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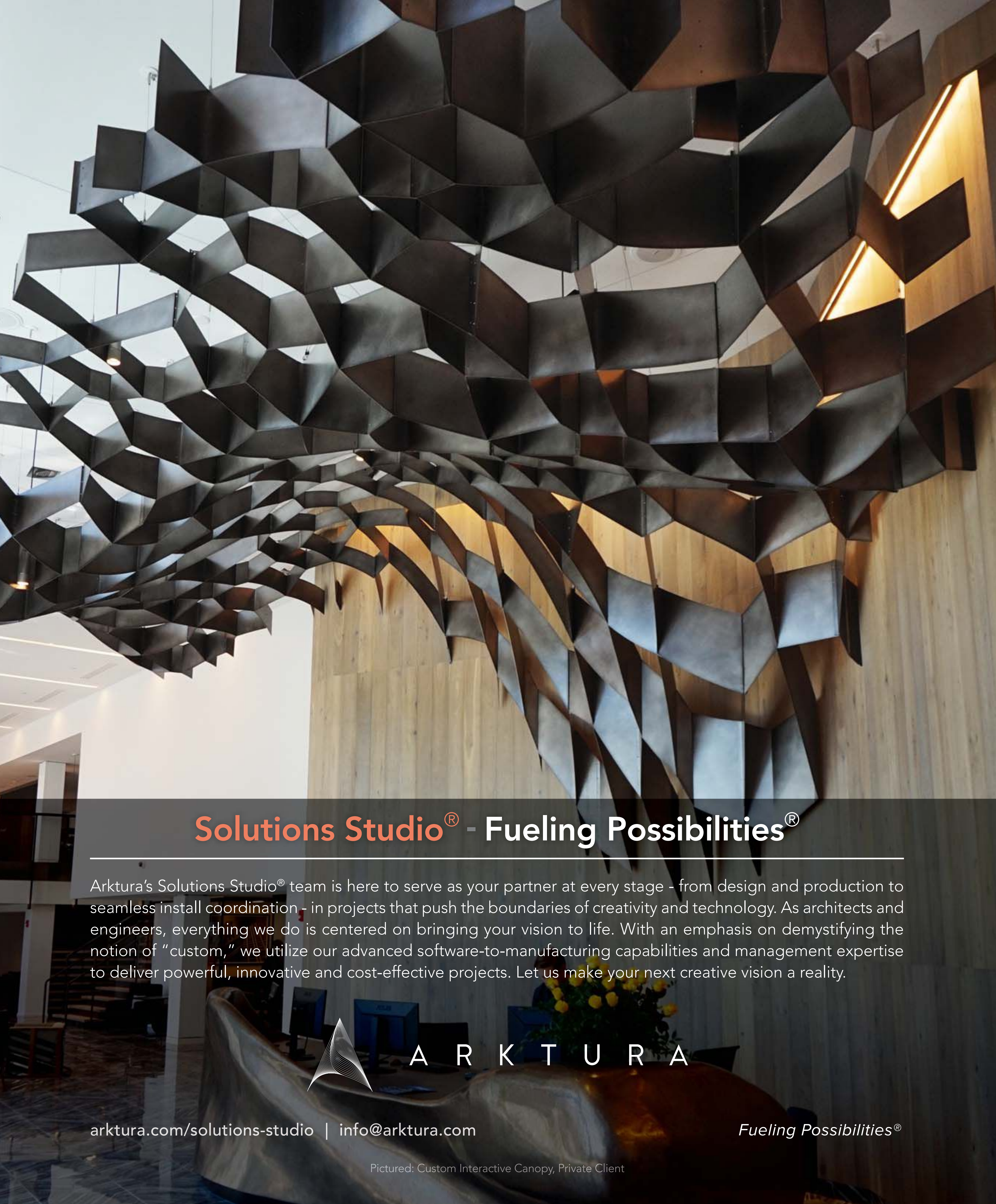

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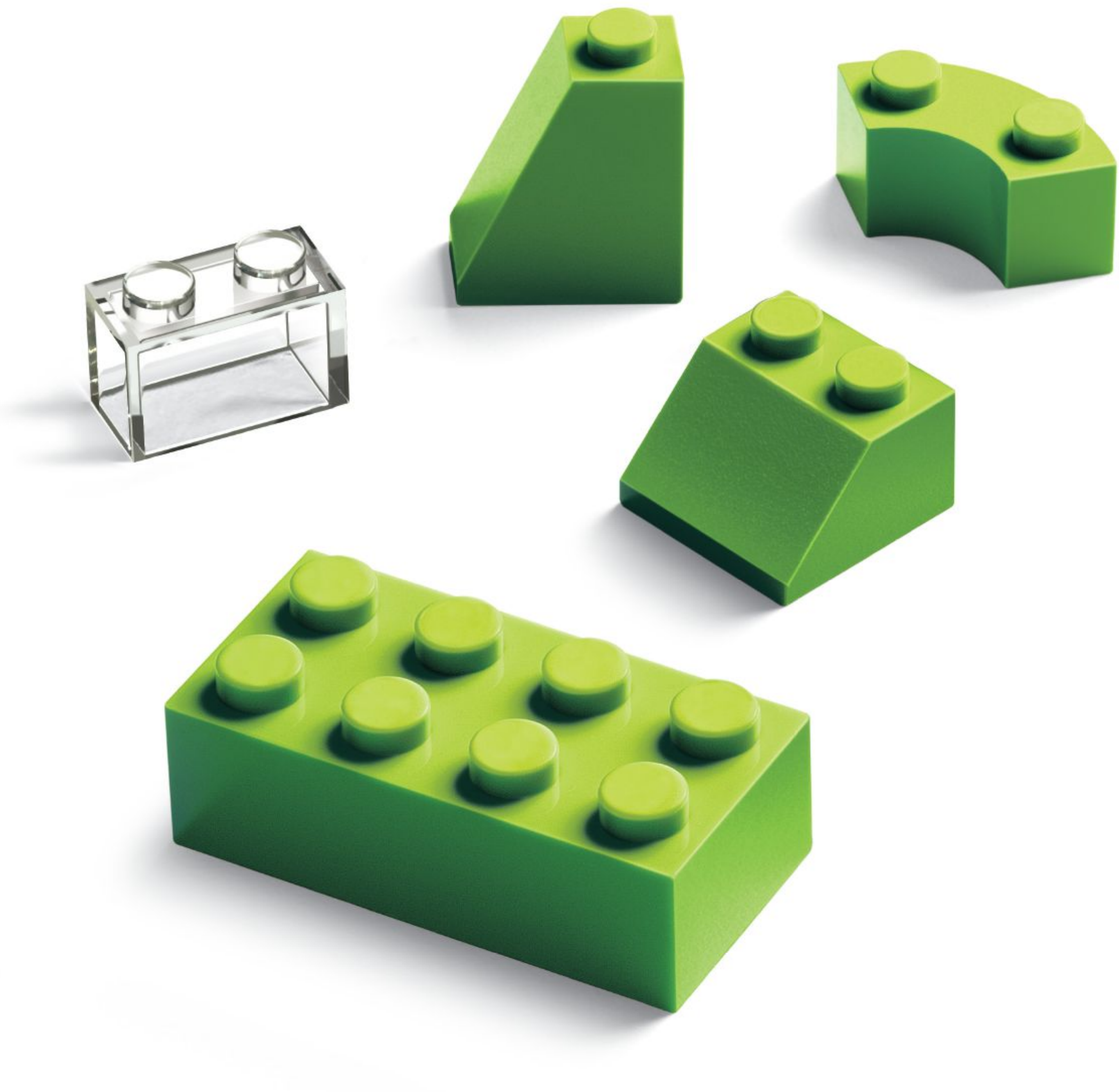

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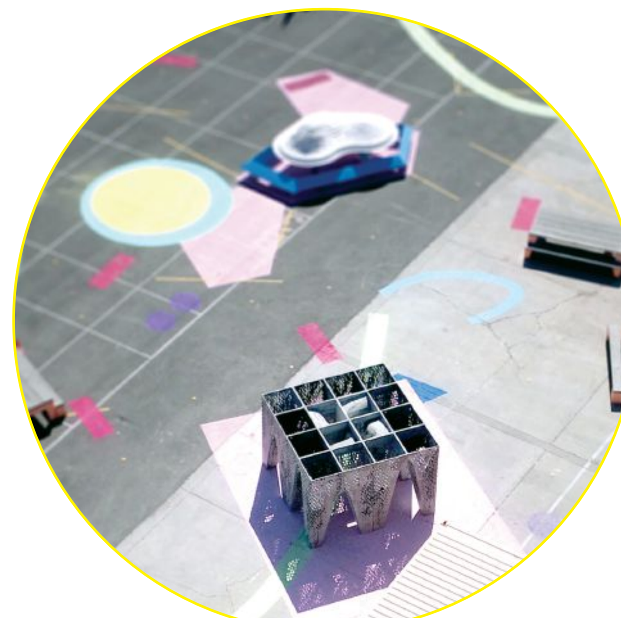
Contents

Volume 107, number 7. July 2018.
On the cover: R+D Award winner Social Sensory Architecture by Sean Ahlquist.



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Architect: Marpillero Pollak Architects
Photograph: Courtesy Marpillero Pollak Architects

Page Turner

Queens' new **Elmhurst Community Library** serves one of the most diverse and vibrant communities in New York. Designed by **Marpillero Pollak Architects**, the LEED Silver-rated facility features two structural glass-encased reading rooms that allow light to flood in during the day and offer glimpses of the state-of-the-art library setting at night. Erected by **W&W Glass**, its glazed features have become beacons for the community, drawing its knowledge-hungry members to the wealth of information within. Read more about it in **Metals in Construction** online.

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Shaking Bad

In New York, passing subways can shake entire buildings, but that wasn't an option for Columbia University's new **Jerome L. Greene Science Center**. Home to sensitive laboratory and imaging equipment requiring exceptional stability, the design by **Renzo Piano Building Workshop** relies on a steel structure to reduce floor vibrations to a miniscule 2,000 mips. Even as the elevated No. 1 train roars past, this helps ensure that nothing distracts from the scientific advances being made within the center's unshakable walls. Read more about it in **Metals in Construction** online.

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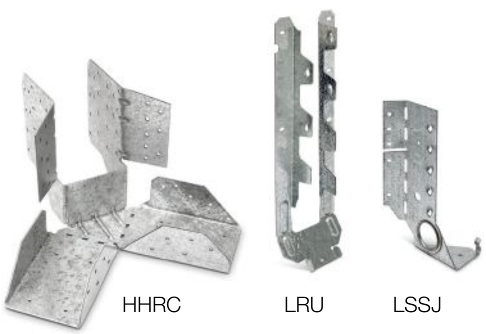
In the Fjords

For centuries, buildings have been sited to capture views of Scandinavian fjords, but for the design of his first building, artist Olafur Eliasson and the architectural team at his eponymous Berlin-based studio did one better: They put the building in the fjord itself. Fjordenhus, the headquarters of investment firm Kirk Kapital, opened last month in Vejle, Denmark, and is clad in glazed brick that reflects the surrounding water. Curved windows in the façade's arched insets allow employees to experience the Vejle fjord from an interior outfitted with custom furniture, lighting, and site-specific art installations, also designed by Eliasson's team. —KATIE GERFEN

> *To see more images of Fjordenhus, visit ARCHITECT's Project Gallery at bit.ly/Fjordenhus.*



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Inside the Garden Walls

For this year's pavilion at the Serpentine Galleries in London, Mexican architect Frida Escobedo combined design influences from her home country with materials from the United Kingdom. Rooting the summer pavilion in place, the walls are built with a ubiquitous British architectural material: cement roof tiles, which are arranged in a lattice pattern inspired by the Mexican *celosia*. A shallow pool less than a quarter of an inch deep and a mirrored canopy inside the pavilion's interior courtyard reflect the surrounding surfaces and landscape. The pavilion is on view through Oct. 7. —SARA JOHNSON

> *Visit ARCHITECT's Project Gallery for more information and images of the 2018 Serpentine Pavilion: bit.ly/Serpentine2018.*

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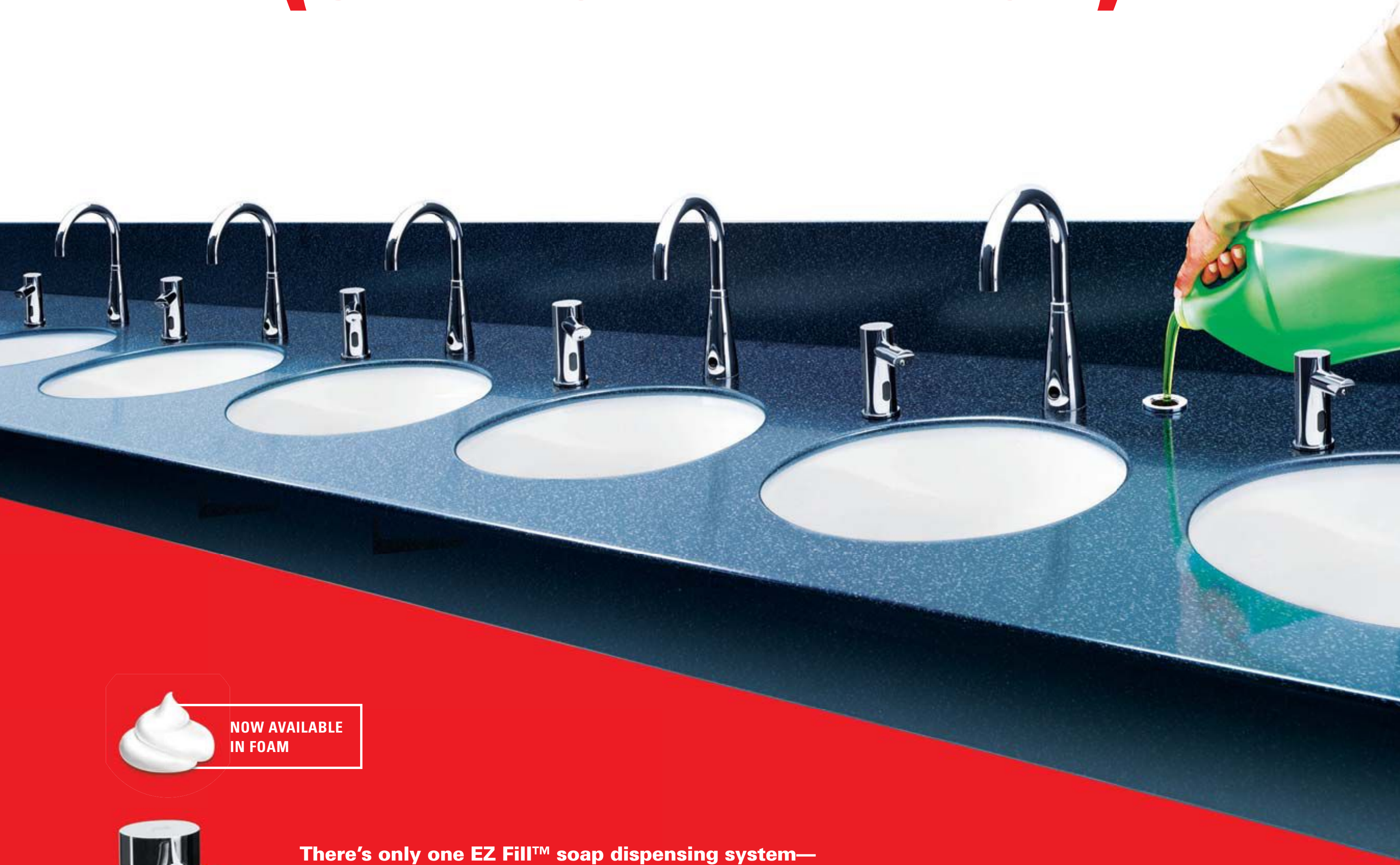

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Small Scope, Big Moves

The American Institute of Architects' annual Small Project Awards program "strives to raise public awareness of the value and design excellence that architects bring to projects, no matter the limits of size and scope." This year's winners range in scope from a pool house in Oklahoma to a play structure in Massachusetts. The Rosewood Park Beach Restoration (shown) in Highland Park, Ill., designed by Chicago firm Woodhouse Tinucci Architects, received recognition in category three, which recognizes work under 5,000 square feet. —SARA JOHNSON

> Check out the rest of the winners of the 2018 AIA Small Project Awards at bit.ly/AIASmallProject18.

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Transportation at the Venice Biennale

Located in the "Freespace" exhibition at the Arsenale, "Somewhere Other" is a highly refined machine, ungainly in outline but richly surfaced in a dark-grained wood. As the funnel-shaped envelope suggests, the installation is a telescope, but one that affords multiple points of view. "It's a long lens that transports you all the way to Australia," says Melbourne-based John Wardle, pointing into the narrow end, where a grooved armature receives the viewer's face and points to it a screen displaying his firm's work. At the wide end, visitors walk into the structure, only to be confronted by a disorienting series of turns inside mirrored walls. —IAN VOLNER

> Visit ARCHITECT's website to read more of Ian Volner's review of "Somewhere Other," as well as other dispatches from the Venice Biennale at bit.ly/SomewhereOther.

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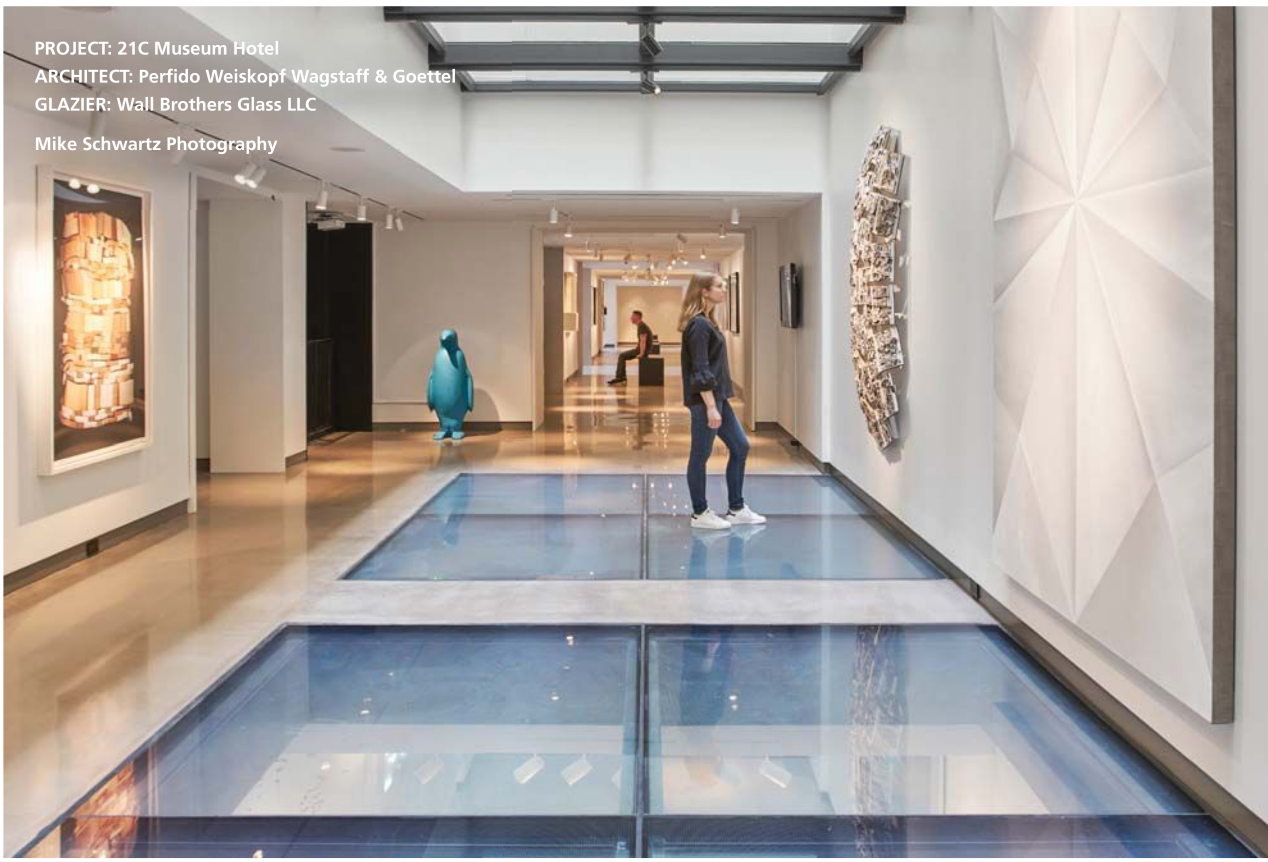

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Best Practices: Public Relations for Small Firms

TEXT BY JEFF LINK

Engaging the right public relations agency can go a long way in helping small firms raise their profiles. Here, several design practices offer strategies for when—and when not—to solicit outside PR help.

Navigating the Media Landscape

When Claus Benjamin Freyinger and Andrew Holder, co-principals of the Los Angeles Design Group, sought to promote their 2017 renovation of a lake house owned by film producer Jason Micallef, they turned to Los Angeles–based consultancy This x That. Holder says they wanted to bring mainstream attention to the Whitney Museum of American Art–inspired hillside dwelling, but felt adrift in the evolving media landscape. "If we wanted to be smart about how to engage that shifting landscape of media dissemination, we had to get experts," he says.

This x That founders Danielle Rago (who has written for ARCHITECT) and Honora Shea pitched a story to *Los Angeles Times* writer Marissa Gluck, with whom they had an existing relationship, and secured what Holder describes as a big win: a stand-alone feature that appeared in the Home & Garden section as part of a recurring series on southern California residences. "Access to an outlet like that had totally evaded us in the past," Holder says. "This x That was able to translate our internal conversations about the project into something the rest of the world could understand."

Establish Expectations

Many agencies can be hired on a proposal, commission, or per-project basis, with specific benchmarks to assess performance. New York–based SO-IL—a firm that can swell to 25 or more people, depending on workload—handles 80 percent of its communications and press relations internally, says strategic communications manager Qionglu Lei. But, occasionally, they will solicit proposals from regionally specific PR firms to lead campaigns for projects abroad. "We try to define the deliverables as much as possible when we start the contract," Lei says.

Sometimes defining and articulating those deliverables is part of the value a consultancy can bring. Ian Besler, co-founder of the Los Angeles–based firm Besler & Sons, says the practice's partnership with This x That helped clarify the market potential of the firm's Props series of terrazzo objects as consumable goods.

"The questions they were asking us—'Where would you want it to be sold? Would you want to be running a distribution center? Do you want to sell hundreds or thousands?'—are a lot more common in other business-oriented disciplines," Besler says. "[They] helped us articulate where we saw the project going."

