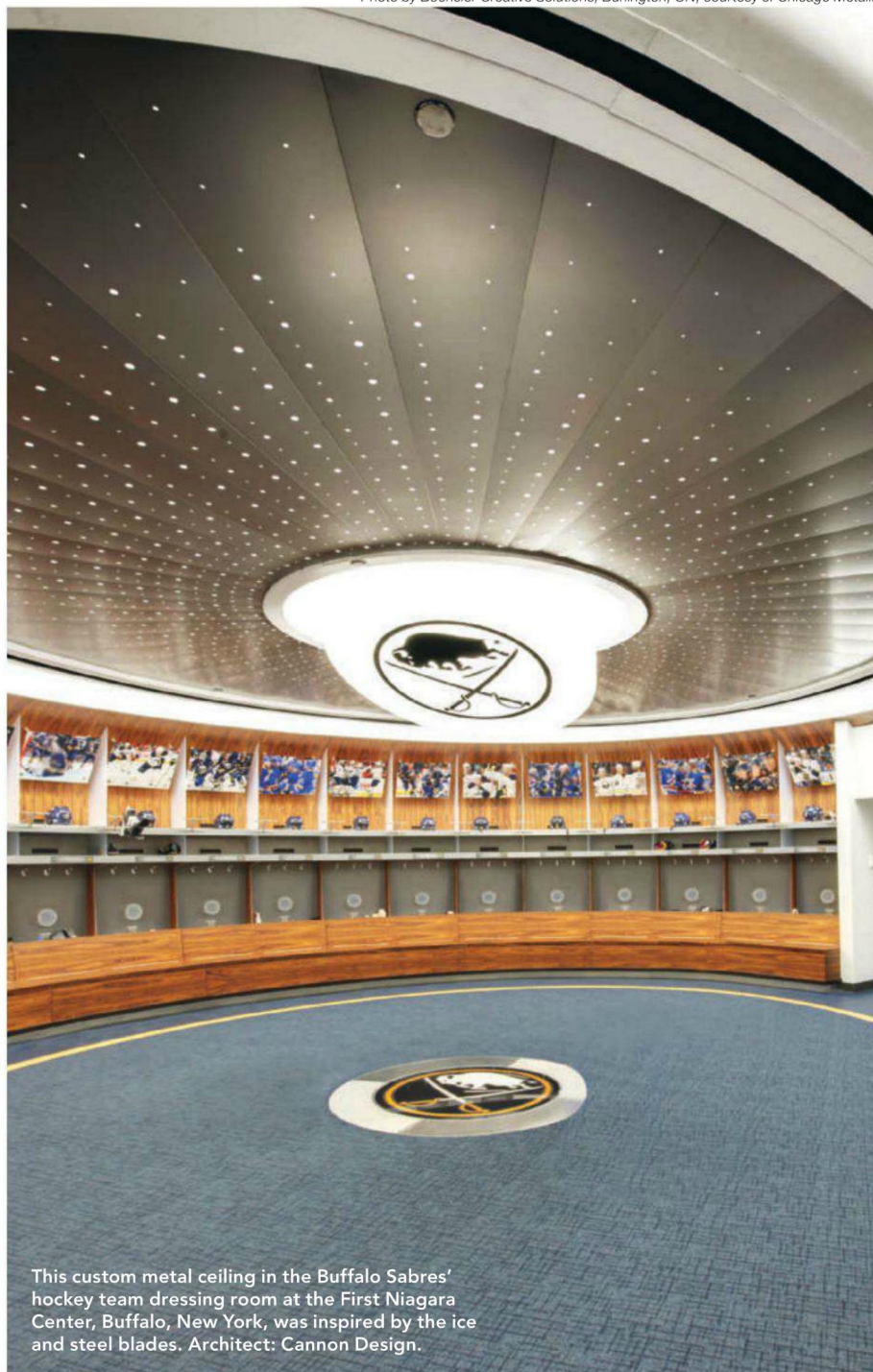
After reading this article, you should be able to:

1. Analyze how titanium dioxide coil-coated aluminum architectural panels can clean buildings and improve air quality, while reducing building maintenance costs.
2. Evaluate the impact of building codes, acoustics, corrosion, and materials when specifying metal ceiling systems.
3. Describe the long-term benefits of using metal panel roofing systems with photovoltaic solar arrays.
4. Explain how insulated metal wall and roofing panel systems lower building energy costs and improve thermal comfort of building occupants.

To receive AIA/CES credit, you are required to read the entire article and pass the test. Go to [ce.architecturalrecord.com](http://ce.architecturalrecord.com) for complete text and to take the test for free.

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*Photo by Bochsler Creative Solutions, Burlington, ON; courtesy of Chicago Metallic*



This custom metal ceiling in the Buffalo Sabres' hockey team dressing room at the First Niagara Center, Buffalo, New York, was inspired by the ice and steel blades. Architect: Cannon Design.

Self-cleaning buildings were unheard of a few years ago but they are now keeping skylines and outdoor air cleaner. Insulated metal wall and roofing panels are proven, energy-efficient systems that are constantly updated and refined to meet emerging technology, building codes, sustainability, and project needs. Metal ceiling systems have a wide range of features and design flexibility to bring visionary concepts to reality, while meeting code requirements.

Reputable U.S. building product manufacturers comply with a multitude of American building codes and performance standards. Many use independent physical testing programs to meet and exceed code requirements on issues such as water penetration, uplift ratings, fire protection, seismic and structural performance. When specifying metal products and panels, architects should verify if products have undergone rigorous testing in the U.S. to ensure reliable performance. Building materials and products are often tested and certified against standards by recognized research organizations such as the American Society for Testing and Materials (ASTM), Underwriters Laboratories (UL), and Factory Mutual (FM).

#### INDUSTRY TRENDS

According to George Rosado, commercial director for Alcoa Architectural Products, “Emerging trends indicate an increasing number of imported metal products. However, using them involves great risk, because there is no control over whether these imports will meet North American building codes and industry standards.” U.S. contractors have no control over what actually gets shipped, and whether appropriate testing and verification is even available on imported materials. If an imported material fails to perform, contacting an overseas manufacturer for replacement may

*Photo courtesy of Metl-Span*



An insulated metal panel system at Pacific Plaza, Tacoma, Washington, provides an air and vapor barrier. Architect: BLRB Architects.