Staying In-House

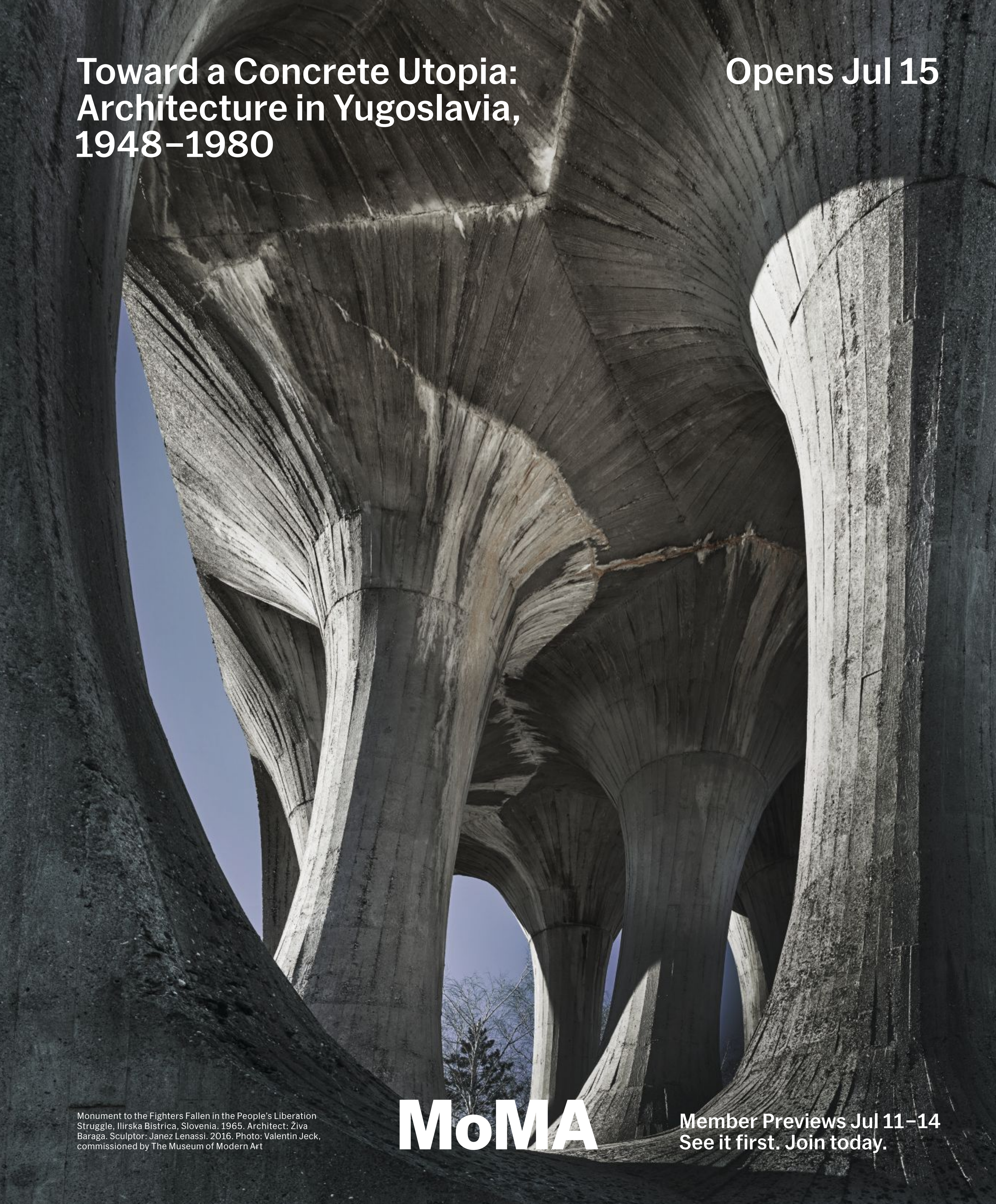
Even if a PR firm's proposal sounds appealing, the price and fee structure must be right to warrant the investment. Brian Bell, AIA, a principal at Atlanta-based Bldgs, says his six-person firm has talked to several service brokers and agents, including one that charges a monthly fee ranging from $500 to $2,000 depending on the outreach services provided. While this fee isn't outlandish, with only three to four projects per year, Bldgs is not yet operating at the scale "to take the plunge," Bell says.

"[They] helped us articulate where we saw the project going."

—Ian Besler, co-founder, Besler & Sons

Nevertheless, Bell says, producing consistently good work, earning the 2017 Architectural League of New York Emerging Voices Award, and appearing in the *New York Times Style Magazine* have resulted in private clients and global design offices such as Steelcase and *Bloomberg*'s Atlanta bureau seeking their expertise. He credits the architecture professorships that he and principal partner David Yocum, AIA, hold at Georgia Tech as another important catalyst for the firm's promotion. Lecturing across the country and sitting on design juries have helped them network with fellow architects whose influence and connections have drawn attention to the firm. "There's no underestimating other architects for promoting your work or getting you out there," Bell says.

> *For more advice on how to decide on a PR strategy, visit bit.ly/ARPRforSmallFirms.*



Monument to the Fighters Fallen in the People's Liberation Struggle, Ilirska Bistrica, Slovenia. 1965. Architect: Živa Baraga. Sculptor: Janez Lenassi. 2016. Photo: Valentin Jeck, commissioned by The Museum of Modern Art

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Detail:
Canadian National Arts Centre Coffers

TEXT BY TIMOTHY A. SCHULER

DOUBLESPACE PHOTOGRAPHY

How to update Brutalist architecture for today's needs is a question architects are increasingly facing. In Ottawa, the original 1969 National Arts Centre (NAC) building featured repeating hexagonal geometries in both its floor plan and finishes, including the lobby ceiling's triangular concrete coffers, tessellated to create a hexagonal pattern. For a $110 million renovation and expansion project, Toronto-based Diamond Schmitt Architects (DSA) wrapped the northwest side of the building with a new, multistory lobby, complete with a ceiling that reinterprets the hexagonal forms of the original lobby, but in wood.

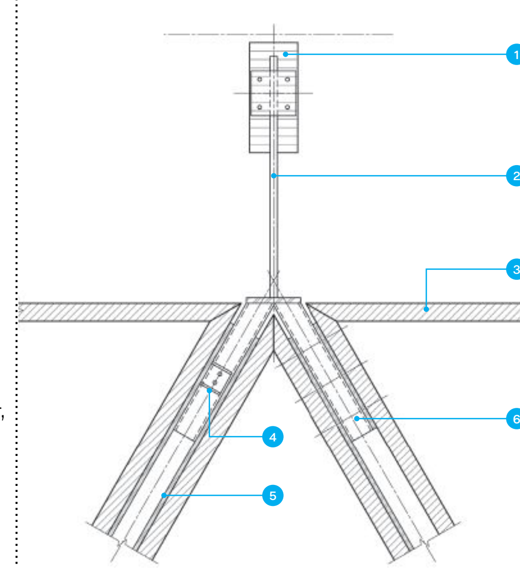
Designed in Autodesk Revit by DSA, the coffers are arranged on a 10-foot equilateral triangle grid, forming hexagons that total 20 feet across. Each triangular coffer comprises three 9.5-foot-long, 3.1-inch-thick glulam members, with slightly rounded edges at their vertices to blur any misalignment. Members taper in depth from 4.25 feet to 3 feet to create a sense of undulation. "The coffers themselves are not connected to one to another except by small pieces of blocking, approximately 10 inches square, maintaining the 150-millimeter [visual] gap between the coffers," says Will Loasby, senior project manager at structural engineering firm Fast + Epp, in Vancouver.

DSA's choice of wood stemmed in part from its desire to celebrate Canada's vast forests and to showcase a domestic product—glulam made from Douglas fir trees grown in British Columbia. Wood is also a warm, "natural material used in a natural state," says principal in charge Don Schmitt, AIA.

Moreover, the wood ceiling could be prefabricated off site, complete with integrated services, including lighting and electrical conduit. The triangular coffers were then trucked to the site in long, linear panels of up to 12 coffers, the largest of which measured 65 feet and weighed 30,000 pounds.

Shortly after the NAC reopened, Schmitt himself had a chance to observe the new lobby in action, attending a lecture on architecture. Afterward, the lobby transformed into a quasi-street fair, with food stalls and an array of musical performances. When Schmitt pulled himself away to leave, around 11 p.m., he was astounded by what he saw: more people newly arriving.

1. Douglas fir glulam column
2. Steel Y-shaped knife plate
3. 3.1"-thick × 9.5'-long Douglas fir glulam coffer, tapering in depth from 4.25' to 3' (typ.)
4. Panel 2 seat onto Panel 1
5. 0.79"-thick × 29.5"-deep steel stabilizing plate
6. 3.9"-wide steel rectangular hollow section



> *To read more about the restoration and construction of the National Arts Centre's new lobby ceiling, visit bit.ly/ARNACHex.*

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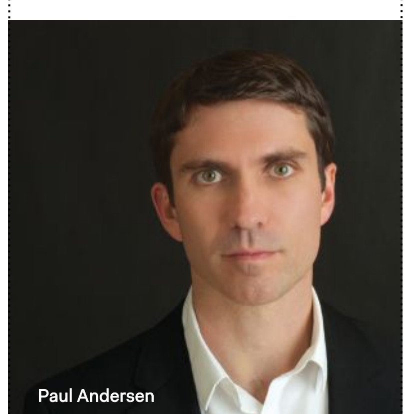
Our first commission was a children's play area at the Museum of Contemporary Art Denver. The project was small, but it worked as a big model for some ideas that we were developing for a block of houses.

Favorite project:
Any project that allows us to use repetition in different ways. In some cases, such as Five Rooms (designed with Paul Preissner, AIA, for the Chicago Cultural Center), repetition produces excess. In others, it's a function of variation. We combined both strategies for a courtyard dorm building at the Catamount Center for Environmental Science & Education, in Woodland Park, Colo.—identical rooms are arranged in semi-regular bars that spiral and stack.

Second favorite project:
Plans for a series of houses that take an unorthodox approach to modular design. They're all made of the same prefabricated steel barn panels—which come in three shapes—but the panels are assembled in varying sequences to give each house a unique profile.

Our method is the inverse of a modern kit-of-parts strategy, where houses share a common form but have different assortments of panels.

Architecture hero:
Oswald Mathias Ungers, because he used rational design principles to produce beautifully irrational architecture. His own house is a paragon of minimalism, but with 177 doors, including six in the surrounding hedges.



Paul Andersen

Design tools of choice:
Laptop, pen, scrap paper, books

Memorable learning experience:
Penn English professor Alan Filreis—a great champion and scholar of modern and contemporary poetry—taught me that history is plastic. It's liberating to know that histories can be designed.

Modern-day architecture hero:
The redoubtable architectural historian Robert Bruegmann. He is eternally curious and takes nothing at face value.

Special items in your studio space:
Full-size fabrication studies for cruciform bubble gum columns; pages from two copies of Robert Venturi, FAIA's *Mother's House* (Rizzoli, 1992) that we cut out so that we can compare design versions side by side; and scale replicas of every carport in Englewood, Colo.

Best advice you've ever gotten:
If you accept that architecture has no inherent value, you'll be free to do some really amazing work.

When not working in architecture, I:
Write the family dictionary with my kids. Recent additions include definitions for accestuator, amn't, Ancestor of the Fee, collaptionist, ginzagar, huhonomous, outwich, recombobulate, and wom, among others.

RICHARD PETERSON

> *To learn more about Paul Andersen and his practice, visit bit.ly/ARIndependentArch.*

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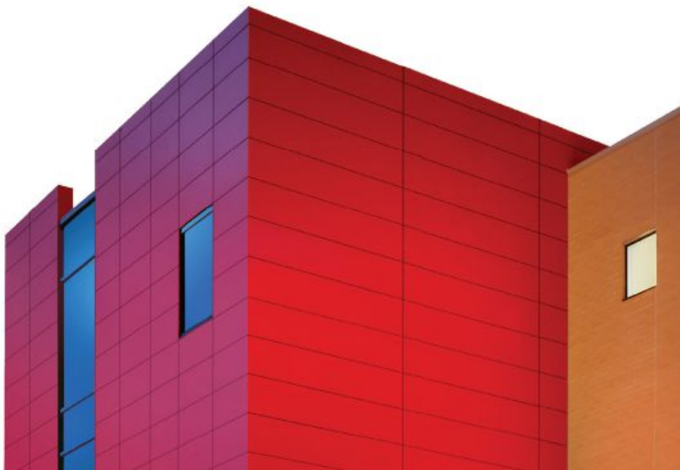
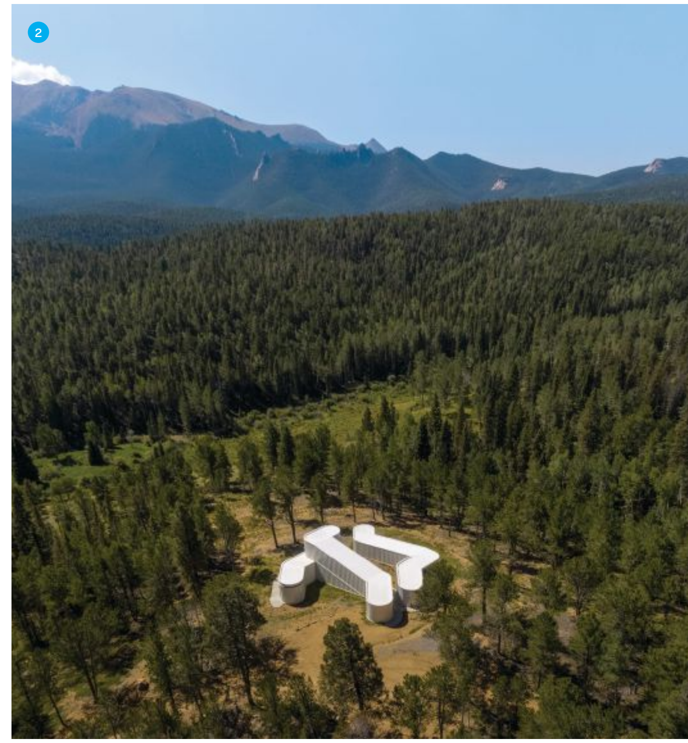
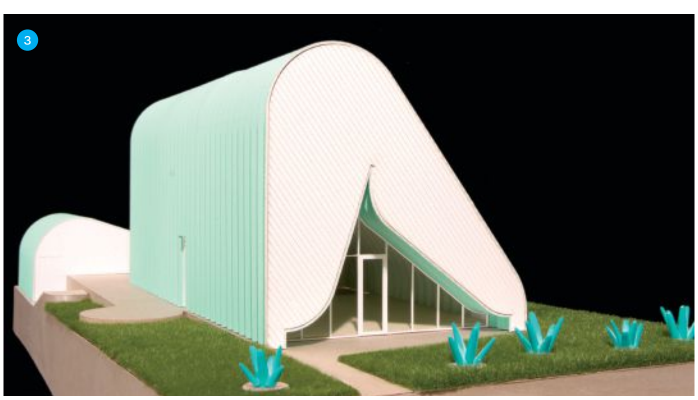
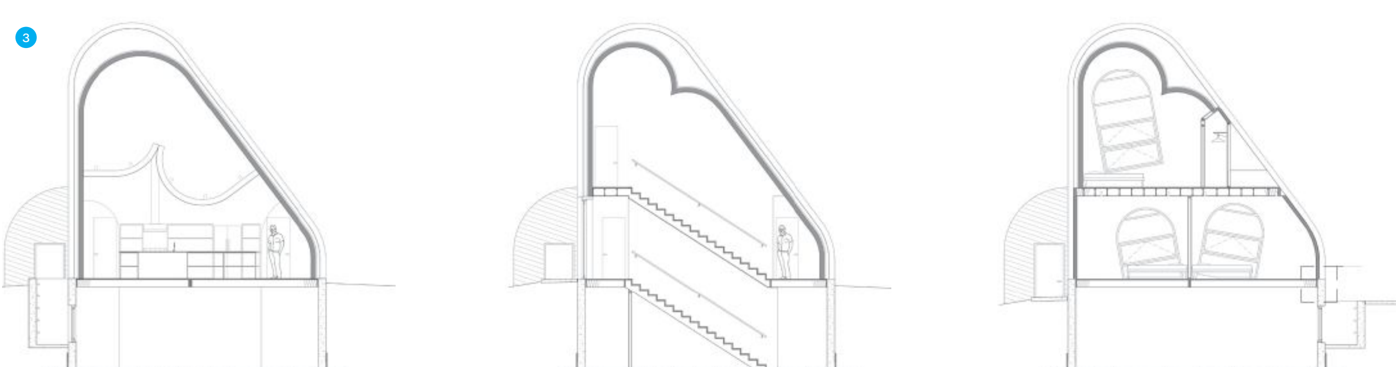


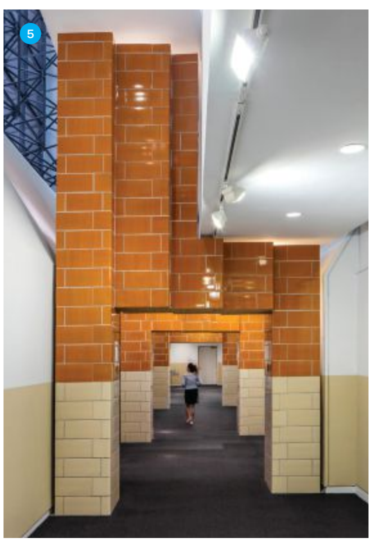
Next Progressives:
Independent Architecture

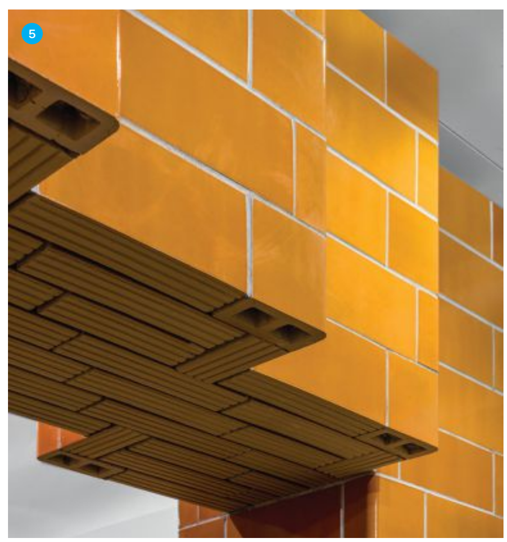


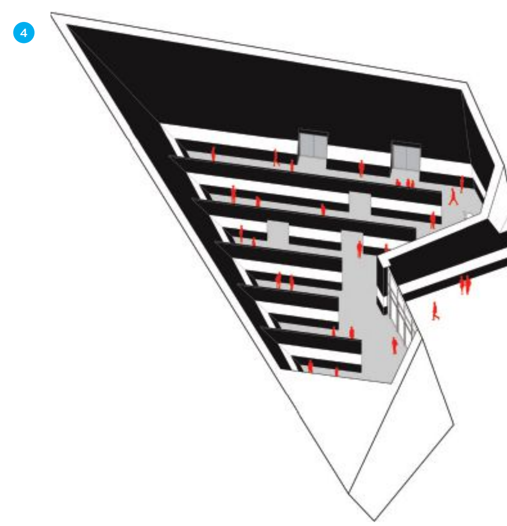


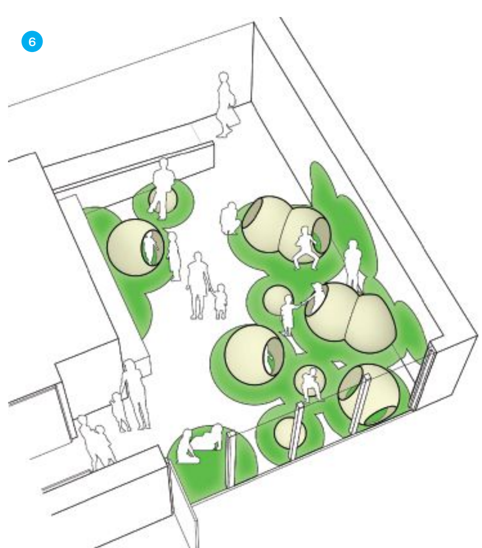


1, 3, 6: COURTESY INDEPENDENT ARCHITECTURE; 2, 5: JAMES FLORIO









1. Designed in collaboration with Guadalajara, Mexico–based artist Gonzalo Lebrija, Bubble Gum Canopy is an award-winning pavilion proposal for the Denver Botanic Gardens that incorporates "bubble gum" columns supporting a canopy, which appears to be "peeled up from the terrace," according to Andersen. **2.** The sinuous, sloping form of the Catamount Center for Environmental Science & Education dormitory enables access to daylight and views from individual rooms. **3.** Andersen proposes sourcing the exterior galvanized steel shell panels for the A-frame Duketh House from a conventional barn kit. **4.** The architect divided the irregularly shaped exhibition space for the 2014 Denver Art Museum show "At the Mirror: Reflections of Japan in 20th Century Prints" with five fin-like partitions to increase wall area. A horizontal white stripe on a black background created the illusion of a floating ribbon of artwork. **5.** Independent Architecture designed the Five Rooms installation, in collaboration with Chicago-based Paul Preissner Architects, for the 2017 Chicago Architecture Biennial. The teams constructed freestanding glazed tile walls at the Chicago Cultural Center to better define the gallery and corridor space. **6.** Located in the Museum of Contemporary Art Denver, Bubble Garden combines synthetic turf with repurposed round ocean buoys as a play area for children.

4: COURTESY OF THE DENVER ART MUSEUM

Opinion: Getting Real About Diversity

TEXT BY IMANI DAY, ASSOC. AIA

In architecture, we use the term "diversity" in a few ways: to illustrate the breadth of work we do, to demonstrate different perspectives as we problem-solve, and to illuminate the range of expertise and experiences we bring to the table. While many architects intuitively understand the economic benefits of diversified project teams, when directly asked to provide actual examples and data, firms often scramble and land on deploying my *favorite* term: diversity of thought.

It's a loaded expression, this kind of diversity. Across industries, corporations have exploited diversity of thought, or the equally hollow sound bite "cognitive diversity," in lieu of confronting their lack of cultural, gender, or racial diversity. In truth, any company with at least two employees with two differing opinions can claim diversity of thought as a core value. However, in our thoroughly globalized society, that bar appears to be awfully low. The notion that cognitive diversity is testament enough undermines the importance of addressing the disparities of representation within the profession.

Too often, companies claim to champion diversity without promoting specific, measurable goals of what they intend to accomplish. It could easily mean "we have more women than before," or "we've recently hired a few people of color." But where is the follow-up to culturally support or retain those people by creating paths to leadership? Firms boldly set revenue and profit goals to ensure business accountability; if diversity is a business imperative, what are the corresponding targets to track cultural change? Though companies can anecdotally say they're "making progress," a lack of data behind that progress challenges the picture quickly.

Consider the percentage of licensed black female architects in the industry. In a little over a decade, this value has gone from 0.2 percent to 0.3 percent. Though that is progress, this still means that of the 110,000-plus architects today, fewer than 500 are black women. While this number does not represent all the black women in the field—for example, those working toward licensure—it is telling of the massive blip in the industry's efforts—or lack thereof—to increase these numbers in earnest.

Instead of blaming the design industry, we should embrace a deeper level of strategy that differs from simply meeting quotas. For example, architects should invest in a pipeline of emerging designers through mentorship and programming that also enables and enhances recruiting. When we know and grow multifaceted types of talent from a diverse pool, it is more likely that we will hire a wider range of people. And when interviewing, designers must look beyond the polished portfolio to the potential of the human being before them, who may think or lead differently.

Ideally, we would see formalized, specific outcomes and strategies expressed from the juggernauts of the field. Right now, we see the bulk of the work to create equity falling to those also in the minority: for example, Milton Curry, who founded the University of Michigan's ArcPrep program, which introduces high school students in Detroit to the field of architecture; and Sarah Rafson, of ArchiteXX and founder of Point Line Projects, who is partnering with other women to tell powerful stories of activism in architecture.

Still, there is no concerted, organized aim to substantially move the equity needle toward accountability or subsequent action. Until then, the profession is essentially forfeiting the possibility of having inclusion or equity become a sustainable reality. How can we muster up some corporate courage to be more transparent? What does it cost? And at whose expense?

No matter what architects call this mission to diversify the field, we still have an opportunity to make good on these promises if we set clear objectives and track palpable progress. This only comes if we definitively articulate our professional values and direct sufficient resources to actualize them. After all, we're supposed to be thinking outside of the box—not aimlessly checking one.

Imani Day, ASSOC. AIA, is a designer in the Detroit office of Gensler, and an editorial fellow with The Avery Review.

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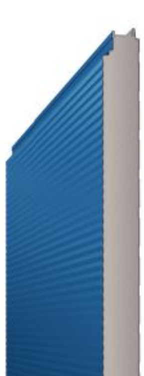

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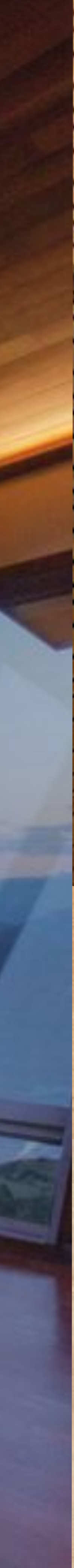

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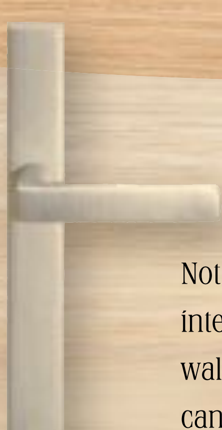

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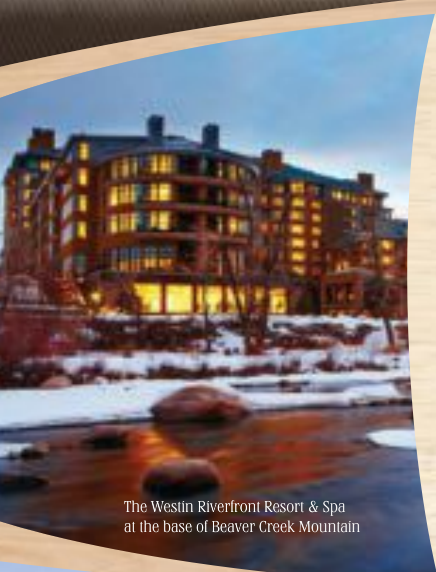

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10. On the Boards (any unbuilt residential project not yet completed)

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11. Kitchen
12. Bath
13. Architectural Design Detail

RECOGNITION

Winners will be featured in the December issue of ARCHITECT with expanded coverage online.

ELIGIBILITY

Entries should be submitted by an architect or designer. Other building industry professionals may submit projects on behalf of an architect or designer. Projects outside the U.S. are welcomed. Any home or project completed after Jan. 1, 2014 is eligible.

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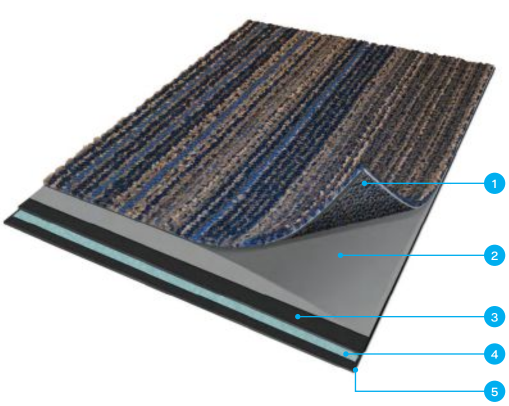
ARCHITECT

Products: How to Specify Carpet Tile

TEXT BY LINDSEY M. ROBERTS

Along with their ability to be custom cut to fit, carpet tiles offer a unique advantage over broadloom carpet: Stained and snagged modules can be replaced without anyone being the wiser. Also called modular carpet or carpet squares, tiles can help unify otherwise disparate programmatic areas and be installed quickly since they do not require a separate carpet pad. What follow are the qualities that Gensler senior interior designer and associate Megan Fogel, based in Atlanta, and Homepolish senior interior designer Gunnar Larson, based in Brooklyn, N.Y., look for, both on and off the spec sheet.

Sample Backing Construction



1. Non-woven primary backing
2. Precoat with antimicrobial preservative
3. Recycled vinyl composite
4. Fiberglass reinforcement
5. Recycled vinyl composite

Certifications
NSF/ANSI 140 Sustainability Assessment for Carpet recognizes commercial carpets and rugs with a silver, gold, or platinum status depending on their evaluation in six categories: public health and environment, energy-efficiency, bio-based content and materials, manufacturing, reclamation and end-of-life management, and innovation. Fogel also looks for the Carpet and Rug Institute's Green Label Plus, which, she says, "recognizes carpets, backings, and adhesives with low VOCs."

Dye Method
How the carpet fibers are imbued with their color is a clue to how their hues will withstand use, Fogel says: "If it is solution-dyed, I know that the color will hold up in high-traffic areas or areas exposed to intense sunlight" because the carpet is dyed all the way through the material. "If it is a printed or piece-dyed carpet, I know I can get a great range in color and pattern, but it may not hold its color long-term under a lot of foot traffic" because the carpet fibers are only coated with color dye on the top.

Construction
"This is something I typically see immediately when looking at a carpet," Fogel says. "Each [construction] type contributes something to the overall look, from a woven to a loop to a tip sheer. It all depends on the look and feel we are going for in the space."

Low, dense carpet with a loop pile will show traffic patterns the least. Beware cut-and-loop or tip-sheared carpet with a high percentage of tip shear as the pattern could dissipate as the carpet mats down.

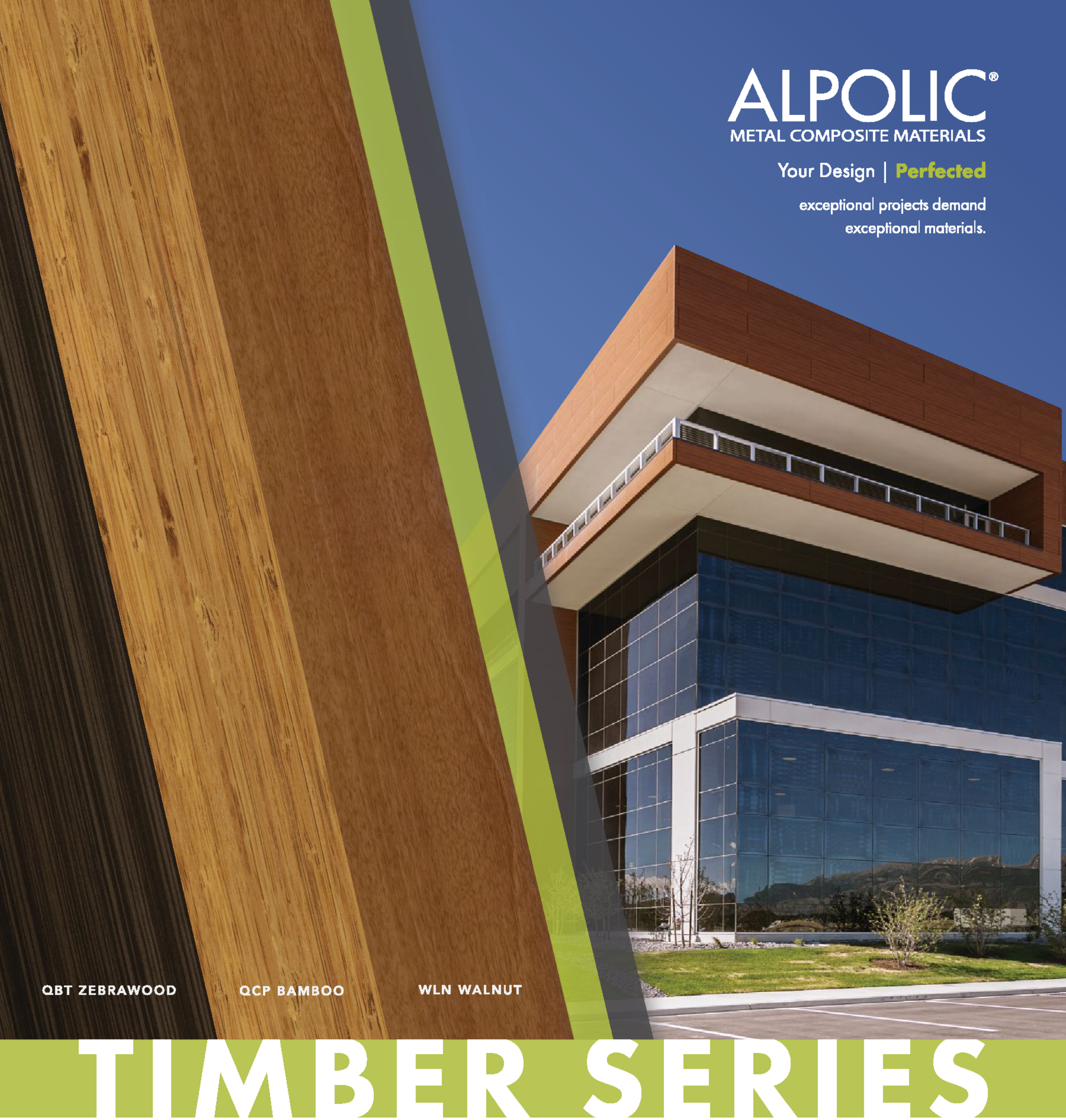
Ounce Weight
The more fiber per square yard of carpet, the plusher the carpet will be, and the more wear and tear it can take. Builder-grade carpet is about 25 ounces per square yard, while anything 50 and up is pretty plush.

Pile
Pile height measures the yarn from the tile backing to top. An entry will require a lower pile height and stronger, more durable fibers than a space that receives less traffic or is designed to evoke a residential feel, "where thicker pile is more desirable for comfort," Larson says. Dense pile will also provide more of a barrier to dirt and stains than will loose pile.

Price
As always, money matters. Fogel asks of any project: "Will this company be staying in this space for an extended period of time? Is budget a major concern? Are there corporate standards we need to adhere to?" Most of the cost of a carpet—about 80 percent—will be in the face material, also called the pile yarn or fiber system. Tiles can cost anywhere from $1 to $11 or more per square foot, not including installation.

COURTESY INTERFACE

> To learn about additional carpet tile features and backing options, visit bit.ly/ARModCarpet.



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Residential: LEFT Architects

TEXT BY EDWARD KEEGAN, AIA

Despite the fact that skiing is a decidedly seasonal sport, and the rare one that makes the outdoors palatable in winter, a new relatively modest house in the prominent Lebanon ski resort Faqra Club embraces the warmer months as well. Beirut- and New York–based LEFT Architects dubbed the project the Out-to-Out House, and according to LEFT partner Ziad Jamaleddine, the inspiration stems from a Lebanese saying: "One can be skiing in the mountains and swimming in the sea within the same day."

Located more than 6,200 feet above sea level and about 20 miles northeast of the country's capital, the 250-square-meter (2,690-square-foot), two-story house sits on a steeply sloped triangular site between two hillside roads. The clients, a married couple with two children, wanted the house to provide varied areas that are suitable for entertaining, which they do often. "There is no hierarchy of spaces," says LEFT partner Makram el Kadi.

The four-bedroom house's layout and geometry are deceptively simple, but it is a simplicity of appearance that masks a complex series of routes through the house using external and internal stairs. The architects placed two 5.5-meter-wide cast-in-place concrete volumes on the high point of the hill, connected at the eastern end. A trapezoidal base is topped by a boomerang-shaped floor that bends toward the south at the western end, creating a sheltered terrace off the base floor.

The boomerang-like form of the house's upper level is designed to maximize views.

Project Credits
Project: Out-to-Out House, Kfardebian, Lebanon
Client: Withheld
Design Architect: LEFT Architects, New York and Beirut · Makram el Kadi, Ziad Jamaleddine (partners); Daniel Colvard, AIA, Ana Conchan, Valeria Fervorari, Mahdi Sabbagh, Karine Yassine (team)
Landscape Architect: Francis Landscapes
Structural/M/E/P Engineer: BTUTP
Contractor: CPM Contracting
Size: 250 square meters (2,690 square feet)
Cost: $1 million

BAHAA-GHOUSSAINY

> Visit ARCHITECT's Project Gallery for more images of the Out-to-Out House by LEFT Architects at bit.ly/OutToOutHouse.

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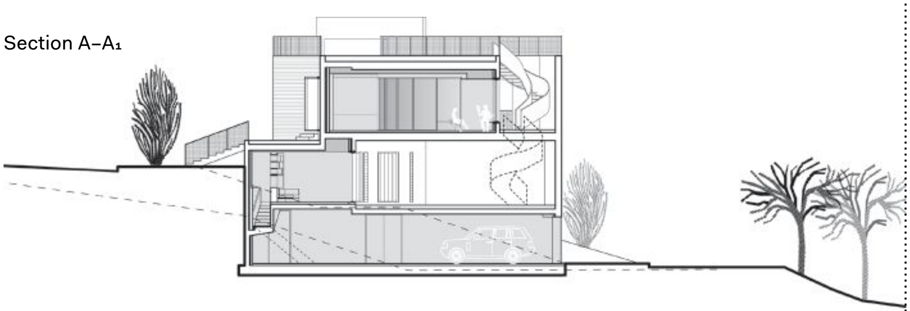
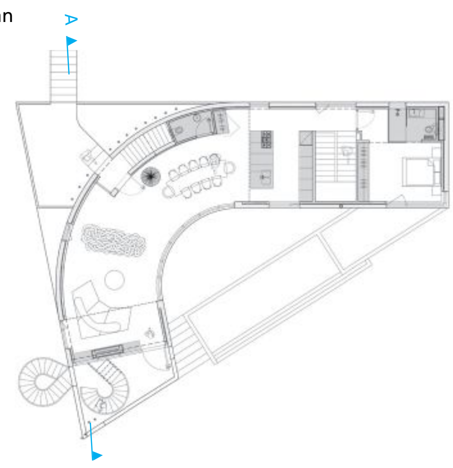
Stealth Cabin, courtesy of superkül. Photography by Shai Gil Fotography.

Residential:
LEFT Architects

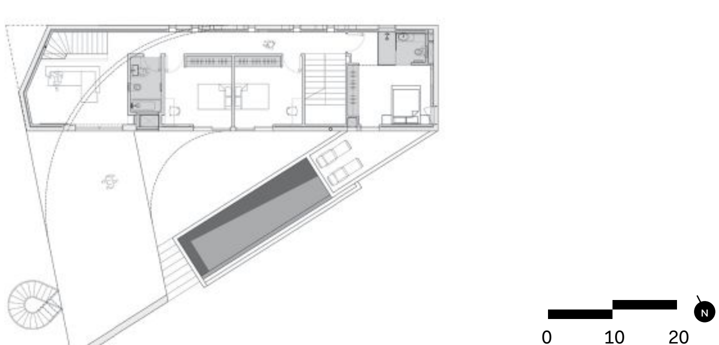
Section A–A_1



Second-Floor Plan



First-Floor Plan



Because of the slope of the site, the entry from the north leads into the house's top curved floor. The open-plan kitchen, dining, and living space share the swoop of the curve, with floor-to-ceiling windows that direct views to the pool below and the mountains to the northwest and southeast. Furnishings are kept minimal though comfortable, with a custom dining table and overhead lighting that match the curve of the walls. At the eastern end of the floor, a bedroom suite is separated from the living space by the main internal stair.

On the floor below, a single-loaded corridor links three south-facing bedrooms that look onto the outdoor pool area. At the western end of the trapezoid, a television room leads to the poolside terrace that sits under the curve of the upper level. A stair in this television room leads to a garage below.

The terrace and pool are among multiple outdoor living spaces designed to maximize the house's entertaining space during the off-ski-season months. The roof deck, considered the home's "hub" by the architects, mimics the shape and function of the living room below, and the roof's metal guardrail widens into bars at the middle of the house's curve, drawing guests to the best viewing points. Sculptural exterior spiral stairs, also metal, start at the poolside terrace and continue through the elevated inner courtyard, a narrow slot off the top-floor living area, to the roof.

While the concrete walls of the house seem impregnable from the north, the upper floor's 14-meter (45-foot) southern span of pre-stressed concrete slabs above the pool plaza demonstrate "porosity"—which el Kadi says the firm intended as a critique of the local typology that uses stone construction with small windows to close the structure from the landscape and weather. LEFT transcends these conventions in Out-to-Out House with a myriad of exterior living spaces and ample glazing, and created a house in a ski resort that functions equally well in the summer.

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Residential:
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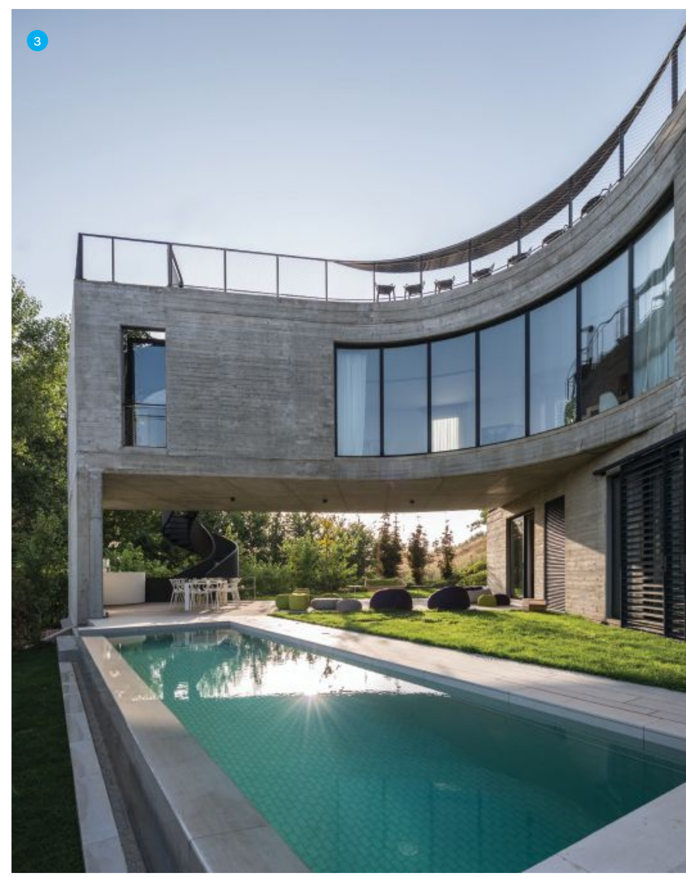

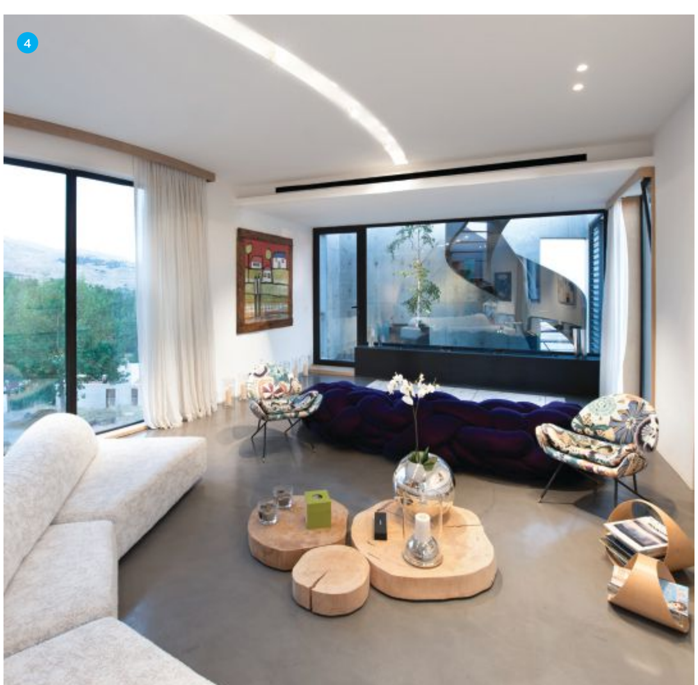

1. Entrance stairs on the north side of the house lead to the living spaces on the upper level. **2.** Inside, on the top floor, the architects created a dining table that follows the curve of the room. **3.** The upper volume wraps around the pool and shelters a terrace at the western end of the site. **4.** Sculptural exterior metal stairs connect the two levels of living spaces to the roof deck.

BAHAA GHOUSSAINY

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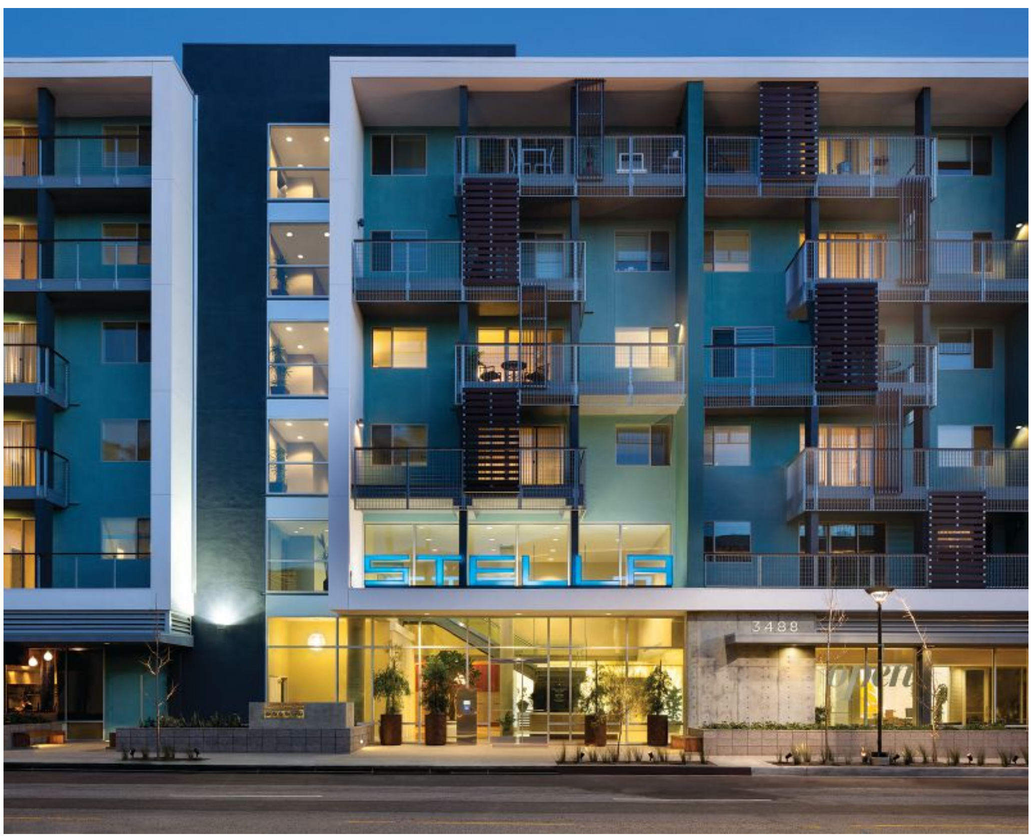

Image courtesy of Lawrence Anderson

LEARNING OBJECTIVES

1. Demonstrate why prefabrication is an efficient and sustainable building practice
2. Evaluate the use of wood components in sustainable prefabricated buildings as well as design and engineering challenges that wood can solve
3. Discuss the advantages of building with prefabricated wood components in terms of speed and efficiency of construction, design flexibility, waste reduction, environmental performance and improved life safety
4. Analyze, through case studies, the different stages of wood building prefabrication from design to installation

CONTINUING EDUCATION

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GBCI CREDIT: 1 CE HOUR

AIA COURSE NUMBER: AR072018-3
GBCI COURSE NUMBER: 0920016493

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PREFABRICATION THEN AND NOW

Prefabricated wood buildings should be considered when designing and building both multi-family and commercial buildings, such as multi-family housing, education, retail, healthcare and institutional buildings, as prefabrication is an efficient and sustainable building practice. Prefabricated wood components used in both light wood frame and mass timber construction can help to solve many design and engineering challenges such as material and process efficiency, environmental performance and life safety.

The practice of prefabricating building elements in a factory was adopted in the United States only in the past century. Prior to that, most buildings were constructed on-site. There was a boom in kit-of-parts building post-World War II. Consumers were enthralled with industrial production and replication, aka mass production, and prefabricated buildings helped fulfill the need for affordable, quality housing post-war. Although mass production has remained vital to our economy and almost all industries, interest in prefabricated buildings fell off in the 1970s. The design and construction industry did not fully embrace the concept because it wasn't well integrated into their traditional business model.

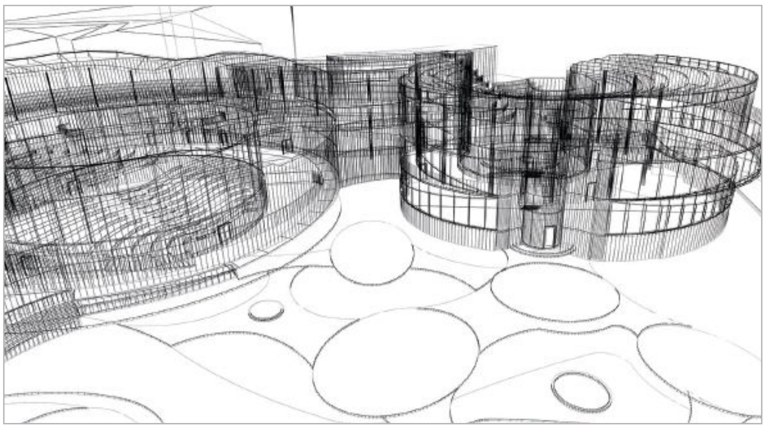
The building industry is now embracing digital tools such as 3D modeling, building information modeling (BIM) and computer numeric control (CNC) machines, making prefabrication and communication amongst building professionals easier. As James

TERMS

Off-Site Manufacture (OSM)
Off-site manufacture is the manufacture of construction components or systems in a factory environment to be transported and assembled on-site.