*Photo by Mark Kempf Photography; courtesy of Alcoa Architectural Products*



The 10-story, 375,000-square-foot Seidman Cancer Center in Cleveland, Ohio, features 59,000 square feet of brushed aluminum composite material on the exterior and the interior building fascia, soffits, and parapet panels. Architect: Cannon Design.

be problematic. The risk can be significant, when the effects of failure, lost downtime, replacement, bonding, and insurance are considered.

Metal ceilings for commercial applications are gaining in popularity in the U.S. after decades of use as building standards in Europe. Public structures such as airports, subways, universities, and office buildings are benefiting from the durability and accessibility of metal ceilings. These applications illustrate the variety of finishes available on metal ceilings, says Edward Williams, business unit manager for metal ceilings at Chicago Metallic.

“Insulated metal panels (IMPs) are highly efficient building envelope products with multiple benefits. Their high R-values and insulating qualities lower heating and cooling costs year-round. IMPs contribute significantly to sustainability and LEED points,” says Doug Pickens, vice president of marketing, Metl-Span.

#### SELF-CLEANING BUILDINGS

Aluminum is the most abundant metal in the earth’s crust, comprising about 8 percent by weight of the earth’s solid surface. Aluminum is silvery white, insoluble in water under normal circumstances, and is known for its ability to resist corrosion. Structural components made from aluminum and its alloys are vital to the building, transportation, and aerospace industries. Due to its infinite recyclability, aluminum could be considered

a manufactured natural resource. At present, almost 75 percent of all the primary aluminum ever produced since 1888 is still in productive use today.

Aluminum composite material is a composite panel consisting of an extruded thermoplastic compound core that is fusion-bonded in a continuous process between two sheets of coil-coated aluminum, brushed aluminum, zinc, stainless steel, titanium, or copper. The result is a highly corrosion-resistant, rigid, flexible material that weighs 3.4 times less than steel and 1.6 times less than pure aluminum.

Aluminum composite panels are flat, malleable, lightweight, durable, and can be painted in a range of colors and finishes with exterior warranties up to 30 years. They integrate easily with most curtain walls, creating a seamless look on building facades. This highly formable material can be used to create curves and design accents.

A new technology is available to assist building owners and architects in addressing building maintenance. An innovative coating, when applied to aluminum composite materials, can help buildings become self-cleaning. Research shows that titanium dioxide coil-coated aluminum architectural panels remove pollutants by using sunlight, water vapor, and oxygen in the air to clean the air around it. Titanium dioxide coil-coated aluminum architectural panels are appropriate



# Reynobond®

Architecture



## Cleaner buildings. Cleaner world.

Imagine a world where buildings can clear the air while they clean themselves. Thanks to the innovative science behind Reynobond® with EcoClean™, architects can now design structures that literally make our environment cleaner. Reynobond with EcoClean actively works to remove smog and other pollutants by using sunlight, water in the air and oxygen to break down organic matter. When it rains, instead of beading up, water will flatten and sheet off on both horizontal and vertical surfaces. As water collapses and runs evenly off the building, organic matter is taken away.

Alcoa Architectural Products developed this proprietary process that leverages HYDROTECT™ technology from TOTO® to apply a titanium dioxide coating, called EcoClean, to the pre-painted aluminum surface of Reynobond. This photocatalytic coating destroys organic pollutants in a reaction with UV light. The result is the world's first coil-coated aluminum architectural panel that helps to clean itself – and the air around it.

Cleaner air, a cleaner building and lower maintenance costs: another example of Excellence in Innovation from Alcoa Architectural Products to change our world for the better. Find out more at [reynobondwithecoclean.com](http://reynobondwithecoclean.com).



CIRCLE 23





IS THE NEW

**Metl-Span's INNOVA3 Insulated Metal Wall Panel sets the new industry standard for thermally efficient architectural panels.** This 3" thick continuous insulation panel delivers a tighter building envelope while meeting the most rigorous sustainability and energy requirements. Its beautiful, sophisticated appearance makes the INNOVA3 ideal for high-profile applications and provides endless design options for any façade. And, when it comes to performance, durability and ease of installation, bigger really is better.

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Photo by Mark Kempf Photography; courtesy of Alcoa Architectural Products



The canopy at the Piedmont College Arrendale Amphitheater, Demorest, Georgia, was sculpted from aluminum composite material to reflect the natural environment bordering the site. Architect: Armentrout Roebuck Matheny Consulting Group.

for office buildings, retail facilities, car dealerships, chain restaurants, elementary schools, and other applications.

### Titanium Dioxide Coatings

Titanium dioxide is a widely used white compound known for its strong ultraviolet (UV) light-absorbing capabilities and its resistance to discoloration under UV light. In powder form, titanium dioxide is an effective pigment that provides whiteness and opacity to products such as paints, coatings, plastics, papers, inks, sunscreen, medicines, and toothpaste, as well as quick-setting concrete and tile grout. Titanium dioxide naturally attacks organic pigments in paint. An innovative titanium dioxide coil-coating process protects paint and enhances paint finish performance, while providing environmental and cleaning benefits. When combined with aluminum, the result is a process that could not occur with either material alone.

### Environmental Benefits

Titanium dioxide has two unique effects. If exposed to sunlight, titanium dioxide acts as a catalyst to break down organic matter, while also creating a superhydrophilic (water-loving) surface. When a titanium dioxide coating is applied to the pre-painted aluminum surface of a metal composite panel, the result is a coil-coated aluminum architectural panel that cleans itself and the air around it.

As a photocatalyst, titanium dioxide interacts with sunlight to break down organic matter on and around the surface of building panels, leaving organic matter on the surface of an aluminum composite panel ready to be washed away. When it rains, water doesn't bead on the surface, but instead runs evenly down the building, removing grime and pollutants.

Buildings are exposed to many organic contaminants. From bird residue to diesel fumes, architectural building panels are constantly exposed to organic material that makes these surfaces appear dirty.

Nitrogen oxide is an organic material constantly bombarding buildings that is harder to see. As the primary component of smog, nitrogen oxide makes buildings dirty and threatens the quality of outdoor air. When nitrogen oxide molecules float near the surface of titanium dioxide coil-coated aluminum architectural panels, they are attacked by free radicals generated from the titanium dioxide reacting with water and oxygen in the air. The free radicals oxidize the nitrogen oxide molecules, converting them into harmless nitrates. Other contaminants are similarly broken down through sunlight's reaction with titanium dioxide, leaving them ready to be washed away. Titanium dioxide coil-coated aluminum architectural panels effectively remove pollutants by using sunlight, water vapor, and oxygen to clean the air.

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Studies show that 10,000 square feet of a titanium dioxide coil-coated aluminum architectural panel have the approximate cleansing power of 80 trees.

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Once the titanium dioxide has done its job—broken down and destroyed the nitrogen oxide and other organic matter on the aluminum composite material—a second major benefit, creating a superhydrophilic surface, comes into play.

Because the titanium dioxide coil coating is superhydrophilic, the surface of aluminum

composite materials becomes very slick in the presence of water. Instead of beading on the surface, rainwater runs evenly off the aluminum panels, taking most of the organic matter and nitrates with it. This helps eliminate the tiger-striped look that often appears on building surfaces around caulk joints, air ducts, and roof water discharge points. The slightest amount of rain or humidity in the air creates the effect; even morning dew activates the process. Each time it does, the water running off the building carries away broken-down contaminants, leaving the building surface cleaner.

### Reduced Maintenance Costs

By constantly breaking down organic matter through its photocatalytic properties, and washing material away through its superhydrophilic properties, titanium dioxide coil-coated aluminum architectural panels can significantly reduce facility maintenance costs. This process helps maintain the building image and appearance over time as first requested by the owner and envisioned by the architect.

The primary indicator that a titanium dioxide coating is working effectively is the building appearance. When exposed to UV light, exterior building panels treated with titanium dioxide coating will be cleaner than those of surrounding structures. The reaction that enables the building surface to maintain its appearance works equally in removing smog and other pollutants. Based on independent testing, findings from a scientific third party confirm that a titanium dioxide coating neutralizes smog.

Studies show that 10,000 square feet of a titanium dioxide coil-coated aluminum architectural panel have the approximate cleansing power of 80 trees. This is the equivalent of offsetting smog created by the pollution output of four cars daily.

The potential environmental and maintenance cost-saving benefits of using high-performance titanium dioxide coil-coated aluminum architectural panels can be quantified. Building owners can forecast savings in operational and maintenance costs while avoiding the use of cleaning chemicals.

An online evaluator tool can determine the equivalent number of trees and cleansing power a building can achieve per day, and the pollution from the number of cars a building can potentially remove from the road per day. Calculations estimate the potential savings generated over time by decreasing the frequency of building cleanings.

These estimates are based on research conducted by the U.S. Forest Service. Removal rate averages were calculated using average pollution removal capacities of urban forests in 55 U.S. cities. Car pollution rates are based on California emission standards, and assume nitrogen oxide pollution by a gas-powered car driving 50,000 miles over five years.

Three variables are used to determine cost savings: wall siding area of the building, the number of times per year the building is cleaned, and anticipated building façade cleaning costs. Based on this model, with the application of titanium dioxide coil-coated aluminum architectural panels, a 10,000-square-foot building cleaned once a year, at \$0.15/sf average cost from market studies, could potentially realize a maintenance cost savings of \$1,300 annually. This represents the approximate air cleansing power of 80 trees, and the cleaning power to offset the smog created by pollution output of four cars per day.

Depending on location and building height, building cleaning costs may range from \$0.05/sf for lower cost locations and low-rise buildings, yielding a \$450 annual maintenance savings to \$0.35/sf in higher cost locations for low- to mid-rise buildings, yielding a \$3,450 annual maintenance savings.

#### ALUMINUM CEILINGS

Metal ceiling systems provide a greater range of finishes than acoustical ceilings made of mineral fiber or fiberglass. Typical finishes include baked-on paint in standard or custom colors, metallic paints, and wood grains in polymer and powder coat. Metal ceiling systems provide owners with a durable ceiling that allows frequent access to plenum areas without damage to the panels. These systems are sustainable, highly recyclable, cleanable,



Interior and exterior linear metal ceilings provide visual continuity and performance at a Go Transit Station in Brampton, Ontario, Canada. Consulting engineer: R.J. Burnside & Associates Ltd.

and promote indoor air quality because they contain no organic compounds to support mold and microbial growth. Because of metal's durability, these systems may be used in exterior environments to create soffits, and can be engineered to withstand positive and negative air pressures.

#### METAL ROOFING AND PANEL SYSTEMS

Metal roofing and panel systems are proven technologies that keep evolving over time in response to technology, codes, standards, and industry demand. Metal roofing systems are low maintenance, durable, and able to resist wind,

fire, hail, and UV rays. Metal roofs are available in colors compatible with cool roofs. A cool roof refers to an outer layer or exterior surface of a roof that has high solar reflectance and reduces heat gain into a building.

Insulated metal panels are a form of continuous insulation, with rigid urethane foam sandwiched between two sheets of coated metal. IMPs serve as walls, ceilings, and roofs for commercial and industrial buildings, in new and retrofit construction. Suitable applications include schools, hospitals, religious, correctional, manufacturing and maintenance facilities, office buildings, aircraft hangars, distribution warehouses, and mechanical penthouses.

IMP systems provide many of the same benefits found with other metal wall and roof systems, plus some unique benefits. IMPs are composite, factory-fabricated units that attach directly to the supporting structure. The panels are factory-insulated, single-element panels with factory-applied coatings. They are lightweight, easy to install, with a one-piece construction process for faster building completion, all year round in any kind of weather, resulting in reduced construction and interim financing costs. There is reduced risk to system integrity since IMPs have few field-assembled components with no multiple installation steps.