Prefabricated (Pre-Fab Construction)
Prefabrication can cover off-site prefabrication of materials and parts, prefabrication of components and subassemblies as well as volumetric units or modules.

Modular Construction
Modularization of construction is a way to reduce complexity but still offer customized solutions. The Modular Building Institute defines modular construction as an off-site process performed in a factory setting, yielding three-dimensional modules that are transported and assembled at the building's final location.



The building industry is now embracing digital tools such as 3D modeling, building information modeling and computer numeric control machines, making prefabrication and communication amongst building professionals easier.

Wood prefabrication has a multitude of benefits, including process efficiency, a controlled environment, a greater return on investment, material efficiency, reduced waste both on- and off-site and sustainability.

Timberlake, FAIA, says in the foreword of Ryan Smith's book, *Prefab Architecture: A Guide to Modular Design and Construction*, "We are now capable of sending a fully visualized, and virtually formed, model to a production line, bypassing the document interpretation phase, with all of its back and forth checking, redrawing and margin for additional errors and omissions, ultimately improving the quality of the final product." Also, improved safety measures and greater productivity are now high priorities, which prefabrication can help achieve. The off-site construction environment is a way to provide workers with safer working conditions to reduce the risks of accidents and related liabilities.

An increase in productivity is especially important because of the high demand for, but short supply of, skilled labor in the construction industry. Some believe that standardizing and automating construction in a factory setting deskills the traditional trades. In reality, it upskills the industry and prepares the trades to efficiently deliver buildings through technologically advanced design, fabrication, logistics and assembly. "We think the recession actually benefited our industry," says Thomas Hardiman, Executive Director of the Modular Building Institute. "During the last recession, many skilled laborers left the construction industry and did not return. That, coupled with developers needing to find greater efficiency, made prefabricated buildings more appealing. The construction industry is very reluctant to change. When things were going well, developers and general contractors may not have felt the pain or need to change. Now they do, and there's no turning back."

In addition, environmental views are changing regarding construction waste, the product supply chain, re-use of building materials and carbon footprint. Wood buildings, particularly prefabricated components, can help designers to balance cost objectives, function and environmental impact. James Timberlake says, "Integration modeling, the backbone of off-site fabrication and manufacturing, leans the product supply chain, helps architects and contractors manage the number of materials needed and allows for a positive repurposing of the leftover materials. Further, off-site assembly offers the promise of disassembly and re-use."

BENEFITS OF WOOD PREFABRICATION

Wood prefabrication has a multitude of benefits, including process efficiency, a controlled environment, a greater return on investment, material efficiency, reduced waste both on- and off-site and sustainability. All of these benefits help to meet demands from owners, designers and tenants for better buildings. **Process efficiency** is possible at every stage, from design to fabrication to construction. Detailed planning allows construction processes to be standardized and streamlined, including construction efficiency that meets aggressive schedules and decreases on-site assembly time. Sequencing is improved, as prefabricated components are sorted and loaded onto trucks, minimizing on-site handling. The process is also more integrated with better communication amongst parties, which reduces costly change orders.

Because prefabricated components are produced in a **controlled environment**, quality and precision of components improve, fabrication productivity increases, safety for tradespeople improves and weather is not a factor in slowing down the construction process. **Budgets** should be easier to meet because redundancies and waste in both materials and time are streamlined. Although building components are often more expensive up front, the complete installed cost is usually less because on-site construction is minimized. **Material efficiency** results because prefabricated components are made off-site and typically via modeling technologies that provide extreme precision. **Reduced waste** both on- and off-site minimizes the environmental impact of a project, as specific sizes and dimensions of components are determined in advance and components are made or cut to tight specifications. This also relates to the **sustainable** nature of prefabrication.

According to Ryan Smith, author of *Prefab Architecture: A Guide to Modular Design and Construction*, "The environmental impact of building requires a quantifiable measurement of impact in total lifecycle from design through facilities management. By controlling the means and methods by which buildings are produced through prefab, architects and construction professionals are able to ensure more sustainable materials and practices for construction as well as have a greater opportunity to predict future energy performance. Prefabrication may be used as a method to revamp the sustainability of construction from the perspective of the total lifecycle of a facility, especially regarding demolition or reuse, as the case may be. The capacity of prefab to deliver buildings that respond to time, change and reuse/recycle may be its greatest benefit toward total lifecycle sustainability in the future."

We will review several case studies that demonstrate these benefits, including an extensive case study to conclude the course that details the process of erecting a prefabricated building from design to construction.

CASE STUDY: MOTO

At MOTO the panelized light frame wood wall system created a dramatic speed of construction that allowed each level to be framed in about a week and the entire project in less than a month, making the project viable for the developer. Architecture: Gensler | Photos: Ryan Gobuty

Denver, Colorado

MOTO is an 82,000-square-foot, Type VA mixed-use, 64-unit apartment building with integrated parking and retail that is located in a Denver area known for its rich cultural, artistic and musical offerings. The four-story light frame wood structure is set over a two-level concrete podium with above-grade parking. 3,000 square feet of retail are anchored by two tenants that were selected to work with the theme of the neighborhood and building. One is an old-time barber shop, and the other is a coffee shop/restaurant that serves small dishes and drinks in the evening. With Denver becoming a workforce destination, this project addresses the growing desire for more compact housing with shared amenities.

Wood was used both as the structural material and a design element that sets the building apart from its contemporaries. The massing of the wood frame apartment building is what makes it distinctive; each level slides two feet away from the level below, revealing a cedar soffit on the exterior that creates a unique experience as one moves around the building. The bathrooms, kitchens and corridors stack in plan, but the remainder of the apartments move with the two-foot shift, as opposed to traditional apartment stacking with flat vertical facades. This means the bedrooms on the exterior wall undulate in and out, with every other unit having more area than the other.

The panelized light frame wood wall system created a dramatic speed of construction that allowed each level to be framed in about a week and the entire project in less than a month, making the

The massing of the wood frame apartment building is what makes it distinctive; each level slides two feet away from the level below, revealing a cedar soffit on the exterior that creates a unique experience as one moves around the building. Architecture: Gensler | Photos: Ryan Gobuty

project viable for the developer. Structural materials include a combination of dimension lumber, I-joists and laminated veneer lumber (LVL), while wood finishes include cedar tongue-and-groove soffits, a cedar trellis that wraps down the façade and pool deck railings, pine slab doors in every unit made from trees killed by the mountain pine beetle and reclaimed veneer pine at the lobby accent wall. The podium is board-form concrete.

According to Nick Seglie, architect at Gensler's Denver office, "One of the major benefits we saw with wood construction on the apartment levels was that we utilized a pre-fab wall system. They built the walls off-site and brought them on-site. That allowed each floor of the residential units to be framed in about a week. The podium took about four weeks to construct and then an additional four weeks until we were framed out, which was great." Also, "Wood provides a lot of benefits as a construction project because it is easy to work with, it's fast and sometimes less expensive. From a design standpoint, we like to bring it in projects as a finish material whenever possible to create warmth."

PREFABRICATED WOOD CONSTRUCTION

Prefabricated wood buildings are no longer limited to single family housing and smaller temporary workspaces but are now being constructed for innovative buildings demanded by tenants and owners. Sectors with redundancies, such as multifamily housing (e.g., condos, student housing and senior housing), education buildings, commercial retail, healthcare and institutional buildings, are more likely to be built prefabricated.

Computer numerical control machining technology is used at the plant to profile wood panels for installation, and sophisticated connection systems with a high degree of accuracy and efficiency are incorporated during prefabrication. Image courtesy of StructureCraft

Wood has many benefits to the building industry, including aesthetics, environmental performance, strength and rigidity, lighter weight (compared to concrete) and energy efficiency. In prefabricated buildings, wood is particularly beneficial; it has the structural simplicity needed for cost-effective projects and design versatility and it can be rapidly installed with reduced waste.

Prefabricated wood wall and floor panels offer easy handling during construction, and a high level of prefabrication facilitates rapid project completion. This is a key advantage, especially in mid-rise construction from five to 10 stories. Lighter wood panels mean that foundations do not need to be as large and smaller cranes can be used to lift panels higher. For example, at the four-story John W. Olver Design Building at the University of Massachusetts Amherst, four 60-foot-tall cross-laminated timber (CLT) panels comprising one of the building's shear wall cores were lifted and dropped into place with a crane and anchored to the foundation, all in one weekend.

Panelization means framing of dimension lumber or mass timber walls produced with a high degree of accuracy in a factory. Computer numerical control (CNC) machining technology is used at the plant to profile wood panels for installation, and sophisticated connection systems with a high degree of accuracy and efficiency are incorporated during prefabrication. Panelizing lowers cost and speeds up the delivery of walls to a site where framing crews install quickly, when compared with on-site framing. The faster and safer contractors and developers can finish a building, even if off-site construction methods are more expensive, the greater the return on investment. For light wood frame construction, on-site framing is still the norm because it continues to make sense from a quality versus cost perspective, but that is slowly changing. In the future, larger projects that demand panels be erected quickly and en masse are more likely to be prefabricated for light wood frame construction.

Building kits include prefabricated elements or sections that are then delivered and assembled on-site. The kit-of-parts approach, via panelization, is typical for mid-rise wood buildings. Image courtesy of LEVER Architecture

TYPES OF WOOD PREFABRICATION

There are two types of industrialized approaches to prefabricated buildings: building kits (kit-of-parts) and finished modules. Building kits include prefabricated elements or sections that are then delivered and assembled on-site. These may include the roofing package (roof panels, fascia, gutter, etc.), roof structure (ceiling deck and beams), glazing package (windows and entrances) and building structure (wall panels, beam pockets, columns and shear paneling). The kit-of-parts approach, via panelization, is typical for mid-rise wood buildings.

Within panelization it is helpful to understand the difference between open structural panels versus closed structural panels. Open structural panels are a pre-assembled wall framework that is later fitted with other elements such as insulation, exterior cladding and weather barriers on-site. While this aids in time savings and flexibility, there is still a lot of site work involved. By contrast, closed structural panels are complete pre-assembled wall panels that may include windows, doors, plumbing, ducting, electrical, finishes, etc. Closed structural panels are larger and heavier, so a crane is typically needed for on-site assembly.

Finished modules, on the other hand, are an entire building delivered and assembled on-site. Individual modules are joined together to make a single building. They are built in a factory, transported to the site, and when on-site the modules can be placed side by side, end to end or stacked, allowing a wide variety of configurations and styles in the building layout. Finish levels on modular units leaving the factory generally include plumbing, electrical, paint, flooring, fixtures, cabinets and appliances. After the modules are craned into place, licensed sub-trades make electrical, plumbing, mechanical and structural connections before finish work is completed and the building is prepped for occupancy.

QUIZ

1. Which of the following is a benefit of wood prefabrication?
   a. Process efficiency
   b. Controlled environment
   c. Material efficiency
   d. Sustainability
   e. All of the above

2. True or False: Sectors with redundancies such as multifamily, education, commercial retail, healthcare and institutional are more likely to be built prefabricated.

3. Which of the following is the most common type of wood construction in North America?
   a. Cross-laminated timber
   b. Light wood frame construction
   c. Nail-laminated timber
   d. Dowel-laminated timber

4. True or False: Glulam is stronger than steel at comparable weights and stronger and stiffer than dimensional lumber, making the material a cost-effective choice for long, structural spans and tall columns with minimal need for additional support.

5. Which prefabrication approach is typical for mid-rise wood buildings?
   a. Kit-of-parts
   b. Finished modules

6. True or False: Open structural panels are complete pre-assembled wall panels that may include windows, doors, plumbing, ducting, electrical, finishes, etc. They are larger and heavier, so a crane is typically needed for on-site assembly.

7. True or False: Because wood panels are manufactured using CNC equipment to precise tolerances, panel joints fit more tightly, resulting in a high degree of accuracy and better energy efficiency for the structure.

8. At Brock Commons, which technology provided a comprehensive 3D model composed of all building elements, from the structure to interior finishes to the mechanical and electrical systems?
   a. Computer numeric control machines
   b. Virtual design and construction model
   c. Building information modeling

9. True or False: At Brock Commons the tolerances for the mass timber components were ±2 millimeters, a requirement that would have been challenging to meet without the use of the VDC model.

10. Which of the following was a benefit of prefabrication at Brock Commons?
    a. Decreased on-site assembly time
    b. Improved quality and precision of components
    c. Better safety for trades
    d. Reduced waste
    e. All of the above

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THE BALANCED DESIGN APPROACH TO FIRE SAFETY

HOW CONCRETE BUILDING SYSTEMS CAN HELP REDUCE RISK

Presented by:


Structure fires, whether caused by accident, arson or wildfires result in significant loss of life and property each year. Designing buildings using a balanced design approach—combining active and passive fire protection strategies—can help save lives and reduce property damage.

LEARNING OBJECTIVES

Upon completion of this course the student will be able to:

1. Identify the reasons for the increase of losses in single-family and multifamily buildings from structure fires and wildfires.
2. Examine how the building code has evolved to increase the reliance on active fire protection systems and reduced their reliance on passive fire protection systems.
3. Recognize the balance fire design principles that can improve fire safety in buildings.
4. Demonstrate the contribution noncombustible materials such as concrete makes to fire safety.

CONTINUING EDUCATION

AIA CREDIT: 1 LU/HSW
AIA COURSE NUMBER: AR072018-1

Use the learning objectives above to focus your study as you read this article. To earn credit and obtain a certificate of completion, visit **http://go.hw.net/AR072018-1** and complete the quiz for free as you read this article. If you are new to Hanley Wood University, create a free learner account; returning users log in as usual.

By: **Lionel Lemay**, PE, SE, LEED AP. Executive Vice President, Structures and Sustainability, National Ready Mixed Concrete Association; **Tien Peng**, Assoc AIA, LEED AP+, PMP. Vice President, Sustainability, Codes and Standards, National Ready Mixed Concrete Association; **James Bogdan**, LEED AP, QEP. Senior Director, Sustainability Initiatives, National Ready Mixed Concrete Association

INTRODUCTION

Natural disasters caused at least $306 billion in destruction in 2017—the costliest year on record. The National Oceanic and Atmospheric Administration, which tracks billion-dollar disasters, notes that the record total came from 16 separate events with damages exceeding $1 billion. Hurricanes devastated Texas, Florida and Puerto Rico, and one of the worst U.S. wildfire seasons in years ignited two-million acres of land causing over $17 billion in losses. Meanwhile, with the boom in multifamily construction, the last several years has also recorded a disturbing number of wood-framed apartment fires.

Direct property damage from fires is only part of the story. According to the report *Total Cost of Fire in the United States* by the Fire Protection Research Foundation and the National Fire Protection Association (NFPA), the total cost of fires in 2014 was $328.5 billion, equaling 1.9% of the U.S. Gross Domestic Product. Of these losses, the expenditures on fire protection such as firefighting, firefighting infrastructure, insurance and so forth constitute $273.1 billion and the losses including deaths, injuries and property loss constitute $55.4 billion.

The U.S. Fire Administration reports that every year, fire kills more Americans than all other


The total cost of fires in 2014 was $328.5 billion according to NFPA. That is nearly two percent of the U.S. Gross Domestic Product.

natural disasters combined. Most fires occur in residential buildings including single family and multifamily. Communities struggle to cope with these devastating wildfires, house fires and massive apartment fires that take the lives and injure thousands of occupants and firefighters, displace thousands of residents and shut down

Property damage from structure fires is increasing over time according to NFPA.

nearby businesses and roadways. Legislators and regulators are slow to react to this epidemic, and it is left to the design community to incorporate sound fire safety practices into their projects to minimize fire risk.

STRUCTURE FIRES

According to NFPA, there were 475,000 structure fires in 2016, causing 2,950 civilian deaths, 12,775 civilian injuries and $7.9 billion in damages. Sixty-nine firefighters were fatally injured, and 62,085 firefighters experienced non-fatal injuries. NFPA estimates 358,500 fires occurred in homes resulting in 2510 deaths, 12,300 injuries and $6.7 billion in damages, and 95,000 occurred in apartment buildings resulting in 325 deaths, 3,375 injuries and $711 million in damages. Property damages from fires have been increasing over time.

As a result of relaxed building codes, developers have increased the use of combustible wood-frame construction for multifamily construction (apartments, condominiums, hotels, dormitories and long-term care facilities) resulting in a rash of fires across the country that are reducing these buildings to ashes, putting lives and communities at risk. The recent spate of fires in low- and mid-rise structures throughout the country is raising questions and concerns about the safety of wood-frame buildings of this size.

Massive structure fires in multifamily buildings built using wood-frame have become commonplace since the building codes have relaxed the requirements for passive fire protection. Source: www.buildwithstrength.com/america-is-burning.

Not only are these wood-frame building fires total losses, but they often cause considerable damage to surrounding buildings and property. Communities and surrounding businesses often don't survive. Not only must businesses and residents endure the disruption of construction of the original building, but then must face further losses from business disruption and relocation while the new building is rebuilt after one of these devastating fire events.

The following are just a sampling of notable apartment fires over the last several years:

January 21, 2015—Edgewater, New Jersey: 240 apartments were destroyed when a fire ravaged an apartment building in Edgewater, New Jersey. The 5-alarm fire displaced about 1,000 residents, 500 permanently. This building was fully occupied when the fire was started by a contractor doing plumbing repair work in a concealed space. This fire garnered significant attention from community activists since the same project burned to the ground in 2000 while under construction and was rebuilt using the same wood-frame construction materials.

March 20, 2017—Overland Park, Kansas: A massive fire at an Overland Park apartment building spread to more than two-dozen homes in an adjacent neighborhood causing $20 million damage to the building and $5 million damage to the surrounding homes. The cause of the apartment fire was accidental, started from a spark from a welder's torch. The fire to surrounding homes was mainly caused by sparks and flying embers from the apartment fire. Three firefighters were injured while fighting the massive blaze.

April 24, 2017—College Park, Maryland: A five-alarm fire at an apartment complex under construction in College Park took more than five hours to bring under control. The fire shut down U.S. Highway 1, caused the closure of the University of Maryland campus and forced the evacuation of a nearby senior apartment complex. The fire caused over $40 million in damages, not including the indirect cost of fighting the fire and evacuation and disruption to nearby businesses. Two firefighters were injured.

November 17, 2017—West Chester, Pennsylvania: Four residents died, and 27 were injured after a massive fire broke out at a senior assisted-living center in West Chester, near Philadelphia. The blaze quickly spread to adjacent buildings forcing the 137 residents and 15 staffers into 40-degree weather. The blaze erupted into a five-alarm fire within 30 minutes of starting.

March 7, 2018—Denver, Colorado: More than 100 firefighters from the Denver Fire Department responded to a massive blaze at an apartment construction site. The three-alarm fire quickly consumed the entire structure and is considered a total loss. Neighboring buildings were also damaged, and 40 vehicles parked in a nearby lot were damaged. Tragically, two construction workers were killed in the blaze, and six others were injured, including a firefighter. Several construction workers were forced to jump from the burning building.

Insurance Risk

Insurers are beginning to understand the risk posed by these massive wood buildings. A recent study was conducted by the National Ready Mixed Concrete Association to determine insurance premiums for builder's risk insurance and commercial property insurance for a 100,000-square-foot apartment building built using combustible construction (wood-frame) and non-combustible construction (concrete) in five cities: Edgewater, NJ; Towson, MD; Orlando, FL; Dallas/Fort Worth, TX and Los Angeles.

All insurance quotes showed the concrete building was less costly to insure than the wood-frame building. For builder's risk insurance, the most significant difference was 72% less for the concrete building, and the smallest was 22% less. For commercial property insurance, the greatest and smallest differences found were 65% and 14% less, respectively. Other studies have confirmed the same trend.

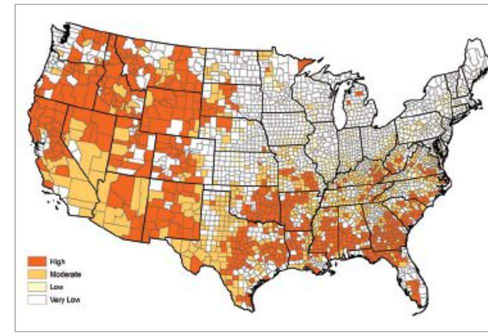
Some insurance agents volunteered their views on the future of insurance rates and practices for different building materials. They suggested that the gap between rates for wood-frame and concrete is likely to increase in the future and that a growing number of insurers are declining to serve as the sole insurer for wood-frame apartment buildings. Additionally, insurers of such buildings are increasingly requiring that the insured take extra measures to protect against fire losses.

As development encroaches on fire-prone areas, the cost of wildfires continues to grow.

WILDFIRES

According to Verisk Insurance Solutions, 4.5 million U.S. homes are at high or extreme risk of wildfire, with more than two million in California alone. According to Munich Re, a reinsurer, there have been $23.1 billion in losses to wildfires in the U.S. over the past five years. 2017 was by far the worst year with $17 billion losses, and that number will likely continue to grow due to climate change which is creating warmer and drier conditions.

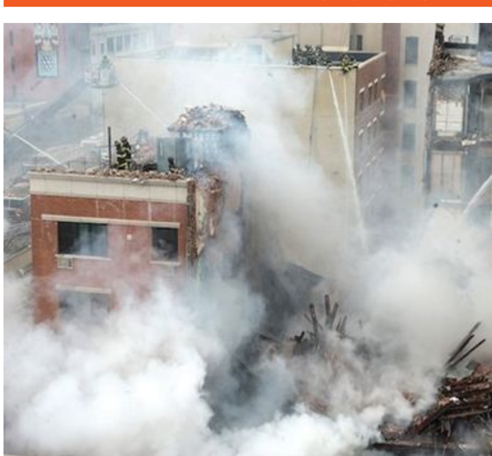
As we continue to build near fire-prone areas, damages caused by wildfires will continue to increase. According to the Bloomberg Businessweek article *Why Is California Rebuilding in Fire Country? Because You're Paying for It*, the 1964 Hanley Fire in Sonoma County destroyed 100 homes whereas the 2017 Tubbs Fire, which covered nearly the same area, destroyed more than 5,000 homes and killed 22 people. The Tubbs Fire was one of 131 across California in October of 2017. By the end of 2017, more than 1 million acres and 10,000 buildings had been destroyed.



Counties with the greatest risk of wildfires characterized by the Counties characterized by higher-than-average annual area burned, structures lost, and homes exposed within the urban wildland interface. Source: www.forestandrangelands.gov.

What is most surprising is that instead of building back to higher standards after the devastating fires, California policymakers are issuing permits to rebuild without updating building codes and even exempting residents from zoning rules so they can build even larger homes. State officials are also mandating that insurance companies not raise insurance rates for people in fire-prone areas thus passing the cost onto homeowners elsewhere in California. The state paid nearly $700 million in fire suppression in 2017, yet California Governor Jerry Brown suspended the fee homeowners in fire prone areas pay to offset the higher risk of wildfires. Although recent attention has been on California because of the wildfires in 2017, there are wildfire risks in most states.

CASE STUDY: CONCRETE APARTMENT BUILDING SURVIVES BLAST AND FIRE



A concrete building survived a blast and fire in New York City and reopened after repairs. Images courtesy of The Bluestone Organization.

In 2014, a massive natural gas explosion in East Harlem, New York City, destroyed two apartment buildings, vacated four neighboring properties, and shattered windows blocks away. Bricks, wood, and other debris landed on the adjacent elevated Metro railroad tracks, suspending service to and from Manhattan for most of the day. Nearby, buildings and households affected by the blast had to deal with the cost to remediate elevated levels of lead and asbestos. In total, the devastation caused eight deaths, 70 injuries and displaced 100 families. Over 250 firefighters, paramedics and police officers responded. The local utility was responsible for $153.3 million damages, the highest payout for a gas safety incident in state history.

Through it all, the adjacent four-story concrete building stood strong. The New York Building Department engineer's report said that amazingly, "there was no structural damage at all," and the blast was located "inches, not feet" from the concrete walls, yet the building was in remarkably good-shape. Damage to the concrete building was caused by falling debris from the blast next door, which penetrated the roof membrane resulting in water damage from firefighting efforts. The building, built using insulating concrete form walls, was reopened after repairs.