Continues at [ce.architecturalrecord.com](http://ce.architecturalrecord.com)

*Barbara A. Nadel, FAIA, principal of Barbara Nadel Architect, in New York City, specializes in security, planning, programming, and design of civic buildings.*

## INSULATED METAL WALL PANELS

**Pacific Plaza**  
Tacoma, Washington  
LEED Platinum  
Architect: BLRB Architects

The Pacific Plaza building was a four-story, crumbling parking garage. The \$35-million renovation features two new floors of commercial space and a green roof. More than 26,000 square feet of IMPs clad the renovated office building and parking structure, for a monolithic, polished look. Panels finished in weathered zinc were installed horizontally. IMPs interface with a cement composite façade system cladding the exterior walls on the parking structure.



Photo courtesy of Metl-Span

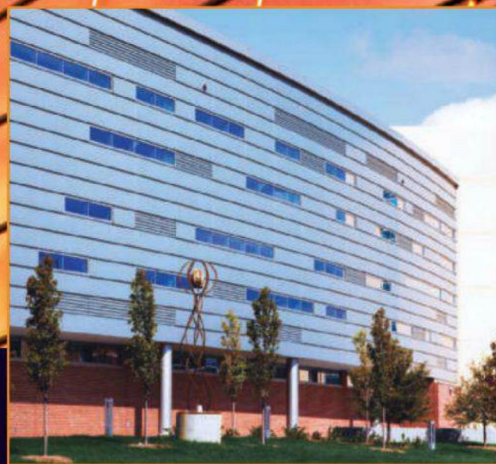
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# PRODUCT REVIEW

Innovative Metal Solutions for the Built Environment

## ALPOLIC Materials



### Aluminum Composite Material

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[www.alpolic-northamerica.com](http://www.alpolic-northamerica.com) Circle 111

## CHICAGO METALLIC®



### Metal Ceilings

SpanAir®—a new generation of metal ceiling systems is true to its name. Designed for large expanses, SpanAir systems combine aesthetic excellence and design ingenuity in a sleek, modern product. SpanAir Plank, Torsion Spring and Clip-In panel systems, each with its own unique quality, conceal conventional suspension systems while providing clean lines, easy ceiling access, fast installation, durability, and sustainability.

[www.chicagometallic.com](http://www.chicagometallic.com) Circle 113

## Alcoa Architectural Products

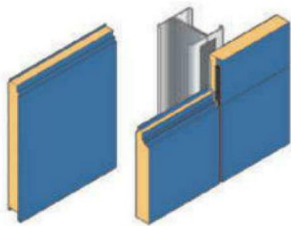


### Nature-Inspired Aluminum Composite Material

Reynobond® Design Line is an innovative, advanced polymer finish for aluminum composite material, available in dozens of nature-inspired patterns and textures. It is ideal for outdoor applications, resisting sun, extreme temperatures—even salt water. And you can count on Reynobond Design Line to last—it's backed by a 20-year warranty.

[www.reynobond.com/DesignLine](http://www.reynobond.com/DesignLine) Circle 114

## Metl-Span



### Insulated Metal Panel

Metl-Span's new INNOVA3™ is a 3" insulated metal panel and is ideal for high-profile horizontal applications. INNOVA3 is specially designed to provide continuous insulation and meet ASHRAE 90.1 R-value requirements for steel framed walls. Unlike more traditional insulation products, Metl-Span's INNOVA3 insulated metal panels are placed outboard of the structural supports, creating a continuous barrier for maximum thermal efficiency with no compressed insulation or thermal bridges.

[www.metlspan.com](http://www.metlspan.com) Circle 112

## CENTRIA



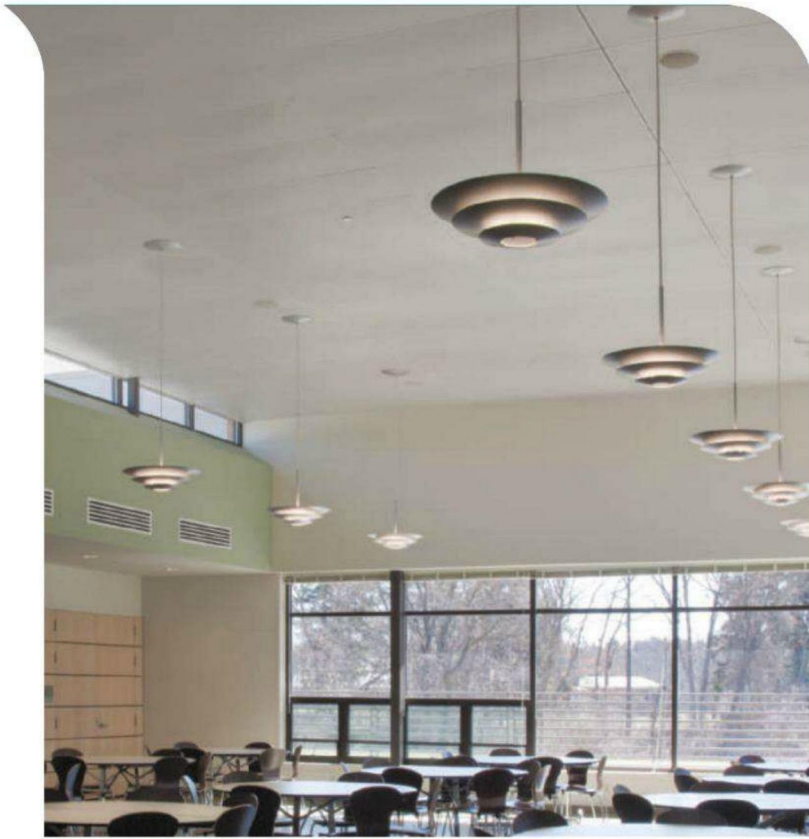
### Integrated Wall Solution

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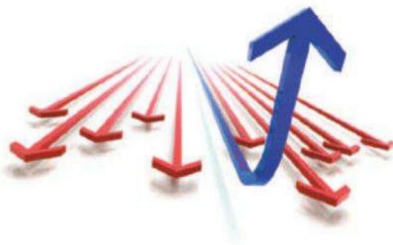
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## Ongoing Exhibitions

### Massimo Scolari: The Representation of Architecture, 1967–2012

New York City

Through November 21, 2012

A comprehensive retrospective of the work of visionary architect and artist Massimo Scolari, this exhibition marks the first U.S. display of Scolari's work since 1986. The show, which originated at the Yale School of Architecture in spring 2012, was curated and designed by Scolari himself and features over 160 original drawings, paintings, watercolors, and other works completed between 1967 and 2012. At the Cooper Union. For more information, visit [cooper.edu](http://cooper.edu).