CASE STUDY: NONCOMBUSTIBLE EXTERIOR FINISHES SAVES HOME FROM DEVASTATING WILDFIRE

Noncombustible exterior finishes including stucco walls along with concrete roof tile helped protect this home during a 1993 wildfire in Laguna Beach, California (AP Photo/Douglas C. Pizac).

Pushed by Santa Ana winds, a 1993 wildfire in Laguna Beach, California consumed 17,000 acres of brushland, destroyed 366 homes and damaged over 500 more homes in a single day. The demand on the Water District's system was high. In fact, everywhere the fire was being fought, reservoirs were being drained faster than they could be filled. Six of the District's 22 reservoirs were completely drained during the fire. It was roughly estimated that the peak demand was approximately 20,000 gallons per minute and approximately 16 million gallons of water over normal usage was needed during the period of battling the firestorm.

Amongst the devastation, there was a lone survivor protected by an envelope of non-combustible building materials. This house was spared due to its construction and landscape design. Detailing included stucco cladding on walls and Class A concrete tile roof that was sealed on the ends with concrete to hide any exposed wood under the eaves to prevent combustion. The house features double-paned glass, which helps to keep heat from igniting the draperies inside the house and landscaping zones of fire-resistant plants also helped. The property had no tall, flammable trees near the house.

In addition to $528 million dollars in damages, the communities impacted responded with 345 fire engines, 17 dozers, 30 aircraft, 11 hand crews and a total of 1,968 fire personnel.

This article continues on http://go.hw.net/AR072018-1.
Go online to read the rest of the article and complete the corresponding quiz for credit.

QUIZ

1. Research into builder's risk insurance quotes found that a concrete building can be less costly to insure than a wood-frame building. For builder's risk insurance, the savings can be as great as:
   a. 14% b. 22%
   c. 65% d. 72%

2. According to Verisk Insurance Solutions, how many U.S. homes are at high or extreme risk of wildfire?
   a. 500,000 b. 1,000,000
   c. 4,500,000 d. 10,000,000

3. Some of the top reasons why fire sprinkler systems fail include:
   a. Equipment was shut off b. Lack of maintenance
   c. Improper design or inappropriate system d. All the above

4. The two general types of building fire protection are active and passive.
   a. True b. False

5. Building codes require designers to provide fire protection for buildings by combining "active" fire protection systems with "passive" fire protections systems. What is this fire protection approach called?
   a. Integrated approach b. Combined approach
   c. Systematic approach d. Balanced approach

6. A balanced fire protection design is a combination of three key elements which include:
   a. Carbon monoxide, fire curtains, sprinkler placement
   b. Smoke detection, fire suppression, and containment (compartmentation)
   c. 2-hr rated roof, floor and wall assemblies
   d. Fire extinguishers, smoke detection, sprinklers

7. In addition to fire resistance, other attributes of concrete building systems include:
   a. Thermal bridging, versatility, and mold resistant
   b. Energy efficiency, noise reduction, and resilience to natural disasters
   c. Easy to install, delivered locally, and permeable to air
   d. Thermal mass, thermal bridging and convection

8. Specific fire protection recommendations may include:
   a. Vertical separations between dwelling units should have a fire rating of two (2) hours
   b. Horizontal separation between dwelling units and attic space, should have fire rating of at least two (2) hours
   c. Vertical separation of buildings should have a fire-resistance rating of at least (3) hours and should extend to the roof
   d. All the above

9. It makes sense to design a structure and go beyond fire code minimums because:
   a. It assures life safety even at a premium cost b. It offers an opportunity to upgrade interior finishes
   c. It reduces risk without significantly increasing costs d. It increases occupant monitoring and reporting of fire hazards

10. The U.S. Fire Administration reports that every year, fire kills more Americans than all other natural disasters combined
    a. True b. False

SPONSOR INFORMATION

BUILD WITH STRENGTH

Build with Strength, a coalition of the National Ready Mixed Concrete Association educates the building and design communities and policymakers on the benefits of ready mixed concrete, and encourages its use as the building material of choice. No other material can replicate concrete's advantages in terms of strength, durability, safety and ease of use.

DON'T GET BURNED BY SOFTWOOD LUMBER

LIGHT-WEIGHT WOOD

V

- Burns quickly, leaving little time for occupants to escape.
- Is notorious for shrinking, warping and rotting with little protection from rain and wind.
- Leaves firefighters unable to reach floors past 65′, putting tenants at greater risk.
- "Every week it seems we are seeing reports and videos of huge fires consuming very large lightweight, wood-frame residential buildings…threatening the lives of citizens and firefighters."
  – Fire Chief J. Gordon Routley

See why non-combustible materials like concrete and steel stand the test of time

Any structure made entirely of lightweight wood is nothing more than a matchbox. Look no further than the recent fires of low- and mid-rise structures ripping throughout America. Weaker building codes, lax inspections and so-so sprinkler systems are fanning the flames for residents and communities. It's time to create new solutions that embrace non-combustible materials like steel and concrete.

S

READY MIXED CONCRETE

- Can withstand temperatures over 1,000 degrees Fahrenheit.
- Offers the safety of a fire-resistant structure.
- Can cost up to 72% less to insure than a wood-frame building
- Combined with other fire-safety systems, concrete allows you to exceed building requirements—instead of just meeting them.

and fire. **Visit BuildWithStrength.com.**

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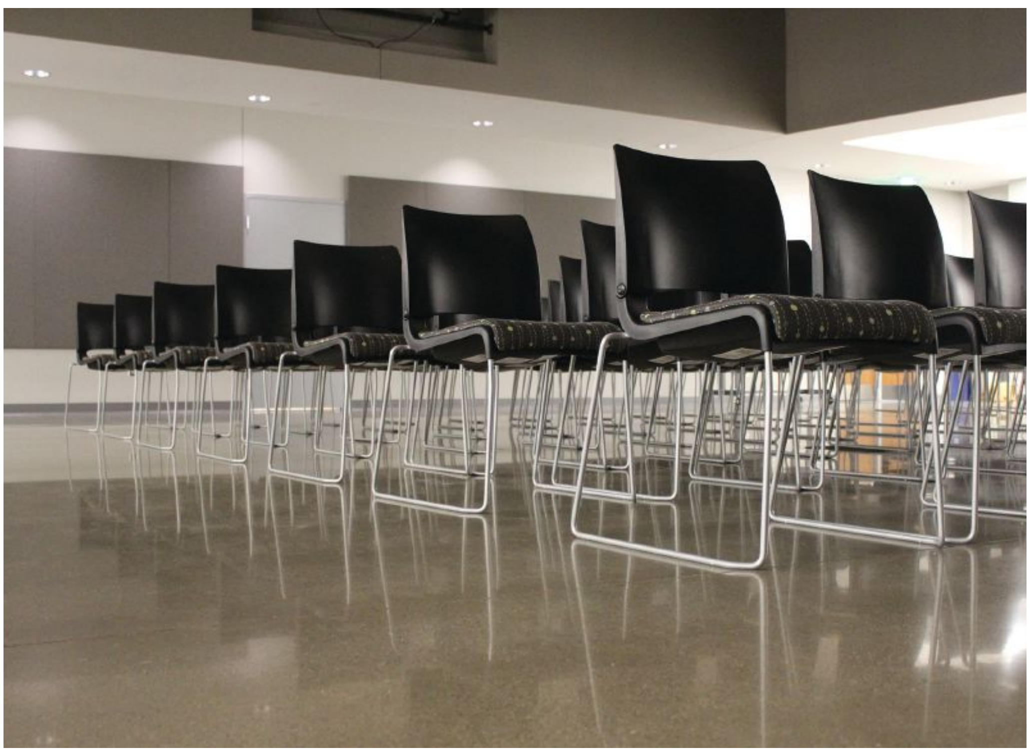

Figure 1. The reflection of the chair legs is from the polished surface of the concrete at Indiana Tech multi-purpose space. Photo courtesy of Dancer Concrete, Ft. Wayne, IN.

LEARNING OBJECTIVES

Upon completion of this course the student will be able to:

1. Examine why building owners value polished concrete flooring for high traffic institutional, commercial, and industrial projects.
2. Understand the physical and performance characteristics of polished concrete flooring systems.
3. Determine the appearance options and their appropriateness in various applications.
4. Recognize what field practices should be addressed in specifications for an optimal outcome.

CONTINUING EDUCATION

AIA CREDIT: 1 LU
AIA COURSE NUMBER: AR072018-4

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By: David Shepherd, AIA LEED AP, Director—Sustainable Development, Portland Cement Association
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INTRODUCTION

Over the past two decades, polished concrete flooring has surged in its popularity, becoming the fastest growing market segment of decorative concrete flooring options. Large-scale manufacturing and industrial clients were the first to adopt polished concrete floors in the mid-1990s, driven by durability, economics of maintenance savings, and light reflectivity. These attributes, combined with safety and slip resistance, and the broad range of visual options and minimal environmental impact have driven polished concrete's rapid growth in popularity. For example, Home Depot began specifying polished concrete around the year 2000 as a low maintenance, high value solution for their stores. Polished concrete floors are a preferred solution for high traffic areas in university and municipal buildings, retail centers, restaurants, airports, and healthcare facilities as well as smaller scale retail and residential markets.

Part of the appeal of polished concrete is the honest expression of the material. The base color of the cement paste (and aggregates if exposed) combined with the natural mottling, creates a unique visual element for each project. Designers can choose appearance and gloss levels, ranging from a soft satin to a highly polished reflection. Today, a broad palette of color created through the use of integral color and modern stains and dyes is available, and the designs can incorporate stenciling, etching, and custom graphics. Even random cracking of an existing floor slab can be embraced to achieve a rustic element to an otherwise mundane surface.

Virtually all commercial, institutional, and manufacturing buildings use concrete as a structural element as either a slab-on-grade, a site cast structural (suspended) slab, or as a topping for either a precast or bar joist/metal pan deck system. By converting this existing surface into a finished product, additional materials and the associated environmental impacts of production, transportation, and installation are not needed. Designers can use polished concrete flooring to reduce operational lighting costs by integrating lightly colored concrete and high reflectivity with a daylighting scheme. Exposed concrete flooring can also be employed as an effective thermal storage solution in passive solar strategies.

The scope of this article focuses on normal-weight concrete slabs-on-grade. Additional consideration beyond the scope of this article is needed for lightweight concrete, suspended slabs, existing slabs, and thin cementitious toppings.

WHAT IS POLISHED CONCRETE?

Concrete polishing is the act of grinding and honing the surface of a concrete slab to a specified appearance. This includes achieving a desired flatness and appearance level and can include color and exposure of internal aggregates. With the advent of modern diamond abrasive technology, a reflective sheen can be achieved. For the purposes of this article, bonded abrasive polished concrete floors will be referred to simply as "polished concrete."

Properly installed, a polished concrete floor surface offers durability and abrasion resistance that industrial, institutional, and retail client's value for long-term performance and low maintenance costs.

The American Society of Concrete Contractors' Concrete Polishing Council (ASCC-CPC) uses the title "Bonded Abrasive Polished Concrete" in their standard Specification (03 3543).[1] This intentionally differentiates polished concrete from less durable surface-coated film applications that also exist in the marketplace.

While the concrete contractor is responsible for placing the slab, it is the polished concrete contractor who is responsible for converting that into a finished floor. For new construction, the ASCC-CPC recommends that a separate specification specifically for polished concrete be established as Section 03 3543–Polished Concrete Finishing, which should then be cross-referenced with Section 03 30 00–Cast-in-Place Concrete.

Creating a polished concrete floor requires more than simply burnishing the surface of an existing slab. For a project to achieve a uniform sheen and durable surface, the contractor typically performs the following steps:

Grinding

This step removes the surface layer of the concrete to open the pores of the slab which were closed during the original finishing process. Grinding can also reduce undulations which will affect the final appearance. Depending on the flatness of the original floor and how much material is removed during this grinding process, the fine (sand) or coarse aggregates may be exposed.

Densification

This is an application of a penetrating treatment after grinding which chemically reacts with calcium hydroxide in the cement paste matrix to create calcium silicate hydrate, one of the stronger and more durable components in concrete. This reaction increases density and hardness, while reducing porosity and permeability. The harder surface lasts longer, has greater abrasion resistance, and is easier to maintain. Densified floors allow for moisture transmission as they are not vapor barriers.

Scratch Removal

Starting with the ground slab and progressing through increasingly finer diamond abrasives, the surface is honed, with each step removing scratches from the previous pass. The final gloss level is determined by the fineness of the last abrasive used and can range from a soft satin to a highly polished mirror finish. Higher sheens require additional labor and consumable diamond abrasives and therefore have a higher installed cost.

Stain

Dyes or chemically reactive stains change the base color. Changing the base color is typically performed during the scratch removal process, before the final gloss level is achieved.

Stain Protection

This is an optional, topically applied microfilm coating which increases protection of the applied color and guards against future staining and etching by contaminants.

TERRAZZO VS MECHANICALLY POLISHED CONCRETE VS CHEMICALLY POLISHED CONCRETE

Modern terrazzo—Consists of chips of marble, quartz, granite, or glass embedded in an epoxy or cement matrix and installed on a concrete slab base. Metal strips typically divide sections or change colors or materials in a pattern. After terrazzo has cured, it is ground and polished smooth to produce a uniformly textured surface.

Polished concrete—As described in the introduction, polished concrete is a mechanical abrasive treatment which removes 1/16" or more of a slab to flatten and develop the desired level of gloss on the surface. Removal of material beyond the surface layer of cement paste may reveal fine or coarse aggregates.

Chemically polished concrete—Using a high speed burnisher, this process melts and buffs a chemical product (typically acrylic or wax-based) that has been applied to the slab surface, much like a wax applied to a VCT floor. The surface of the slab is not ground to expose aggregates. While this can have an initial lower cost, it does not offer the visual clarity and uniformity or ease of maintenance and durability of a mechanically polished concrete floor.

FINISHING OPTIONS

A specifier's finishing options include the level of aggregate exposure, appearance (sheen), and color. A cream finish, where only the surface layer of cement paste is visible, typically provides a sophisticated minimalist background to highlight other elements within a space, while deeper grinding exposes fine or coarse aggregates to add a natural visual texture. The specular reflection of the floor can range from a soft matte with minimal reflection to a high polish finish that provides a high level of clarity for reflected objects. Applying color and/or a pattern can add warmth and offer visual movement. Scoring, custom graphics, borders, and decoratively colored aggregates provide further options to meet a client's objectives.

Degree of aggregate exposure. It is important to recognize that the size, density, and distribution of the exposed aggregate is highly dependent on the concrete mix design, placement techniques, and slab finishing operations. Floor flatness at the time of grinding and polishing operations is an important consideration in selecting the appropriate aggregate exposure class. The ASCC-CPC offers a chart titled "Polished Concrete Aggregate Exposure Chart"[2] that defines a general level of expectation for three aggregate exposure classes:

Class A.

Frequently referred to as a cream finish, this popular polished concrete style removes very little of the surface and exposes little to none of the fine aggregate. Left unstained, the color is primarily influenced by the cement paste and typically is revealed as a subtle mottling. Cream finishes can also be stained in a wide range of colors. Assuming that the initial slab is flat and level, a cream finish may decrease the installation cost because of less initial grinding.

However, it may also reveal shadowing, stains, or discoloration that might have been removed by a deeper cut.

Class B.

Also called a salt and pepper finish, this style requires approximately 1/16" to 1/8" surface cut depth and has fine aggregate exposure with little or no medium aggregate exposure. Consideration of aggregate types by the specifier is warranted for this option because as aggregates are exposed, they influence the visual texture and overall color of the floor. The consistency of this type of exposure is highly dependent on the initial slab being flat and level.

Class C.

This style has more of the look of terrazzo as 1/8" to 1/4" of the surface is removed to reveal the coarse aggregates. As the cut increases (greater than 1/4"), larger cross sections of aggregate are revealed. Similar to the Class B designation, aggregate selection will have a significant influence on the color of the final installation.

All areas with exposed aggregate need to be grout coated. During the original mixing and placement of concrete, minute air bubbles are trapped between aggregates. While vibration during placement will remove most of the larger voids, small air pockets can remain. When grinding to a depth that exposes aggregates, these small air voids (1mm or less) are exposed as well. Grouting these will fill the voids that diminish the reflectivity of the surface as well as eliminate areas for dirt to accumulate. Typically, the chosen grout color is a close match to the cement paste after any color treatments.

While not an official classification, the aggregate exposure within an existing slab could be considered "random," as there is no guarantee that the original concrete installation procedures would result in a uniform distribution of aggregate. In select applications, such as a casual restaurant, this random exposure pattern may be acceptable or even desirable. The best way to ensure a satisfied client is to evaluate the existing slab with a consultant and to specify that mock-ups be performed.

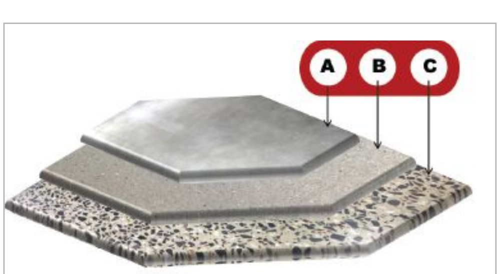

Figure 2. Image courtesy of ASCC-CPC, Nov. 2017.

Figure 3. A subtle satin sheen on a grey dyed and polished concrete floor adds sophistication to a lobby reception area. Photo courtesy of Colorado Hardscapes, Denver, CO.

CONCRETE POLISHING COUNCIL

POLISHED CONCRETE APPEARANCE CHART

REPLACES CPAA FINISHED GLOSS CHART

LEVEL	NAME	DISTINCTNESS-OF-IMAGE (DOI) GLOSS	IMAGE CLARITY VALUE, %	HAZE INDEX
1	Flat (Ground)	Images of objects being reflected have a flat appearance.	0 – 9	<10
2	Satin (Honed)	Images of objects being reflected have a matte appearance.	10 – 39	
3	Polished	Images of objects being reflected do not have a sharp and crisp appearance but can be easily identified.	40 – 69	
4	Highly Polished	Images of objects being reflected have a sharp and crisp appearance as would be seen in a near-mirror like reflection. May require grouting.	70 – 100	

Figure 4. Table courtesy of ASCC-CPC, Polished Concrete Appearance Chart, Nov. 2017.

GLOSS LEVELS

The finished gloss on a concrete surface, from flat to highly polished, is classified as levels 1, 2, 3 and 4, with increasing degrees of sheen and clarity. The technique for creating higher levels of reflectivity involves additional steps of polishing with increasingly finer abrasives. The designer should consider the impacts of direct and indirect lighting as well as daylighting to minimize issues with glare. Although all gloss levels are similar in durability, a higher gloss requires additional polishing steps with associated costs. Consequently, specifying a high gloss, Class 4 finish for a manufacturing plant could be an added expense with no increase in durability or reduction of maintenance costs.

The ASCC-CPC has established two field measured metrics for specifying reflectivity values:

- Distinctness-of-Image (DOI)—DOI is the sharpness of reflected images of objects created by the polished surface, sometimes referred to as "image clarity." These can be measured per ASTM D5767 utilizing an Image Clarity Meter. The DOI is obtained from this test method over a range from 0 to 100 with a value of 100 representing perfect DOI (mirror finish).
- Haze—Haze is the cloudiness or halo-like appearance of images produced by reflection in a polished surface. These are quantified by an ASTM D4039 using a glossmeter. The Haze Index, obtained from this test method, is computed using the numeric difference between the value of specular gloss at 60° and the value of specular gloss at 20°.

The Image Clarity Meter and Glossmeter must be calibrated and used in accordance with ASTM D5767 and ASTM D4039. A minimum of three tests should be conducted, distributed across the polished surface for areas up to 1,000 square feet; and one additional test for each 1,000 square feet or fraction thereof. This applies to both the Image Clarity Value and Haze Index. The mean (average) values of the test results should be used to evaluate compliance with the following chart from the ASCC-CPC that establishes reflectance guidelines:[3]

COLOR

Concrete is a unique substance. It is strong enough to support buildings, yet permeable like a sponge, enabling it to be modified to almost any color desired. The main methods of coloring polished concrete consist of integrally coloring the concrete mix and staining or dyeing the surface (or a combination of both). Stains, dyes and integral pigments come in a variety of different formulations, running the gamut from water-based, low-VOC products to chemically reactive, acid-based solutions. Should an exposed aggregate finish be desired, colored aggregate or crushed glass can also be added to the concrete mix or hand seeded into the top layer of the slab where it will be revealed during the grinding process. Each has its advantages and disadvantages depending on the application and the preferred visual effect. Regardless of the color options selected, it is prudent to specify mock-ups to ensure the final color meets the project goals and owner's expectations, as each mix design and manufacturer's product will differ in the final color achieved.

QUIZ

1. Which of the following is not true of polished concrete flooring?
   a. Offers a low cost of maintenance when compared to other flooring alternatives
   b. Meets or exceeds ASTM slip resistant standards when wet
   c. Can be stained or dyed in a broad range of color
   d. Reflectivity can range from satin to semi-gloss

2. True or false: An existing concrete slab with random cracks is not suitable for polishing.
   a. True b. False

3. A specifier's finish options include all of the following except:
   a. Level of aggregate exposure b. Level of reflectivity or sheen
   c. Thermal storage capacity d. Color

4. How many levels of aggregate exposure are listed in the American Society of Concrete Contractors—Concrete Polishing Council's "Polished Concrete Aggregate Exposure Chart?"
   a. 2 b. 3
   c. 5 d. 6

5. True or False: When determining the field reflectivity of the floor, "haze" is defined as the cloudiness or halo appearance of images produced by reflection in a polished surface.
   a. True b. False

6. Which of the following is not suitable for polished concrete flooring applications?
   a. Topical film-based paint b. Integral colorant mixed at the ready mixed concrete plant
   c. Reactive stains d. Translucent penetrating dyes

7. True or False: The aggregate is the most abrasion-resistant component in a polished concrete floor.
   a. True b. False

8. When specifying air entrainment in the mix design for polished concrete floors, the maximum percentage allowed should be which of the following:
   a. 1% b. 3%
   c. 6% d. 10%

9. The preferred method for curing a concrete slab to be polished is:
   a. Liquid "cure and seal" product, applied with a roller at a rate of 1 gallon per 1000 square feet
   b. 6 mil polyethylene film installed immediately after finishing
   c. Wet curing with burlap or cellulose blankets
   d. Liquid applied dissipating curing product, spray applied per the manufacturer's recommendations

10. When producing a field mock-up on the project, it should include all of the following except:
   a. An example of the expected condition after five years of anticipated traffic
   b. Produced by the installers that will be working on the project
   c. Include the exact same manufacturer's products (densifier, colorant, and equipment) that will be used on the project
   d. Sections from differing concrete installation procedures (finishing techniques, batches, curing conditions, etc.)

This article continues on http://go.hw.net/AR072018-4. Go online to read the rest of the article and complete the corresponding quiz for credit.