### Yung Ho Chang: Material-Ism

Beijing

Through December 2, 2012

*Material-Ism* is a comprehensive retrospective of the groundbreaking, cross-disciplinary work of China's first international architect, Yung Ho Chang. For this exhibition at the Ullens Center for Contemporary Art (UCCA), the center's Great Hall is turned into an updated hutong neighborhood, containing six courtyard-like modules that each address a different aspect or focus of his practice, including inhabitation, construction methods, urbanism, tradition, perception, and culture. For more information, visit [ucca.org.cn](http://ucca.org.cn).

### Currents: Suprastudio Neil Denari Geo\_Graphics 2011–2012

Los Angeles

Through December 7, 2012

This exhibition at UCLA highlights the work from Suprastudio *Geo\_Graphics 2011–2012*, led by professor of architecture and urban design Neil Denari. Students explored what a new urban quarter of Los Angeles—the old Westwood Village becoming the new Westwood City—would look like if it were an amalgamation of new public infrastructure not dictated by automobiles and conventional street and transit systems. For more information, visit [aud.ucla.edu](http://aud.ucla.edu).

### Frames for Living: The Work of William Wurster

Cambridge, Massachusetts

Through December 28, 2012

William Wurster (1895–1973) was a pioneer of Modernist architecture and one of the most influential architecture educators of the 20th century. Appropriate to the California landscape and climate, his houses capture living space from the outdoors and feature high ceilings and overscaled windows that belie their

small size. *Frames for Living* examines the innovative houses that are often regarded as Wurster's greatest accomplishment as a designer. At the Massachusetts Institute of Technology. For more information, visit [mit.edu](http://mit.edu).

### Anri Sala: Two Films

Detroit

Through December 30, 2012

Albanian-born artist Anri Sala's films *Dammi i Colori* and *Long Sorrow* are the focus of this exhibition at the Museum of Contemporary Art Detroit. The films are portraits of communities in crisis and reflect on the human condition during periods of political unrest.

Although the films are distinct artworks, both reveal the connective tissue between cities and people. Related programming includes artist talks, musical concerts, and lectures. For more information, visit [moca-detroit.org](http://moca-detroit.org).

### Eero Saarinen: A Reputation for Innovation

Los Angeles

Through January 3, 2013

Born in Finland, Eero Saarinen is recognized today as one of America's most influential architects of the 20th century. This exhibition at A+D Architecture and Design Museum will highlight his short but brilliant career that is bookended with two iconic buildings: the



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## dates&events

unbuilt Smithsonian Gallery of Art and Dulles International Airport. For more information, visit [aplusd.org](http://aplusd.org).

### **California's Designing Women, 1896–1986** Los Angeles

*Through January 6, 2013*

Presented at the Autry National Center, this unprecedented exhibition honors 46 women designers and includes more than 200 examples of textiles, ceramics, furniture, lighting, jewelry, clothing, and graphics. These functional and decorative objects—from Arts and Crafts to Art Deco to Mid-Century Modern and beyond—exemplify California's national and international reputation for unrestrained creativity. For more information, visit [theautry.org](http://theautry.org).

### **Field Conditions**

San Francisco

*Through January 6, 2013*

This exhibition at the San Francisco Museum of Modern Art bends and blurs the boundaries between conceptual art and theoretical architecture, using the notion of the “field” to frame an investigation into the construction, representation, and experience of space. Nearly 30 works in various media by both contemporary artists and practicing architects will be on view, including pieces by Tauba Auerbach, Daniel Libeskind, Rafael Lozano-Hemmer, Sol LeWitt, and Lebbeus Woods. For more information, visit [sfmoma.org](http://sfmoma.org).

### **A Long-Awaited Tribute: Frank Lloyd Wright's Usonian House and Pavilion** New York City

*Through February 13, 2013*

In 1953, six years before the Frank Lloyd Wright–designed Solomon R. Guggenheim Museum opened to the public, two of his structures—a pavilion and model Usonian house—were built on the future site of the museum to house a temporary exhibition displaying the architect's lifelong work. This exhibition at the Guggenheim Museum comprises selected materials from the Solomon R. Guggenheim Museum Archives, highlighting the first Wright buildings erected in New York City. For more information, visit [guggenheim.org](http://guggenheim.org).

### **The Lost Vanguard: Russian Modernist Architecture, 1922–32**

Chicago

*Through February 16, 2013*

This exhibition at the Graham Foundation features the work of Modernist architects in the Soviet Union in the years following the 1917 revolution and the period of instability

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during the subsequent civil war. *The Lost Vanguard* demonstrates that in little more than a decade, some of the most radical buildings of the 20th century were completed by a small group of architects who developed a new architectural language in support of social goals of communal life. For more information, visit [grahamfoundation.org](http://grahamfoundation.org).

**Echoes of Silence: Philip Trager, Early Photographs, 1967–83**

New York City  
Through February 17, 2013  
Philip Trager is widely acknowledged as one of the foremost photographers of architecture and dance of the 20th century. This exhibition at the New York Public Library Stephen A. Schwarzman Building focuses on Trager's early work. Included in the exhibition are seldom-seen landscape studies and photographs taken in San Francisco, Barcelona, and Paris. It also includes several selections from an unfinished commission to document the architecture of Frank Lloyd Wright. For more information, visit [nypl.org](http://nypl.org).

**Detroit Disassembled**

Washington, D.C.  
Through February 18, 2013  
In this exhibition at the National Building Museum, Andrew Moore examines the tragic beauty of the unsettled and unsettling territory of a ruined Detroit. Thirty monumentally scaled photographs depict windowless grand hotels, vast barren factories, collapsing churches, offices carpeted in velvety moss, and entire blocks reclaimed by prairie grass. These images disclose how the forward march of the assembly line has been thrown spectacularly into reverse in Detroit. For more information, visit [nbm.org](http://nbm.org).

**Building: Inside Studio Gang Architects**

Chicago  
Through February 24, 2013  
Studio Gang Architects is a team of 40 architects, designers, and thinkers who have produced some of the most inventive and award-winning

architecture today. Featured not as a survey or retrospective, Studio Gang Architects projects at this exhibition at the Art Institute of Chicago are showcased in an engaging workshop-like environment that reveals the practice's creative processes as they address pressing contemporary issues through architecture. For more information, visit [artinstituteofchicago.org](http://artinstituteofchicago.org).

**Tokyo 1955–1970: A New Avant-Garde**

New York City  
Through February 25, 2013  
MoMA presents *Tokyo 1955–1970*, the first museum exhibition to focus on the city of Tokyo during the remarkable period from the mid-1950s through the 1960s, when it transformed itself from the capital of a war-torn nation into an international center for arts, culture, and commerce. For more information, visit [moma.org](http://moma.org).

**Skyline Adrift: Cuban Art and Architecture**

Ghent, New York  
Through May 2013  
This politically and aesthetically groundbreaking show of multidisciplinary, site-specific installations by two Havana-based architects (Yilena Lourdes Feitó Echarri and Yoandy Rizo Fiallo) and two internationally established Cuban artists (Alexandre Arrechea and Armando Mariño Calzado) will be on display at the OMI International Arts Center. The exhibition reflects current Cuban creative sensibilities across a broad spectrum of sculpture, architecture, and installation art. For more information, visit [artomi.org](http://artomi.org).

**Night (1947–2015)**

New Canaan, Connecticut  
Through 2015  
*Night (1947)* by sculptor Alberto Giacometti was one of a handful of artworks that Philip Johnson displayed in the Glass House while he lived there. In homage, the Glass House presents *Night (1947–2015)*, an innovative sculpture-in-residence exhibition guest-curated by Jordan Stein. The ongoing exhibition will feature



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contemporary artists whose works contend with the legacy of *Night*. For more information, visit [philipjohnsonglasshouse.org](http://philipjohnsonglasshouse.org).

### Lectures, Conferences, and Symposia

#### 2012 Curry Stone Design Prize Forum

Cambridge, Massachusetts

November 15–16, 2012

The Curry Stone Design Prize will announce its 2012 recipients during a two-day forum at the Harvard Graduate School of Design. The announcement of the winners will include an evening awards ceremony on November 15 followed by a full day of presentations. The annual prize celebrates social-design pioneers and the influence and reach of design as a critical force for improving lives and strengthening communities. For more information, visit [currystonedesignprize.com](http://currystonedesignprize.com).

#### Propeller Z

Los Angeles

November 26, 2012

Since 1994, Propeller Z has developed a variety of standards in architecture, interior design, exhibition/set design, and graphic design through experimental work. The studio uses a nonlinear analytic process to sharpen and formulate design solutions. At UCLA. For more information, visit [aud.ucla.edu](http://aud.ucla.edu).

#### Eduardo Souto de Moura

New York City

November 27, 2012

Pritzker Prize–winning architect Eduardo Souto de Moura, based in Porto, Portugal, will speak at the Pratt Institute School of Architecture about his work and career. Since forming his own office in 1980, Souto de Moura has completed well over 60 projects in his native Portugal and in Spain, Italy, Germany, the United Kingdom, and Switzerland. Often described as a neo-Miesian, he has achieved much praise for his exquisite use of materials as well as his unexpected use of color. For more information, visit [pratt.edu](http://pratt.edu).

### Competitions

#### 2013 AIA Small Project Awards

Submission Deadline: November 12, 2012

The Small Project Practitioners (SPP) knowledge community presents the ninth annual Small Project Award Program to recognize the work of small-project practitioners and to promote excellence in small-project design. This award program strives to raise public

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awareness of the value that architects bring to all project types, including renovations and additions, no matter the limits of size and budget. For more information, visit [aia.org](http://aia.org).

## **Innatur\_2 Competition**

*Registration Deadline: November 27, 2012*

Organized by Opengap, the second edition of this open-ideas competition seeks innovative, cutting-edge, and contemporary proposals to address the challenges of implementing architecture in a protected natural environment. Participants are invited to find spaces that promote a deep understanding and assimilation of nature and promote synergies between nature and the building itself. The competition is open to all architects, designers, planners, architecture students, and others interested in the topic. For more information, visit [opengap.net](http://opengap.net).

## **Rudy Bruner Award for Urban Excellence**

*Submission Deadline: December 10, 2012*

This award celebrates urban places that are distinguished by quality design as well as social and economic innovation. Winners offer creative solutions that transcend the boundaries between architecture, urban design, and planning and showcase innovative thinking about American cities. Projects must be a real place, not just a plan or a program, and be located in the 48 contiguous United States. For more information, visit [brunerfoundation.org/rba](http://brunerfoundation.org/rba).

## **International Ideas Competition**

*Registration Deadline: December 15, 2012*

This competition, commissioned by the Association Atelier PAEMA, requires participants to express an "ideal symbol" of Europe and propose an area to place it. The design idea can be seen as an expression of architecture, art, landscape, urban design, engineering, or any combination of these subjects. For more information, visit [atelierpaema.eu](http://atelierpaema.eu).

## **eVolo 2013 Skyscraper Competition**

*Registration Deadline: January 15, 2013*

eVolo magazine invites architects, students, engineers, designers, and artists to redefine skyscraper design through the implementation of novel technologies, materials, programs, aesthetics, and spatial organizations. There are no restrictions in regards to site, program, or size. Participants must answer the question: What is a skyscraper in the 21st century? For more information, visit [evolo.us](http://evolo.us).