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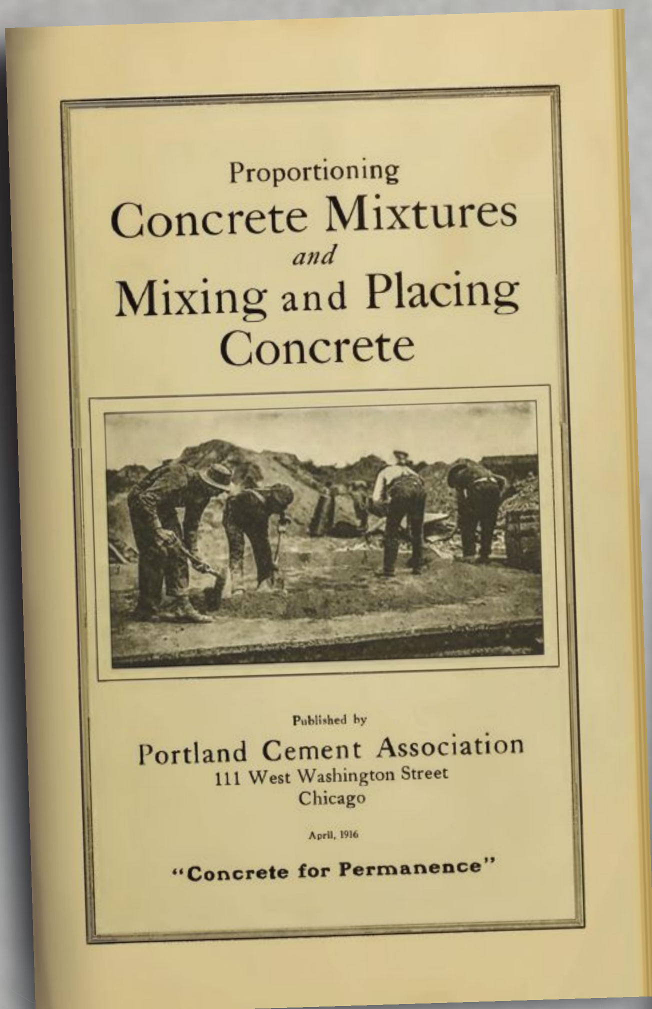
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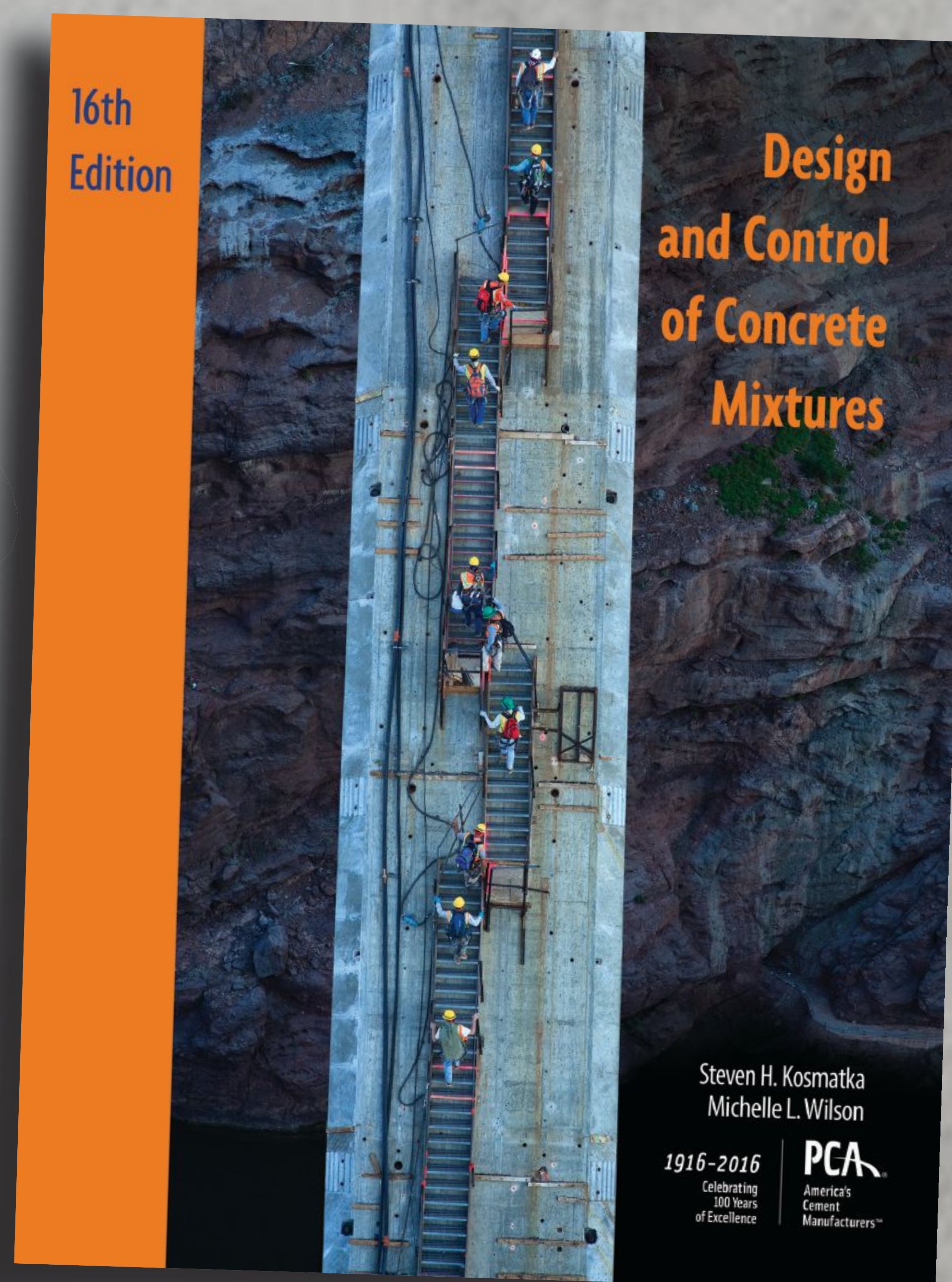
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SOLVING DESIGN CHALLENGES WITH ADVANCED FIRE-RATED GLAZING ASSEMBLIES

Presented by:

TGP FIRE RATED

INTRODUCTION TO FIRE-RATED GLASS AND FRAMING

The technical properties and performance characteristics of fire-rated glazing systems often cause confusion in the building industry. For example, specifying fire-**protective** products in fire-**resistive** applications and vice versa is a common mistake. In addition, fire-rated glazing products have become more sophisticated to align with today's increasingly complex building designs, so it is important to understand your options and how to use fire-rated glazing assemblies to solve design challenges that arise in areas with strict fire and life safety criteria, such as sight lines, glazing size, glass clarity, aesthetic discrepancies, and increasingly complex building designs. The large, open spaces common in contemporary design pose challenges for spaces requiring fire protection or fire resistance, as do poor visual transitions between fire-rated and non-rated glazing systems. Advanced fire-rated glass and framing can solve these challenges and preserve a building's open layout by providing transparent compartmentation, dramatic visuals between building levels, and the slender, sophisticated aesthetic of non-rated glazing assemblies.

Fire-rated glass is now available in larger sizes with thinner fire-rated frame profiles, has improved energy efficiency, and more advanced security options. A growing number of products are also air and water pressure tested and approved for the rigors of exterior use. They are increasingly installed in the building envelope to safeguard property lines as cities grow denser. While these new products are propelling fire and life safety design into an era of innovation, they are not without challenges. Building teams now have numerous product lines with similar attributes at their disposal; however, each has slight variations in function, application, and

LEARNING OBJECTIVES

At the end of this program, participants will be able to:

1. Understand fire-rated glass and framing
2. Identify common fire-rated glazing materials
3. Analyze how fire-rated glazing assemblies have changed over the last decade
4. Illustrate solutions to common design challenges in fire-rated areas

CONTINUING EDUCATION

AIA CREDIT: 1 LU/HSW
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code-approved fire ratings. Given the prominent role fire-rated glass plays in the safety and design of today's buildings, it is imperative that architects know how to specify glazing materials that are credibly tested, free of hidden limitations, and perform as expected to achieve well-performing, safe, and attractive buildings. As Steve Jobs once said in a November 30, 2003 New York Times article, *The Guts of a New Machine*, "Design is not just what it looks and feels like. Design is how it works." By staying on top of current product offerings and codes, architects can support fire and life safety design that delivers both beautiful and high-performance buildings.

A fire-rated glazing system provides stylish lot-line protection, while its strength allows for 21-foot free spans.

WHAT IS FIRE-RATED GLASS AND FRAMING?

Fire-rated glazing products are not your typical building materials. They serve a unique purpose by balancing transparency with fire defense, and they are required by building codes in certain applications. Chapter 2 of the 2015 International Building Code (IBC) defines fire-rated glazing as, "Glazing with either a fire-protection rating or a fire-resistance rating." Fire-protection rating is "the period of time that an opening protective will maintain the ability to confine a fire as determined by tests prescribed in Section 715. Ratings are stated in hours or minutes." Fire-resistance rating is, "The period of time a building element, component, or assembly maintains the ability to confine a fire, continues to perform a given structural function, or both, as determined by the tests, or the methods based on tests, prescribed in Section 703." Additionally, fire-protective glass only stops flames and smoke, while fire-resistive glass stops flames, smoke, and heat transfer.

Fire-rated glazing is specialized glass designed to provide the necessary level of fire protection or fire resistance for the duration of its fire rating. While crucial in defending against fire, it is just one component of the overall protection solution. The frames that retain the fire-rated glass must also be able to withstand flame, smoke and, if necessary, heat spread. In fact, to maintain compliance with the IBC, all fire-rated glass assembly components must have the same or greater ratings than the required code minimums for the location. As such, integrated assemblies, such as fire-rated glass curtain walls, are tested as a complete system, from the glass and frames to hardware and all component parts. The fire rating therefore encompasses the profiles, the maximum glass size, and how the glass is captured. This helps ensure the entire assembly provides the same category of fire defense and carries the minimum fire rating, as required in the IBC.

Glass and frames earn fire ratings through rigorous testing processes at independent laboratories such as Underwriters Laboratories, Inc.® (UL). Fire-rated glazing is available rated from 20 minutes to 3 hours. The rating reflects the amount of time the material has been tested to remain in place with no flaming on the exposed surface. Such fire-rated materials are designed to help slow or stop the spread of fire and smoke, a term called compartmentation. Compartmentation is an important component of passive fire protection in a building and is accomplished by dividing the building into smaller compartments using fire-rated materials.

Protective vs. Resistive

As you can see from the two previous definitions, the IBC distinguishes between fire-rated glazing products, which are defined as either fire-protective or fire-resistive. Each category has its own set of performance features, test standards, and allowed applications. Fire-protective glazing helps to contain smoke and flames, but does not provide shielding against radiant or conductive heat transfer. This "thin" glazing is made of fire-rated material such as wired glass with a surface-applied film, specially tempered glass, and glass ceramic. Fire-protective frame options include traditional hollow metal steel frames and precision engineered fire-rated steel frames.

Since fire-protective glass is designed to compartmentalize smoke and flames, but not heat transmission, it is subject to building occupancy, application, area, and size limitations under the IBC. This glazing is typically used in doors and openings and may not exceed 25 percent of the aggregate length of the wall. In addition, products with fire ratings over 20 minutes must pass the required hose stream test.

Outside of these parameters for fire-protective glazing, fire-resistive products must be used. Fire-resistive products, including both glass and frames, are designed to stop flames, smoke, and radiant and conductive heat transfer. This "thick" glazing is tested to the industry standards for walls, meeting ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, and Underwriters Laboratories (UL) 263, *Fire-resistance Ratings*. As such, it is classified as a "wall" rather than an opening (window). Fire-resistive framing is rated up to 120 minutes and also defends against the transfer of heat. It is required to be tested as an assembly, meaning both glass and framing. It's not only fire rated, but is also hose-stream tested and positive pressure tested.

Several fire-resistive framing options are available including filled profile systems, steel framing systems, aluminum-clad systems, and butt-glazed systems, among others. In addition, fire-resistive products can be used in exterior applications, as well as for glass flooring, among other specialty applications. Due to these systems being tested to the same fire test standards as wall construction, they are not limited in size (beyond what is tested) or to the total aggregate area, as may be the case with fire-protective glass assemblies.

Fire-rated glass products with fire-ratings over 20 minutes must pass the required hose stream test.

PASSING THE TEST

Various levels of testing are required to ensure the fire-rated glazing product's level of performance. The **fire test** measures the amount of time, in minutes or hours, that materials or assemblies can withstand fire exposure in a test furnace without shattering or allowing flames on the non-fire side of the assembly. Fire-protective assemblies use test standard UL9, *Standard for Fire Tests of Window Assemblies*, to qualify the glazing for use as a window in a wall, door, or a sidelite in a door assembly. The UL9 test standard does not have the same rigid criteria as the fire-resistive wall test standards. Windows and non-temp rise doors are classified as opening protective assemblies, as opposed to fire-resistive assemblies. They do not need to block the transfer of radiant heat.

Fire-resistive assemblies, including fire-rated transparent glass wall panels, fire-rated curtain walls, and fire-rated glass floor systems meet more stringent test requirements. These include ASTM E119 and UL 263, which, as discussed earlier, are the fire-resistance standards for walls. To achieve this level of performance, such products often use multiple layers of glass with special fire-resistant interlayers.

In addition, the **hose stream test** is required for products rated 45 minutes and up. After heating the glass and framing in a furnace, testing labs spray them with water from a fire hose. The test evaluates the impact, erosion, and cooling effects of water on glazing and eliminates inadequate materials or constructions that may fail under similar conditions. Withstanding the stress and thermal shock imposed on the assembly by the hose stream is critical, since most buildings today include fire sprinkler systems. If the hot glass fails, flames and smoke may be able to spread throughout a building. To earn a hose stream designation, the glass and framing must remain intact.

The **impact safety test** measures the ability of glass to withstand impact. Ratings are given in levels based on the amount of force the glass can resist from a 100-pound bag dropped at the height of either 18 or 48 inches. The Consumer Product Safety Commission (CPSC) developed the guidelines for Testing and Certifying Safety Glazing Glass Products used in Architectural applications. The local and national building codes recognize the CPSC 16CFR 1201 Category I and Category II (Category One and Category Two) as the impact-safety standard for glass. Category I is for products less than 9 square feet and Category II is for products of unlimited size. The testing requirement for Category I and Category II are different, with Category II being more stringent. This rating is the highest standard impact-safety rating available and indicates the glass can safely withstand an impact similar to that of a full-grown, fast-moving adult. Today, numerous products meet this criteria and also have the capability to provide supplemental security protection, such as bullet and hurricane resistance.

SAFETY GLAZING CLASSIFICATIONS

Safety Glazing Classifications are as follows:

CPSC 16 CFR 1201 (Category II)
400 ft. lbs. pressure
Tempered glass, typical laminated glass, filmed glass

CPSC 16 CFR 1201 (Category I)
150 ft. lbs. pressure
Permitted up to 1,296 in^2

ANSI Z97.1
Class A: 100# bag dropped from height of 48 inches
Class B: 100# bag dropped from height of 18 inches

TODAY'S FIRE-RATED GLAZING PRODUCTS

Wired Glass

The first fire-rated glass in North America was wire mesh glass, also called wired glass. Wired glass has a thin metal wire mesh running through the glass that prevents the glass from falling out of the frame if it cracks under heat stress. For decades, traditional wired glass was the only product option that could pass a fire test. While the wires were often misinterpreted as adding a level of security, the reality is they were only there to hold the glass in place during a fire. The material was actually a low impact product, and the wires could cause significant injury when broken. However, the product was given a code exemption and granted use in high-impact areas that required fire protection since it was the only material that could protect against the spread of fire for a reasonable length of time.

Because the wire mesh was not aesthetically-pleasing, the product's use was limited regarding design and visibility. As new wireless products for fire-rated applications were developed, and as building codes changed to eliminate the use of traditional wired glass in certain applications, the glazing industry began to provide many options for designing fire-rated applications that offer both safety and aesthetics.

While traditional wired glass is still allowed in certain applications, building codes have evolved to limit the allowable use. In fact, the 2003 IBC restricted the use of traditional wired glass in hazardous locations in schools, athletic facilities, and daycares. The 2006 IBC extended the restriction to hazardous locations in ALL building types. "Hazardous" locations include doors, sidelites, transoms, windows near the

Fire-rated transparent wall panels can satisfy stringent building codes and exceed 25 percent of the total wall area, creating light-filled and open pathways in critical fire areas. Photo courtesy of Heidi Gumula—DBVW Architects floor, and other areas at risk for impact. Per the code, glazing in "hazardous" locations must now also pass impact safety testing, which measures the ability of the glass to withstand impact. As discussed earlier, ratings are given in levels based on the amount of force the glass can withstand.

Glass Ceramic

The next iteration in fire-rated glazing was ceramic glass. Fire-rated glass ceramic is clear and wireless and can better mirror the appearance of typical float glass, providing great design flexibility as it can be used in much larger sizes than traditional wired glass. The introduction of glass ceramic products for fire-rated applications in the 1980s took compartmentation to the next level. They provided designers and architects with the opportunity to create fire-rated spaces that included glass without the presence of wires.

Similar to most building materials, ordinary glass expands when subjected to high temperatures. But glass ceramic has a high resistance to thermal shock (exposure of hot glass to rapid cooling) because of an extremely low coefficient of thermal expansion. While ordinary glass breaks at 250 degrees F, glass ceramic maintains its stability in temperatures exceeding 1,600 degrees F. As with wired glass, fire-rated glass ceramics can withstand the thermal shock of water from sprinklers or fire hoses, with a fire rating up to 3 hours with the required hose stream test. Glass ceramic can be insulated when necessary, providing thermal efficiency as well as fire protection. It is listed for use in doors, sidelites, transoms, and borrowed lites and protects from fire on both sides of the glass.

Where impact safety is required, filmed or laminated glass ceramic products can meet safety code requirements with up to Category II impact-safety ratings. Filmed glass has a fire-rated film applied to one side of the glass ceramic. Laminated glass is comprised of two pieces of fire-rated glass ceramic laminated together. Both product options protect against impact from both sides of the glass.

Fire-Rated Transparent Wall Panels

Fire-rated transparent glass wall panels go a step beyond fire-rated glass ceramic. They meet the fire test standards for walls and can exceed 25 percent of the wall area as a fire-resistive material. To achieve this level of performance, the product incorporates intumescent interlayers that turn to foam when exposed to heat. However, when it's not called into action, the high-performance material provides nearly the same level of clarity as ordinary float glass. As a result, it allows for the look of non-rated glass in a range of settings with stringent fire and life safety criteria. The product can have a fire rating of 45 to 120 minutes and is listed for use in doors, sidelites, transoms, borrowed lites, and wall applications. It is suitable for use in wall-to-ceiling and wall-to-wall applications, or in full-lite glass doors.

This article continues on http://go.hw.net/AR072018-2. Go online to read the rest of the article and complete the corresponding quiz for credit.

QUIZ

1. True or False: Fire-protective glass only stops flames and smoke, while fire-resistive glass stops flames, smoke, and heat transfer.

2. Fire-rated glass products with fire-ratings of _____ minutes or greater must pass the required hose stream test.
   a. 45 b. 60
   c. 90 d. 120

3. True or False: A frame's rating must be equal to or greater than the required code minimums for the glass.

4. Which of the following is a design challenge architects often encounter with fire-rated glazing and framing?
   a. Interrupted sight lines b. Thicker frames
   c. Limited glazing sizes d. Clarity of glass
   e. Aesthetic discrepancies f. All of the above

5. Which fire-rated glazing product has a monolithic appearance?
   a. Silicone-glazed b. Butt-glazed
   c. Horizontal assemblies d. Both A and B

6. True or False: Depending on the application, design professionals can select from fire-resistive glass horizontal assemblies that can support live loads up to 300 psf.

7. Which of the following daylighting strategies can be used with fire-rated glazing?
   a. Glass floor systems b. Fire-rated glass transparent wall panels in corridors and elevator shafts
   c. Exterior curtain walls d. All of the above

8. Which product allows glazing in spaces that previously would have required opaque fire-stopping like concrete and corrugated steel?
   a. Silicone-glazed fire-rated curtain walls b. Butt-glazed fire-rated glass walls
   c. Horizontal fire-rated glass assemblies d. All of the above

9. True or False: Glass floor systems that are tested in accordance with ASTM E119, UL 263, and NFPA 251 standards are available with fire-resistance-ratings up to two hours.

10. True or False: A silicone-glazed fire-rated curtain wall is available with up to 120-minute fire ratings for unrestricted glazing as a fire-resistive assembly.

SPONSOR INFORMATION

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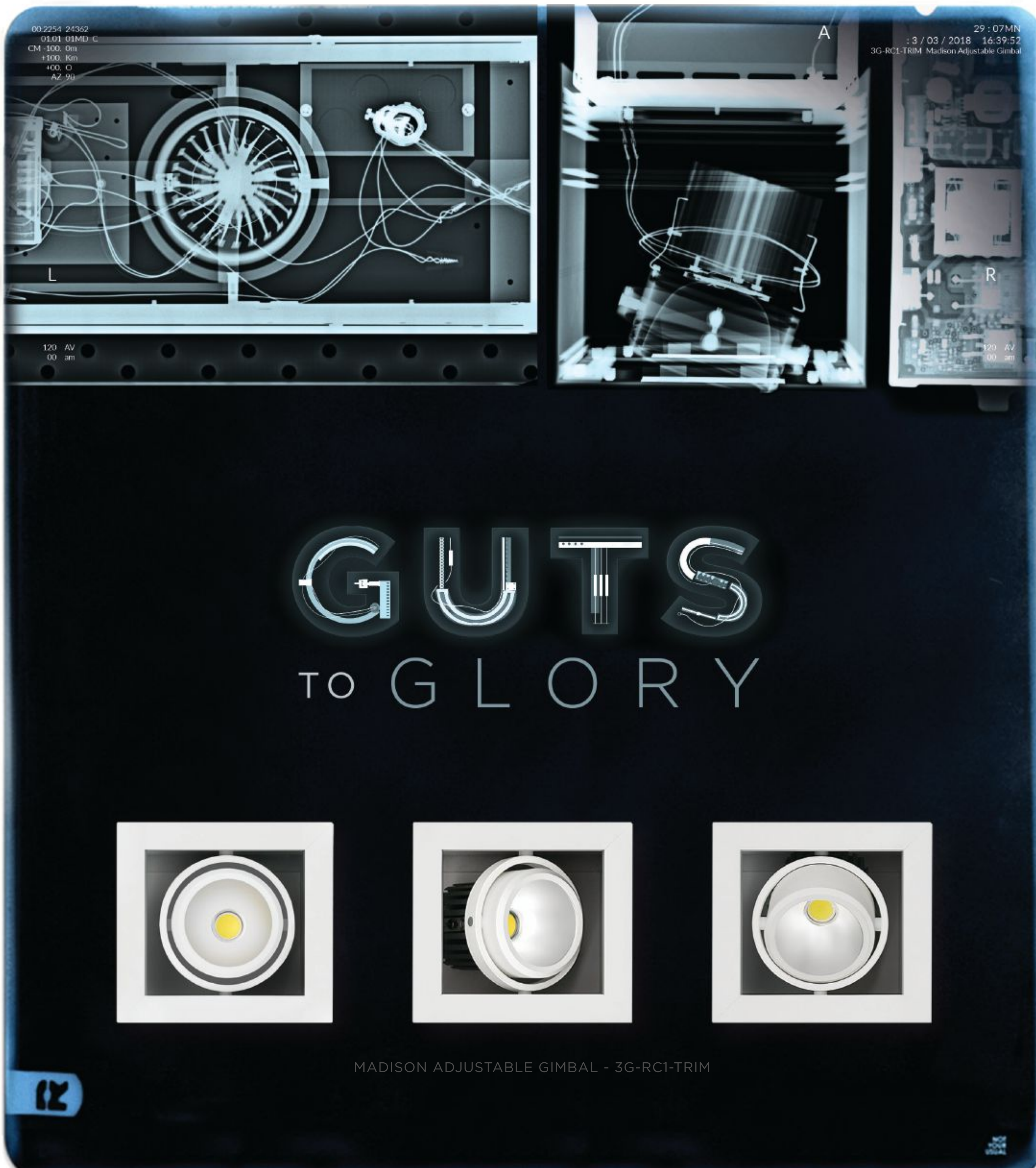
Technical Glass Products (TGP), a division of Allegion, is the recognized leader in the fire-rated glass and framing field, offering the FireLite® family of ceramic glazing, Pilkington Pyrostop® transparent wall panels, and Fireframes® fire-rated framing. The company provides AIA-registered continuing education, project consultation, product specifications, CAD drawings, BIM models and rapid-response quoting.



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Advocacy at All Levels

There are no passive advocates.

Nathaniel Hudson, AIA, is a native Nevadan whose career spans teaching, art, and architecture. He currently works to provide dignified affordable housing in Reno and hopes to take advantage of the unique landscape of northern Nevada to develop region-specific architecture. Hudson is also expanding the architect's role in local government and state legislative agendas while leading emerging professionals in fundraising efforts for ArchiPAC and advocating for the National Design Services Act.

As told to Kathleen M. O'Donnell.

Architects bring unique values and skills to society, so I don't view advocacy as something purely political. I've worked to address issues relevant to architects, designers, and artists at various levels of government, but also within my communities directly.

One of the beauties of living in a smaller U.S. city is that people remember you; a handshake really does mean something. Those of us that are passionate about something are afforded many opportunities. As a member of AIA Northern Nevada, I helped to establish their first Advocacy Committee, and our first big task is working in Reno to establish an architectural review committee within the local city government. It will be a legitimate governmental body that impacts the architectural possibilities in this community. I've also assisted the cities of Reno and Sparks with rezoning and master plan development, and I believe it's a substantial honor to have architects participating in that work.

At the state level, AIA Nevada is adamant about using opportunities to meet with legislators on Capitol Hill about our issues. We have a good track record of success when it comes to introducing white papers and bills to our representatives, some of whom have sponsored legislation we recommended. That's a powerful thing, and I get a lot of charge from seeing a manifestation or result of those acts.

On the national scale, I recognize and deeply value the mission of ArchiPAC. The PAC is a very important component to our overall legislative capacity as an organization. You can have a bunch of legislative items—and governmental advocacy committees can set priorities and targets—but if you don't have a PAC, you can't really get into the conversation. I intend to spread this message to future AIA leaders, who can build on our momentum and continue breaking ground in architectural advocacy.

You can't be a passive advocate, and I believe that contributing to the community that my family calls home is my guiding principle. If I'm not an active member in society and in life, then I don't feel as though I'm doing what I need to be. AIA

AIANow

Saarinen Soars Again

Written by Kim O'Connell
Art Direction by Jelena Schulz

Eero Saarinen, born seven years before Finland declared its independence from Russia, brought the ethos of his home country with him when his family emigrated to the United States in 1923. He went on to study art and architecture in Paris and at Yale, and eventually became a world-famous modernist architect. Today one of Saarinen's masterpieces—the long-vacant TWA Flight Center at the John F. Kennedy International Airport in New York—is being meticulously restored and expanded to become the new TWA Hotel. Designed to capture the romance and glamour of the Jet Age, the hotel will open sometime next year. Richard Southwick, FAIA, director of historic preservation at Beyer Blinder Belle, the restoration architects for the project, shares some details about the project and how it celebrates Saarinen's midcentury modern vision.

TWA Hotel

ARCHITECTS
Beyer Blinder Belle | Lubrano Ciavarra Architects

ASSOCIATE DESIGNERS
INC Architecture & Design | Stonehill Taylor

OWNER
MCR Development

LOCATION
Queens, N.Y.

Flight Center: The adaptive reuse of the iconic Flight Center will build on Beyer Blinder Belle's previous work there, which involved the stabilization of the original structure and removal of additions that detracted from the building's historic 1962 appearance. Now the design team is replacing the nearly 500 panes of custom-sized glass that make up the building exterior as well as restoring historically significant interiors. These include the two "tubes" that connect the building to the boarding areas.

Lounge Areas: Four terminal lounge areas are being returned to their former midcentury modern glory, as is the hotel lobby. The design team ordered some 10 million penny tiles, a distinctive aspect of Saarinen's interior, and are restoring the cherry-red upholstery and carpeting, as well as adding other period furnishings (including pieces designed by Charles and Ray Eames). Also being restored are the Solari-designed split-flap boards that once listed departures and arrivals: They can now be customized with messages for hotel guests via an app.

ILLUSTRATION: LAUREN NASSEF

TWA History: The design team relied heavily on the Saarinen archives at Yale University, which are made up of more than 750 boxes of drawings, notes, and even sample boards. Saarinen and TWA—their stories forever intertwined—will also be the focus of a Jet Age museum in the facility that will interpret the airport's history and legacy. "People have donated all sorts of artifacts," Southwick says. "We are trying to be as accurate as we can, and have a lot of fun with the new work, too."

Hotel Buildings: Two new six-story hotel buildings will flank and provide a backdrop to the historic Flight Center, adding 505 rooms as well as an observation deck and rooftop infinity pool, conference center, and other gathering places. The hotel curtainwall is triple-glazed and consists of seven layers of glass for high energy efficiency and insulation against jet noise, says Southwick. An off-grid cogeneration plant that will produce all the power for the complex. The project is targeting LEED Gold designation.

Lockheed Constellation: The restoration and placement of a vintage Lockheed Constellation aircraft—once a workhorse of the TWA fleet—has a lot of architects and aviation buffs buzzing. Located between the two historic tubes, inside the plane you will find a cocktail bar and restaurant. TWA had begun phasing-out the Constellation, which had given the company an advantage over is rival PanAm for a decade, by the time Saarinen's Flight Center opened for business. Like Saarinen's building, however, the plan remains an icon.

AIAFeature

Preserve or Raze?

Preservation experts in three cities explain how and why a building is deemed worthy of protection.

By Steve Cimino

PHOTOGRAPHY: TOM BONNER

This loft project in Los Angeles' Little Tokyo neighborhood, designed by M2A Architects, turned a 1930s elevator manufacturing facility into 161 units of rental housing.

Should we preserve it, or should we knock it down? Over the last 50 years, this has become a real question in towns and cities across the country. As urban areas continue to grow, and as local leaders increasingly embrace the historic buildings that communities were built around, it often falls to design boards or commissions—and the architects who populate them—to decide what stays and what goes.

Los Angeles boasts one of the country's first preservation committees; the city passed the Cultural Heritage Ordinance in 1962, which led to today's Cultural Heritage Commission. It is currently made up of five commissioners, four with ties to architecture: two architects, the president of an architectural firm, and an architectural historian. Their job is to review buildings based on a specific set of questions: Does it stand out architecturally? Was the architect or designer a master in his or her field? Was the property ever associated with anyone historic? And, finally, does it represent a broader social history?

If one or more of the above returns a "yes," answer, the building is likely to be declared a monument and preserved accordingly. But even a negative response doesn't mean the building is tapped for destruction.

"We don't decide if something gets demolished or not," says Gail Kennard, commission member and president of Kennard Design Group. "We accept applications from property owners and other interested individuals and groups, and then we deal with the merits of the building. Even if we deny a request for designation, that doesn't mean we think it should be torn down."

Being declared a monument means your building is deemed relevant to LA's history and social fabric. But it also gives the commission partial oversight of the property to ensure no "character-defining features" are modified by overeager owners. And there are consequences for unapproved actions, even if your building itself isn't declared a monument.

"If you own in what we call a 'historic preservation overlay zone,' and the property is considered a contributor to the zone, if you alter your house in any significant way or demolish it," Kennard says, "you could face severe repercussions." Those include a "scorched earth punishment" wherein owners who are investigated and deemed negligent or detrimental to a protected building are barred from any transactions related to their property for five years.

Of course, not every preservation decision is a matter for the local government. Barry Milofsky, a commission member and founding partner of M2A Architects, has worked in preservation for decades. He recalls one instance where design-centric recommendations couldn't convince the owners to save the backdrop for one of our country's most shocking moments.

"We were hired to explore reuse options versus demolition options for the Ambassador Hotel," he says, "and we informed the clients that it could indeed be preserved." The commission provided options for the owners, including adapting it into a high school or market-rate workforce housing, all while preserving Robert F. Kennedy's assassination site and other rooms with deep ties to Hollywood history. The owners passed.

"It's their building," he says. "If the community steps up and exerts power or pressure, it can make a difference. But it begs the question: Is it the job of the owners to pursue their specific needs, or do they have a larger responsibility to society in general?"

The Queen City

Burlington, Vt., adopted regulations to protect historic buildings in 1973. Its leaders have a keen awareness that, as a New England city organized in 1785, they are stewards of many significant structures that define the country's past.

"Historic architecture makes us who we are as a community," says David White, the city's director of planning and zoning, "and that's not just Burlington." This sentiment is shared by many residents, though some vocalize frustrations that anything notable has also been deemed irremovable. But White reinforces that this isn't the case: "While it is not our preference to tear buildings down, we do recognize that sometimes that is the

AIAFeature
CONTINUED

M2A Architects received two preservation awards for restoring and adapting this one-story residence designed by modernist architect Rafael Soriano.

PHOTOGRAPHY: M2A MILOFSKY AND MICHALI ARCHITECTS

appropriate choice, and we want there to be clarity around the process."

As with many burgeoning cities and towns, Burlington is dealing with issues of housing affordability and availability. When it becomes a direct one-to-one comparison—such as preserving a historic structure versus building additional housing units—White notes that the members of the city's Design Advisory Board have to ask themselves a series of important questions.

"There are subjective questions like, 'Does the existing building have true historic value?'" he says. "But beyond that, 'Is the building structurally sound?' 'Can it be moved to another site?' 'What is the cost of tearing it down or remediating the site?' And, at the end of the day, 'Will whatever replaces this building compensate the community in some capacity?' And 'Will it serve a higher and better use?'"

"If the community steps up and exerts power or pressure, it can make a difference. But it begs the question: Is it the job of the owners to pursue their specific needs, or do they have a larger responsibility to society in general?" —Barry Milofsky

History's Real Value

In Charlottesville, Va., another city with a rich history, what to raze and what to preserve is frequently discussed as well. Mary Joy Scala, who served as the city's preservation and design planner for 14 years, has seen architects recommend protecting buildings for a bevy of reasons. "Older buildings were built to last a lifetime, not 20 years," she says, "and anyone interested in sustainable design knows that it is often better to reuse in some capacity than to discard it all in a landfill." She references a neighborhood called Vinegar Hill that was destroyed in the early 1960s, noting that "people are still, rightly, talking about that. They're asking, 'Why did that neighborhood that belonged to us get torn down?'"

It's not as if the city wants to forgo modernity entirely. In fact, Scala notes that Charlottesville encourages modern design for its new buildings. "Some localities do want their new buildings to look like the old buildings," she says, "but when you mix, you get a much more complex and intriguing built environment—especially when the new ones draw on certain specific features of the old."

Scala admits that the city is uniquely positioned to value preservation. Tourism is not only one of Virginia's major economic drivers, but also one of the Charlottesville region's major drivers—with historic buildings like Monticello comprising several of the biggest draws, as well as having the University of Virginia School of Architecture (and its highly respected historic preservation program) within city limits. It all adds up to a higher overall level of awareness among locals (and visitors) alike.

That said, she also recognizes that architects shouldn't take this level of appreciation for granted. "It is so important to consider public education and outreach," she says, "so the people living in and around these buildings understand why preservation matters. You can't do that through regulation alone. If your fellow citizens can grasp the design thinking and the architectural reasons that fuel your recommendations, they'll be that much more cooperative."

Milofsky echoes that sentiment. Long interested in preservation professionally, he made that interest well-known and took on volunteer opportunities whenever they arose.

"It's the same way you get clients," he says. "You don't sit in your office and wait for someone to ring your doorbell. You have to be active in what matters to you." AIA

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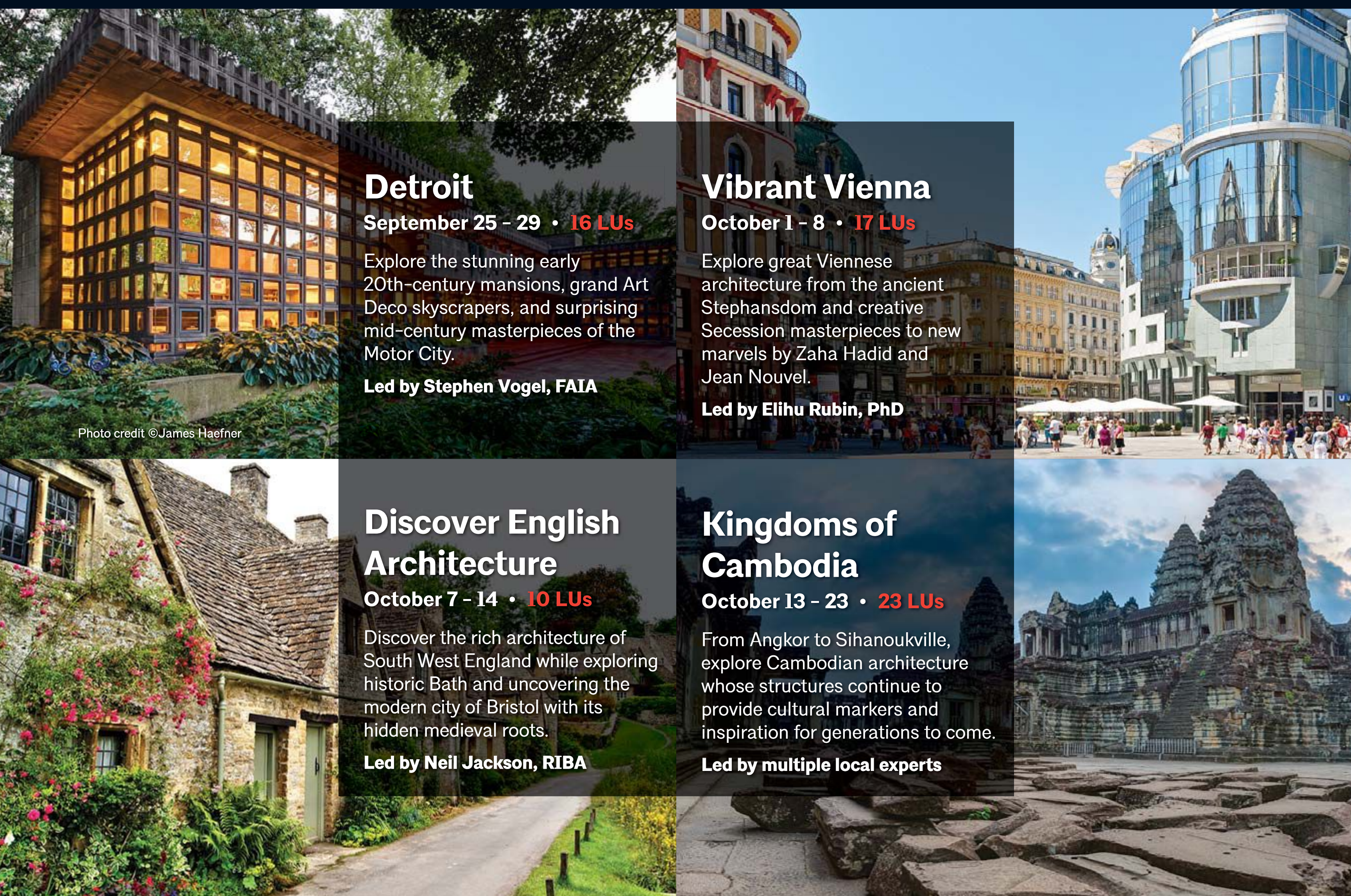

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Improve Your Firm, Hire for Culture Fit

Prioritizing culture fit over technological savvy in the hiring process can yield surprising results.

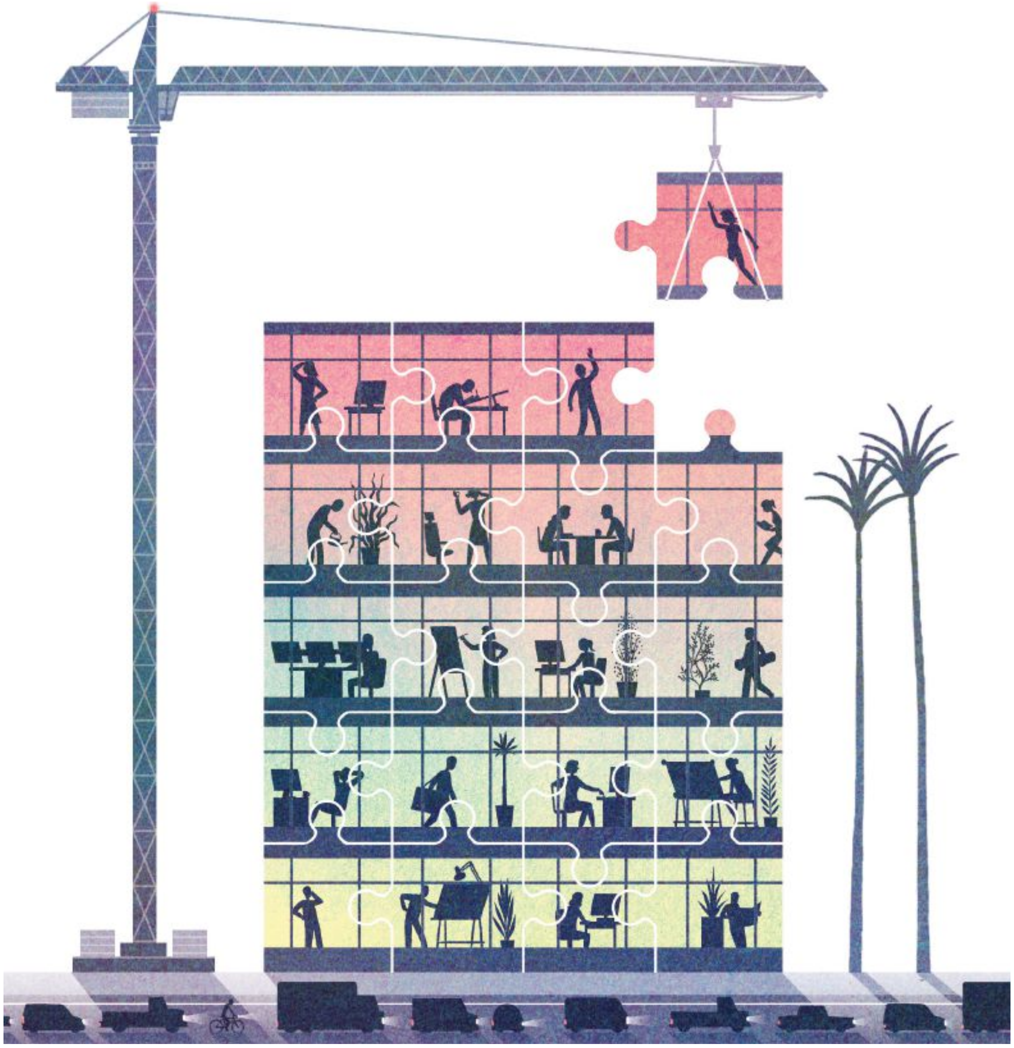

ILLUSTRATION: MICHAEL KIRKHAM

What should architecture firms prioritize when scouting for new hires? For Dattner Architects, a New York–based firm focusing on civic architecture, pinpointing their ideal characteristics in a job candidate was a matter of finding the answer to one specific question: What, exactly, anchors an architect to their practice?

In thinking about recruiting candidates to Dattner—and, more specifically, ones just starting their careers—human resources director Mary Beth Lardaro singles out the sense of purpose that also played a major role in her decision to join the firm.

"Recent graduates are looking for meaning in their work, they're looking for a sense of connection, they're looking for a belief that they're doing something for the greater good," she says. Tectonic shifts around work-life balance and office culture in the last decade, as well as shifting ideas about compensation and advancement in the workforce, are molding firms' thinking as they staff up for the future—and strategize around not only how they're going to find candidates that are good fits both in terms of technical skills and firm culture, but also how they're going to retain them.

"It's something that we get asked in every interview: What's your firm culture?" says Seth Anderson, AIA, a principal at Ascent Architecture and Interiors in Bend, Ore. According to the Society for Human Resource Management, the result of turnover due to poor culture fit can cost an organization 50 to 60 percent of an employee's annual salary. Giving candidates a satisfactory answer to the culture question can be the key to finding the best fits for a given firm—and keeping them.

What Skills to Prioritize?

Several of the firm owners and principals interviewed for this story said that, when it came to hiring mid-career professionals (as opposed to recent graduates), it was becoming increasingly difficult to find qualified candidates with experience. "Our strategy has been to hire and train ourselves," Anderson says. "That's not always easy, both in terms of the training period—the time it takes to get people qualified—but also just because we are in need of some of those more experienced individuals, and they're harder to find."

David Cheney, AIA, a principal at Washington, D.C.–based architecture firm CORE Architecture + Design, has a similar perspective. "I think what we're finding right now, particularly in the last six months, is that it's becoming increasingly competitive to find good talent," he says. "Everyone's hiring, making the pressure even greater. And so to do that we're trying to find people … who can anticipate our clients' needs the best. We don't know what those are until it happens, so the more flexible [candidates] are with the way they work, the better."

While technical skills and strong portfolios are always going to be necessary, Anderson and Cheney both emphasize the importance of adaptability over an abundance of experience with, say, one specific type of software.

"We're not really limiting ourselves to certain people who only have certain skill sets," Cheney says. Strong basic skills, however—like knowing how to draw by hand—will always be important.

"We still want to see a lot of sketching and artistry. People who have the strongest overall portfolio have a strong drawing component as well," he says.

Simon Goodhead, an Atlanta-based principal consultant with the Coxe Group, a Seattle-based company that works nationally with architecture and design firms around issues of leadership and management, says that he has observed firms placing more of a priority on "non-technical skills"—that is, communication, business development, and leadership. They understand that they're going to be able to train more technical skills based on the firm's needs. Similarly, Lardaro says that Dattner is always on the hunt for team members who will both produce compelling designs and effectively communicate with the client about them.

Both Cheney and Goodhead emphasize that new hires—not just Millennials, but also mid-career professionals—are coming in with increased expectations about learning opportunities and career advancement.

"There are people coming in with the expectation of being able to progress quickly," Goodhead says. "We've seen that the firms that have been particularly successful are looking more at the competency of individuals, and allowing advancement based on that

AIAPractice

CONTINUED

competency, and aligning it with the overall strategic goals of the firm."

CORE has also made an effort to give its staff more outlets for skill-building and networking.

"[Newer hires] have had opportunities to join more professional organizations, meet more people, take on more responsibilities a little bit quicker," Cheney says.

One of the specific ways that Dattner is seeking to contribute to public discourse is through design and ideas competitions, such as New York Governor Andrew Cuomo's design competition to overhaul LaGuardia Airport. They're interested in hiring designers who will be able to successfully navigate these types of challenges, but Lardaro admits that it can be hard to suss out those qualities in the recruiting process.

"That's really something that we're looking for: designers who are thinking big in terms of what the workplace will be like in 20 or 50 years but are also able to focus on the micro-level of 'What does that mean for each of our projects—whether a building, master plan, interior fit-out, etc.—even down to the details?'" Lardaro says. "Hiring people who can design at a variety of scales is really important to us"

Looking to the Long Term

How are these individual considerations going to be beneficial to the future of the firms in which they're implemented? With a workforce that has stronger communication, collaboration, and decision-making capabilities, the hope is that even though firms may experience increased internal complexity in the next 20 to 50 years—around technology, around expertise, and around specialized skill sets—a team that knows how to collaborate effectively will be able to overcome any obstacles, despite potential deficits in individual areas.

"With that collaboration, there's a greater need for hiring for fit—those being values, compatibility, culture, and collaboration ability—and how to connect across different skill levels and experience," Goodhead says.

All forward-thinking firms are going to be investing in new technology, but experience in those areas can be learned on the job. Fit and a willingness to share ideas, many seem to think, is the more innate and intangible X-factor.

"You can train people into a role," Goodhead says. "You can't train them how to fit in with a group of people." AIA

— Katherine Flynn

AIAPerspective

PHOTOGRAPHY: GABRIELA MARKS

Carbon or Architecture?

History records the evolution of architecture over thousands of years. As architects, we appreciate that this evolution represents a great deal more than stylistic change. It illustrates evolving expectations and demands. In 1871, the need for fire-safe buildings rose from the ashes of the Great Chicago Fire. In 1906, from the rubble of San Francisco came understanding that earthquake risk is a design imperative. But today's emerging design imperative, zero net carbon design and construction, will not be revealed in a single catastrophic event that forces society and our profession to acknowledge it.

What does carbon have to do with architecture? Why should eliminating the release of greenhouse gases guide every architect's design decisions? Can architects make a difference? Answers to these questions define the evolution of architecture in the 21st century.

Transition to the "carbon economy" is proceeding at the global scale, and quickly. It represents the most profound economic realignment since the dawning of the industrial revolution. These days, we hear a lot about the bubbles people live in. Today, one that defines our nation is the climate-change-denial bubble, and because of it, America is being left on the sidelines of the carbon economy. Thankfully, California is taking the lead by developing its carbon economy, and hundreds of cities are finding ways around federal inaction.

The architectural profession, the construction industry, and the building sector are woven inextricably into the fabric of climate change response. The building sector releases far more greenhouse gases than either the transportation or industrial sectors. There is no climate change solution without our profession, our industry, and our economic sector.