## **National Humanities Medal Design Competition**

*Submission Deadline: February 1, 2013*

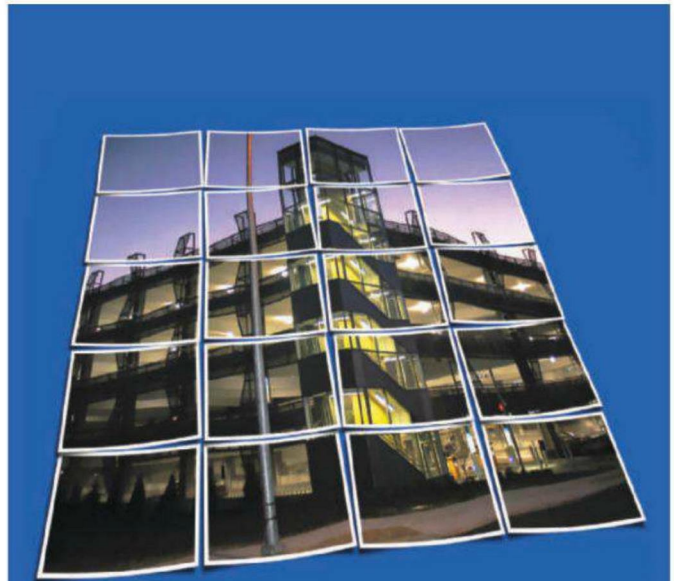
The National Endowment for the Humanities is seeking a new design for the National Humanities Medal, which is bestowed annually by the president of the United States in a White House ceremony. The winning designer will receive \$3,000 and be invited to an unveiling of the final medal in Washington, D.C. For more information, visit [humanitiesmedal-design.challenge.gov](http://humanitiesmedal-design.challenge.gov).

## **Bentley System's 2013 Design Competition**

*Submission Deadline: April 5, 2013*

This competition invites university, college, high school, and technical-school students to submit projects designed using Bentley software, along with a short essay describing their work. Project submissions will be judged by an independent panel of educators and industry professionals from around the world. The judges will assess creativity and skill in applying design and engineering principles. For more information, visit [bentley.com](http://bentley.com).

*E-mail information two months in advance to [recordevents@mcgraw-hill.com](mailto:recordevents@mcgraw-hill.com). For more listings, visit [architecturalrecord.com/news/events](http://architecturalrecord.com/news/events).*



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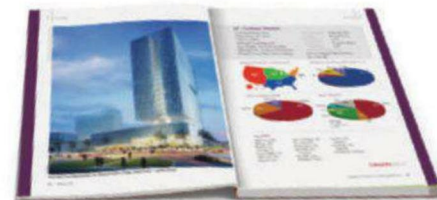
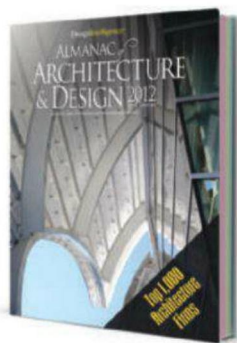
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- C. Total paid and/or requested circulation-average number of copies of each issue during preceding 12 months, 51,360; actual number of copies of single issue published nearest to the filing date, 46,796.
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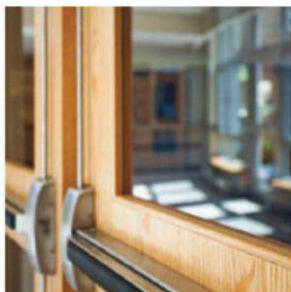
▲ FireLite® family of products from Technical Glass Products is UL listed and labeled and offers fire ratings up to 3 hours.

**Product Application:**

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**Performance Data:**

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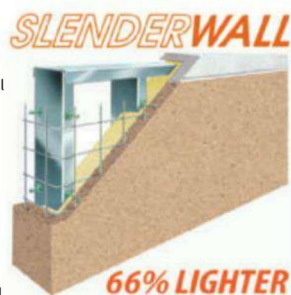
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**Product Application:**

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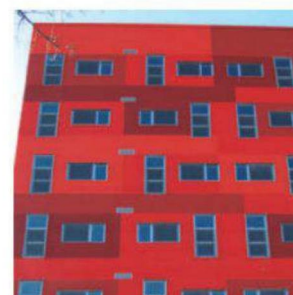
▲ ATAS offers a variety of horizontal and vertical wall panels; mix and match profiles for visual impact with interesting patterns and designs.

**Product Application:**

- Profiles: ribbed, corrugated, smooth, structural panels with exposed or concealed fasteners; complementing Elite Trim for crisp sight lines; mix and match profiles with multiple color choices

**Performance Data:**

- Performed panels; multiple gauges and various colors


[www.atas.com](http://www.atas.com)

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▲ PAC Precision Series wall panels have a corrugated 4-in. rib profile in 12-in. and 16-in. widths. These panels are 7/8 in. deep to create a dramatic shadow line. Can be installed horizontally or vertically.

**Product Application:**

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**Performance Data:**

- Direct concealed fasteners or clip installation
- Cost-effective installation in all weather conditions


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 800.PAC.CLAD | **Contact:** Blake Batkoff

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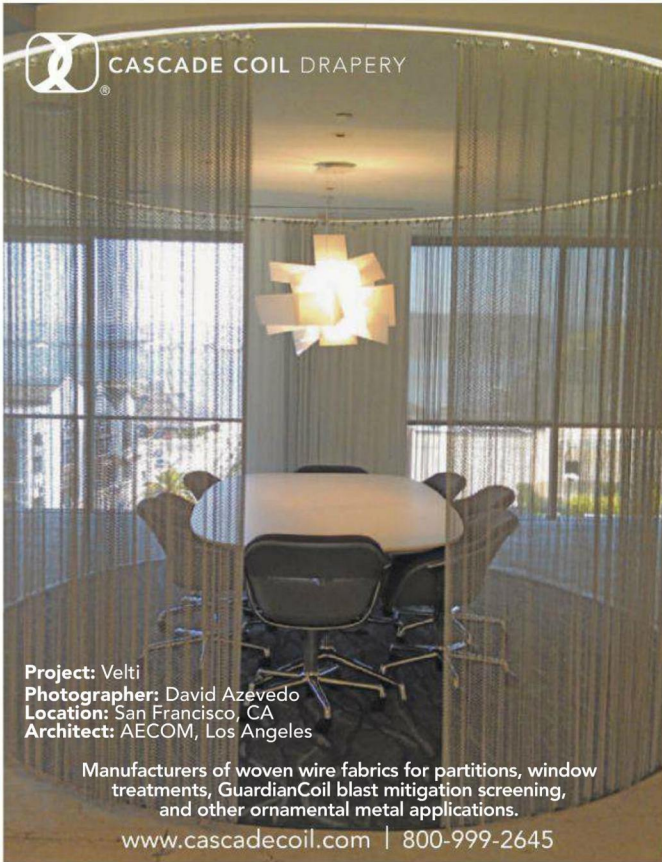

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**Circle 157**



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Project: Velti  
Photographer: David Azevedo  
Location: San Francisco, CA  
Architect: AECOM, Los Angeles

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FIRMS BY PRODUCT / BRAND



FIRMS BY LOCATION



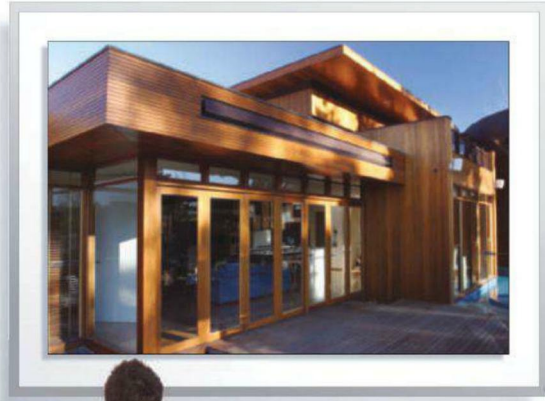
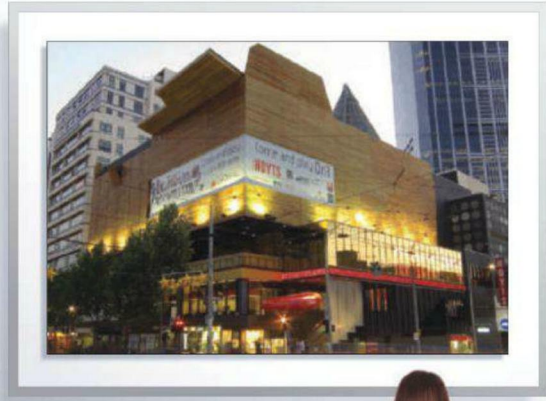
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Rank	Firm Name	City	State	Pre-Bld	Building	Post-Bld	Rates For Spec Rate	Types	Design Phase	Post-Project	Website
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2	Defco Builders	Marion	IN	91	43	321	1220	50-99	10-25		
3	XYZ Architects	Piquette	MI	40	11	120	1120	10-49	5-10		
4	Northern	Bentonville	AR	40	11	120	1120	10-49	5-10		
5	Regional	Columbus	GA	21	11	14	110	10-49	5-10		



**BEHIND ENGAGING** architecture there is tension. Indeed, Rembrandt's famous high-drama juxtapositions of light and dark were the inspiration for the conversion of a century-old slaughterhouse in southern Madrid into a new cultural center and public film archive. The Matadero Madrid art center, which reopened last year after a two-year, \$5 million renovation by the Spanish firm Churtichaga+Quadra-Salcedo, now offers two movie theaters, studio space for filmmakers, a café, and a rich archive of 7,000 documentaries available to both researchers and more casual browsers. A portion of the collection is housed in this cavernous 125-by-16-foot room, which served as the facility's refrigerator in its former life. Clad in dark-gray wood paneling, the archive is illuminated by thousands of feet of LED-infused plastic tubing interwoven in a basketlike form that soars above. A true *mise-en-scène*, the space draws from the mood and theatrics of film, as well as the powerful rhetoric of its more gruesome history. Against this dramatic backdrop, the Matadero center establishes its own emphatic narrative. *Laura Mirviss*

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## Design Awards 2012

The Western Red Cedar Lumber Association (WRCLA) is calling for entries in the 2012 Western Red Cedar Architectural Design Awards program. The awards recognize innovative design and architecture using one of the world's most unique and sustainable building materials, Western Red Cedar.

To enter, submit your project at [www.construction.com/community/WRCLA2012/](http://www.construction.com/community/WRCLA2012/) before December 15, 2012. A panel of notable architects will select the winning projects in early 2013. Winners will be announced and their projects will be profiled online and in print publications in February and March 2013.

Official contest rules, information and a listing of 2010 winners are available on the contest website.



Left Picture - Architect: Ashton Raggatt McDougall  
Right Picture - Architect: Saaj Design

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# Lutron systems help the Empire State Building achieve sustainability goals.

Lutron lighting controls and sensors **save up to 65% of lighting energy.\***

- **Wireless** – simplifies installation and minimizes disruption
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- **Expandable** – add to a system or reconfigure at any time

“Lutron products are state-of-the-art, cost effective, and architecturally beautiful. We worked with Lutron to develop wireless solutions for the Empire State Building — now you can buy our choice for energy-saving light control.”

**Anthony Malkin**

Empire State Building Company

## Empire State Building sustainability goals

Building energy reduction	38%
Building carbon emission reduction (over the next 15 years)	105,000 metric tons
Annual building energy bill reduction	\$4.4 mil

## Lutron contributions toward overall goals

<b>Projected lighting energy reduction</b>	<b>65%</b>
<b>Projected lighting controls installed payback</b>	<b>2.75 years**</b>

For more information please visit [www.lutron.com/esb](http://www.lutron.com/esb) or call 1.800.523.9466 for 24/7 support.

\* Compared with manual (non-automated) controls, up to 65% lighting energy savings is possible on projects that utilize all of the lighting control strategies used by Lutron in the ESB project (occupancy sensing, high-end trim, and daylight harvesting). Actual energy savings may vary, depending on prior occupant usage, among other factors.

\*\* Estimates based on Lutron controls installed in ESB pre-built tenant space. Payback claims assume 65% reduction in energy costs and energy rates of 22 cents per kwh. Actual payback terms may vary.

The Empire State Building design is a registered trademark and used with permission by ESBC. Empire State Building sustainability goals are provided by ESBC and contain energy saving strategies in addition to lighting control.

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CIRCLE 74