There is pressing urgency to this work. Once released, greenhouse gases such as carbon dioxide remain in the atmosphere and oceans for generations. Reducing carbon now matters most. Buildings release carbon throughout every stage of their life cycle. The decisions architects make affect every stage.

At the Paris summit on climate change, the achievement of America's architects was the most hopeful story. In the decade leading up to Paris, the U.S. building sector grew by 20 billion square feet, yet overall energy consumption remained flat. This seemingly impossible feat was accomplished by making energy a design imperative, by retrofitting existing buildings, and by designing new high-performance buildings. By achieving Paris Agreement goals, architects have the opportunity to usher in a generation of prosperity. Architects must seize opportunities to help our clients and communities realize climate solutions. A zero net carbon building sector is the architectural design imperative of our time. AIA

—Carl Elefante, FAIA, 2018 AIA President

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How We Got to Now

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“She has produced a thorough accounting of this period, not as some overstuffed scholarly survey of built work, but rather through the lens of that now-ubiquitous medium, the architectural exhibition.”

Exhibitions that Transformed Architecture by Eric Wills

Writing a definitive history of architecture in the second half of the 20th century is no trivial undertaking, but Eeva-Liisa Pelkonen, an associate professor at the Yale School of Architecture, has found a rather nifty shortcut. She has produced a thorough accounting of this period, not as some overstuffed scholarly survey of built work, but rather through the lens of that now-ubiquitous medium, the architectural exhibition. *Exhibit A: Exhibitions That Transformed Architecture 1948–2000* (Phaidon, 2018), reviews the most influential shows of the postwar era. Unlike their landmark prewar counterparts, which Pelkonen argues focused more on completed work, postwar exhibitions increasingly challenged the established orthodoxy and heralded new frontiers and avenues of research. Here we spotlight some of the most provocative installations that Pelkonen features, which together reflect the rise and fall of the movements and ideas that defined architecture's postwar period.

1948: Case Study House Program

As the need for middle-class housing surged during the postwar boom in California, the Case Study House program offered a sleek and inviting solution. Sponsored by *Arts & Architecture* magazine and launched in 1945, the program in its initial three years had attracted more than 350,000 visitors to the first six model houses that had been constructed in Los Angeles. Julius Shulman's photograph of Pierre Koenig's Case Study House #22, the living room appearing to levitate over the nighttime megalopolis below, would prove to be the program's most indelible image. But this was not some traditional gallery exhibition, largely captured in two dimensions. Visitors could step inside the actual structures, in their actual locations, and see for themselves how these surprisingly affordable designs heralded a new age of modern living.

1959: American National Exhibition

In the midst of the Cold War, in the heart of Moscow's Sokolniki Park, George Nelson curated this exhibition as an unabashed act of political propaganda. Funded by the U.S. State Department, and managed by the Cold War–era U.S. Information Agency, the show (intended to inspire cultural exchange between the two countries, with the Soviets hosting a sister exhibition in New York earlier the same year) featured displays of automobiles, consumer goods, farm equipment, and science experiments. Charles and Ray Eames' film *Glimpses of the U.S.A.* played under a gold-anodized aluminum dome designed by Buckminster Fuller. Most famously, the exhibition featured a full-scale model of a typical American suburban kitchen—the site of Richard Nixon and Nikita Khrushchev's celebrated kitchen debate.

MIDDLE: ARCAID IMAGES; BOTTOM: EAMES OFFICE

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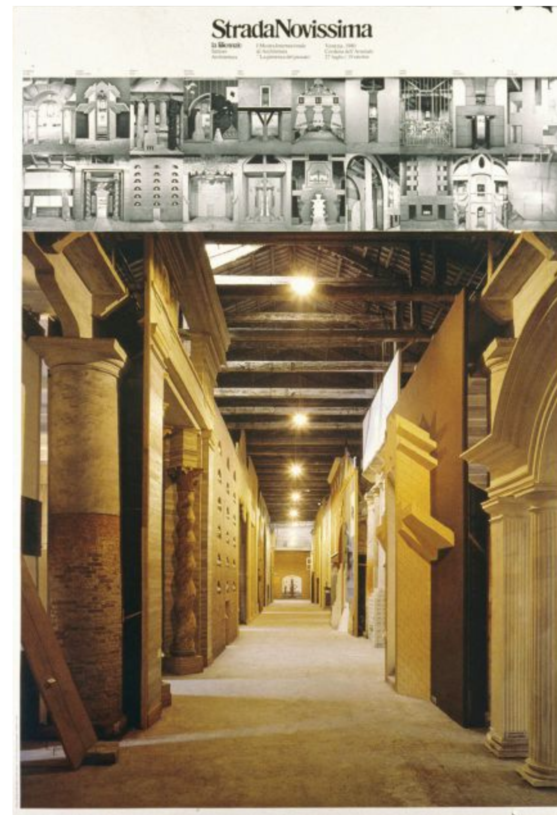
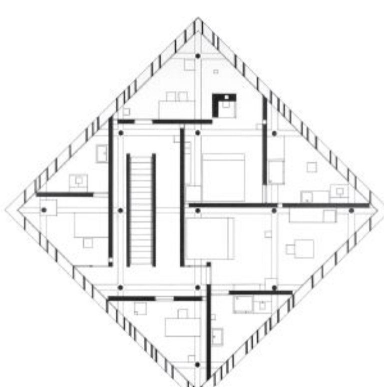
1964: Architecture Without Architects

For his doctoral thesis, Bernard Rudofsky analyzed examples of prehistoric concrete vaulting on the Greek Cyclades Islands, and then expanded his research by touring through the Mediterranean to chronicle other examples of vernacular architecture. From his peripatetic studies came this charged and revolutionary exhibition, staged at the Museum of Modern Art in New York. As Rudofsky argued, the profession had completely ignored the rich history of vernacular building, which responded deftly to its local climate and culture, because it lacked official sanction—the signature of a trained modernist architect. As Ada Louise Huxtable wrote in her review in *The New York Times*: "More than an exhibition, then, this is a protest—a pointed, bitter, desperate broadside from a cultivated, rebellious heart and mind against the sacrifice of the well-built landscape to the urgencies of the industrial, nuclear age."



1980: Venice Architecture Biennale

The first independent gathering of architects at the Biennale, the 1980 installment was "a return of the architecture to the womb of history," as the show's curator, Paolo Portoghesi, HON. FAIA, put it. An unabashed paean to Postmodernism, "La Presenza del Passato" (The Presence of the Past) featured the Strada Novissima, which looked like some sort of surreal stage set. It was composed of a series of 20 façades or storefronts, each designed by a Biennale participant (including Frank Gehry, FAIA, Stanley Tigerman, FAIA, and Robert Venturi, FAIA, and Denise Scott Brown, HON. FAIA), and each opening into a small exhibition space where participants showcased their work.



1969: The New York Five

If Rudofsky's exhibition was a broadside against an elitist profession, MoMA's decision to host the Conference of Architects for the Study of the Environment—or CASE—marked a return to the establishmentarian status quo. Organized by Arthur Drexler, the conference celebrated the work of a group of architects who favored the formal rather than the social dimensions of Modernism, and who would become known as the New York Five: Peter Eisenman, FAIA, Michael Graves, Charles Gwathmey, John Hejduk, and Richard Meier, FAIA. The event inspired a book and then an exhibition, which was first mounted at the architecture school at Princeton University in 1974; then in the Castel Nuovo in Naples, Italy; and later at Peter Cook's ArtNet gallery in London.

TOP: THE MUSEUM OF MODERN ART, NEW YORK; MIDDLE: THE VENICE BIENNALE; BOTTOM: JOHN HEJDUK

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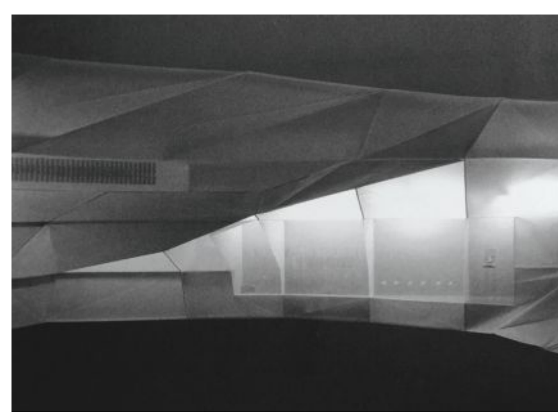
1988: Deconstructivist Architecture

Not long removed from stamping the Postmodern movement with his official imprimatur, Philip Johnson helped identify the next new thing with this exhibition, staged at MoMA. Along with co-curator Mark Wigley, AIA, and inspired by Jacques Derrida and Russian Constructivism, Johnson grouped the work of Zaha Hadid, Rem Koolhaas, HON. FAIA, Coop Himmelb(l)au, and others under a single umbrella—Deconstructivism—signaling the rise of this post-Postmodernist era in architecture.



1995: Animate Form

If Deconstructivism gave wider play to the destabilizing geometries of Zaha Hadid and her fellow compatriots, "Animate Form," an exhibition mounted by Greg Lynn at Artists Space in New York, took another metaphorical sledgehammer to the established constraints on architectural form. Using computer animation software, Lynn designed faceted and Mylar-covered panels made of vinyl and plastic that evoked continuous movement. His goal: to inspire architects to banish their preconceived limits with the aid of the computer.

TOP: THE MUSEUM OF MODERN ART, NEW YORK; BOTTOM: GREG LYNN FORM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1999: Metacity/Datatown

The MVRDV-designed Metacity/Datatown, mounted at the Stroom Den Haag, helped usher in the age of big data in architecture. The exhibit featured an imaginary city—400 kilometers by 400 kilometers (the distance a bullet train could travel in one hour) with a population of 241 million—that had no established geography or context and that was defined only by the flow of information it generated. MVRDV described the show as "an attempt to understand the contemporary city at a moment when globalization has exploded its scale beyond our grasp."

2000: PS1 Young Architects Program

MoMA's Young Architects Program, officially launched at the turn of the millennium, heralded the rise of New York–based SHoP Architects. The firm's installation in the PS1 courtyard, Dunescape, functioned as an urban beach, an alluring and shaded hangout spot that was constructed on the cheap. "SHoP's main interest was translating the digital into the actual," recalls Gregg Pasquarelli, AIA. "How could an architect extract what was so provocative on the screen and retain this once it's built? How do you do that on a limited budget without making it look like a school project?" Dunescape reaffirmed the notion of architecture as spectacle: bright, shiny, and sponsorable.

TOP: COURTESY MVDVR; BOTTOM: COURTESY SHOP ARCHITECTS

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“He realized that some part of the current shortage of affordable housing has to do with the fact that home building is a ‘completely opaque process.’”

Blokable’s Quest to Disrupt Prefab by Karrie Jacobs

The signs have been clear for some time now: Elon Musk is planning to dig tunnels under cities for his Hyperloop transportation projects and newly announced "car skates" that will, someday, perhaps, zip vehicles from downtown Chicago to O'Hare Airport. Google is building a dense mixed-use development for its workers in Sunnyvale, Calif., and a highly optimized, sensor-filled, data-driven neighborhood in Toronto. Tech hothouses like Y Combinator have periodically announced plans to build entire cities from scratch. Clearly, the tech industry has grown bored with the virtual world and now has designs on reshaping our actual urban reality. This is happening even in the torpid backwater that is the residential construction industry.

Consider Factory OS in Vallejo, Calif., which is manufacturing housing modules designed to be stacked into four- and five-story apartment buildings. The company delivers units "tech ready" and fabricates them with "cutting-edge software." It's launching an Innovation Lab at the factory in partnership with UC Berkeley. Meanwhile, Menlo Park, Calif.–based Katerra, with over a billion dollars in venture capital, is applying its technological know-how to the manufacture of engineered timber building components for use in multifamily residential and mixed-use projects.

"They Are Going to Change the Paradigm"

This comingling of tech and home building practices, driven by an urgent need to build more quickly and inexpensively, is what brought me in early April to a beige industrial park near the port of Vancouver, Wash., just across the Columbia River from Portland, Ore. I was visiting the manufacturing site for a company called Blokable—a 50,000-square-foot warehouse that the firm regards as its "prototype small factory." The company, according to founder and co-CEO Aaron Holm, is in the business of "delivering housing development as a service."

I first heard about Blokable from an old friend who lives in Portland and sent me a message via Twitter: "They are going to change the paradigm." I was immediately skeptical. I visited the firm's website and found a rendering showing a 328-square-foot unit of hyper-optimized living space, standing alone against what looks like a sky at twilight, with trees and water in the background. It could be Thoreau's Blok. Nothing distinguished it from the legions of precious mini-houses that have proliferated online in recent years, most of them more cute than revolutionary. What really got my attention, though, what made me think my friend's claim was not just hype, was the story Holm told about his compulsion to build housing for more people, both cheaper and faster.

Prior to founding Blokable in 2016, Holm worked in project management at Amazon, handling the rollout of two of its brick-and-mortar outposts, Amazon Go and Amazon Books. That's when he became infatuated with boxes—shipping containers, to be precise. He noticed that even though they're made of "terrible building materials," designers have been compelled to transform them into housing. He also noticed, as he got Amazon's storefronts up and running, that the construction industry can be frustratingly inefficient. He realized that some part of the current shortage of affordable housing has to do with the fact that home building is a "completely opaque process."

Blokable could be just another company hawking diminutive but swank homes to post-Millennials. But Holm has no interest in supplying the high-end market with prefab status symbols. Instead, he's taking on our current housing crisis. According to a 2017 study by the National Low Income Housing Coalition, on average there are just 35 affordable and available rental homes for every 100 extremely low-income families. The tech industry itself is partly to blame for rising real estate, with tech-rich cities like Seattle experiencing skyrocketing rates of homelessness. In a January op-ed for a Vancouver-area newspaper, *The Columbian*, Holm wrote: "We must shift the focus from a construction challenge to a manufacturing challenge and drive time, complexity, and cost out of the process to bring housing supply to the market where it's most needed."

Holm founded Blokable to manufacture an object that had the formal simplicity of a shipping container but that was properly outfitted as a house, and that would more or less materialize on its foundation with

Blokable's Blok S unit

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the myriad layers of permits and approvals signed and sealed. Holm imagined that he could "create a product that could be purchased and delivered like a car."

Holm is, of course, not alone in his dream of the assembly-line house. The concept stands at the core of decades and decades of prefab fantasies. (See Buckminster Fuller.) Everyone thinks they can be the next Henry Ford. But houses, unlike cars, have an additional layer of regulatory challenges. Building codes and zoning can differ from town to town or block to block. It takes a lot of disrupting to upend that reality.

For instance, consider Kasita, an Austin, Texas–based company selling a sleek 374-square-foot unit that, like Blokable's, can be freestanding or stacked. Targeted to the individual home buyer, someone who might want an accessory dwelling unit (ADU) for the backyard or a dedicated Airbnb rental, the Kasita is available at three price points. The high end, $129,000, includes automatic blinds and a long list to Holm, from "investors who believe that the built environment is about to undergo a fundamental transformation driven by technology" and also those who see "housing as a platform to create opportunity." Although not impressive by the standards of the tech industry, the seed money has given the company an important luxury: the ability to spend the first years of its existence perfecting the box and the systems that support it.

Legos to Build With

During my visit in April, I spent the better part of an hour in a conference room with Nelson Del Rio, the company's co-CEO and one of its founders, and Timothy Miller, the vice president of design. Del Rio is a developer whose other company, Sonnenblick-Del Rio, specializes in upgrading the quality of public buildings by changing the financing model. He talks a great deal about "the dirt," as in: "I understand what it means to build on dirt. I know what dirt value is."

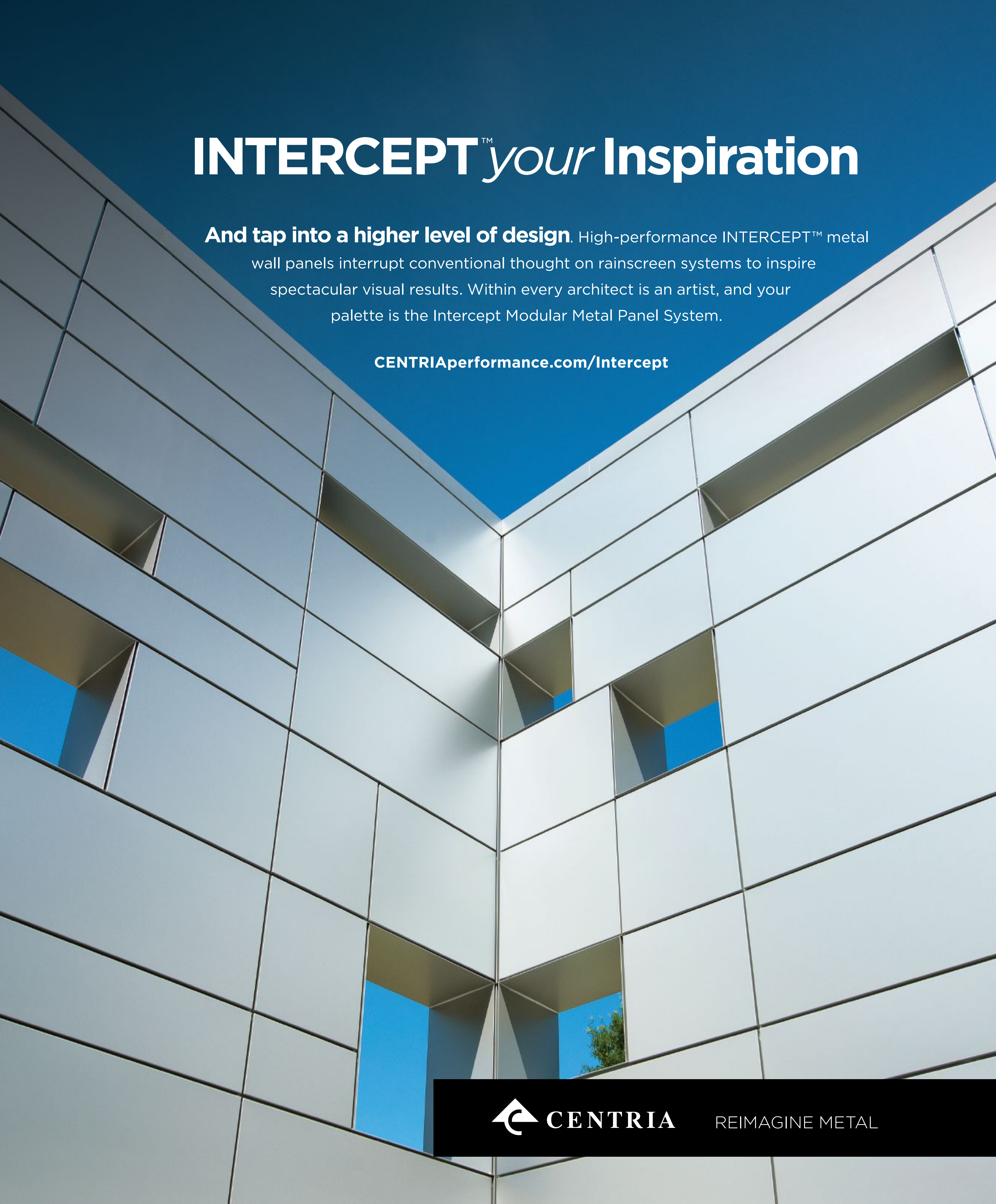
Prototypes on Blokable's factory floor

ANDREW POGUE

of brand name upgrades: Bosch appliances, a Casper mattress, a Sonos Connect streaming audio device. What's not included in this seamless lifestyle package: an estimated $24,000 in permitting, site preparation, utility hookups, foundation work, and shipping. If you've ever built a house, you know that that's an optimistic cost estimate, and the workload associated with these additional tasks can seem infinite.

Blokable, on the other hand, is unusually focused on these grittier pieces of the puzzle. The company has raised money from Paul Allen's Vulcan Capital ($4.8 million) and another $11 million, according

Miller, who got his architecture degree at Tulane University and went on to study design strategy and business, spent a few years at the Seattle office of Teague and, like Holm, is a veteran of the Amazon Go project. He thinks of what he's doing at Blokable as developing "architecture for manufacturing instead of architecture for construction." Miller doesn't regard himself as the designer of the final product, whether that's a cluster of single-family homes or multifamily developments constructed from stacks of Bloks. Rather, he sees himself as the creator of a tool kit that architects can use to design their own bespoke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projects. "It gives them the puzzle pieces," says Miller, "the Legos for them to build with."

Whether or not architects buy in, Blokable's vision is a radical departure from previous prefab projects, from Marmol Radziner's line of multimillion dollar units to Michelle Kaufmann's more attainable Glidehouse line. The first generation of 21st-century prefab designers were auteurs, intent on playing the conventional role of architect, always retaining creative control. Blokable professes to be in pursuit of something else entirely: the ideal version of the generic, replicable housing unit.

"If you look at the type of housing that we really need to build—middle-income, low-income, no-income housing—standardization is great," Holm argues. "The nonprofits we work with … they don't want to pick the toilet. They want a good product team to go in make those decisions and figure out how, by using standardization, we can drive the price down."

On the other hand, a more design-driven client might want to customize a standard module, in which case Del Rio believes the firm can accommodate those changes. "Without telling you how our buildings are put together, they're designed to be highly flexible on the standard production process. Let's say we had a west L.A. architect who said, 'I want a NanaWall across the whole side of the building.' We can handle that. If they want to put a giant window on one side and one on the end, we can handle that."

When I visited the factory floor, I saw a trio of rectilinear prototype units, each steel framed but with slightly different configurations and palettes of cladding materials, including a ceramic product, cement board, acrylic/resin panels, paper fiber composites, and Cor-Ten steel. The one that I actually stepped into is set up much like the mock-up I've seen on the website: It's an extremely modest arrangement featuring a living/sleeping room with kitchenette, a closet, and a bathroom. The entrance is on the side with a big window next to the door and a slight overhang above, suggesting the potential for a porch.

Each Blok is a puzzle—like a Rubik's Cube—of

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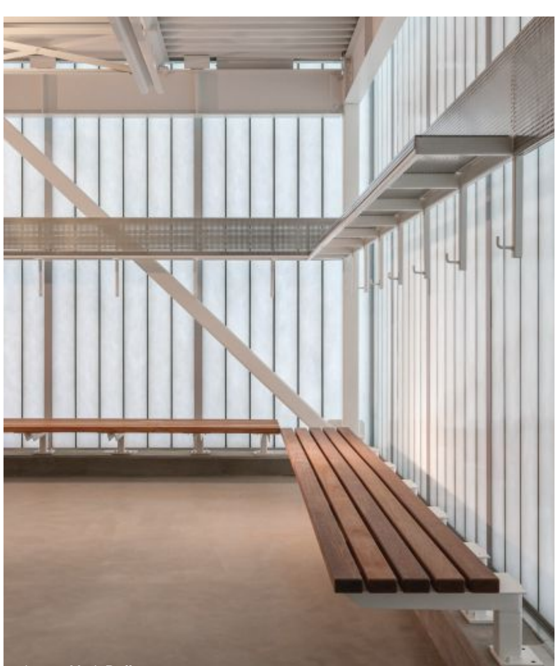

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Top: A worker on Blokable's factory floor
Above: Rendering of Seattle multifamily infill made from Bloks

TOP: ANDREW POGUE; BOTTOM: COURTESY BLOKABLE

functions that the design and construction teams are configuring and reconfiguring. Miller and Del Rio pointed out prosaic details like a floor drain that will help mitigate a shower or toilet backup. They told me the interiors will feature a type of bathroom wall paneling, Krion, that purifies the air and kills bacteria. While Blokable hasn't fully embraced the "smart house" concept, each unit is designed for net-zero-energy use and is, says Holm, "fully integrated and managed by a software platform. All of the customers have a dashboard where they can see in real time everything that's going on for power, water, humidity, air quality."

When I visited, the warehouse, apart from the model Bloks, was conspicuously empty. I was told that sometime in the near future it will support two production lines with 16 to 18 units in various stages of completion, including a village of 12 Bloks, seven one-bedrooms and five studios, destined for a site in Auburn, Wash. The client for that project is a mental health and substance abuse nonprofit called Valley

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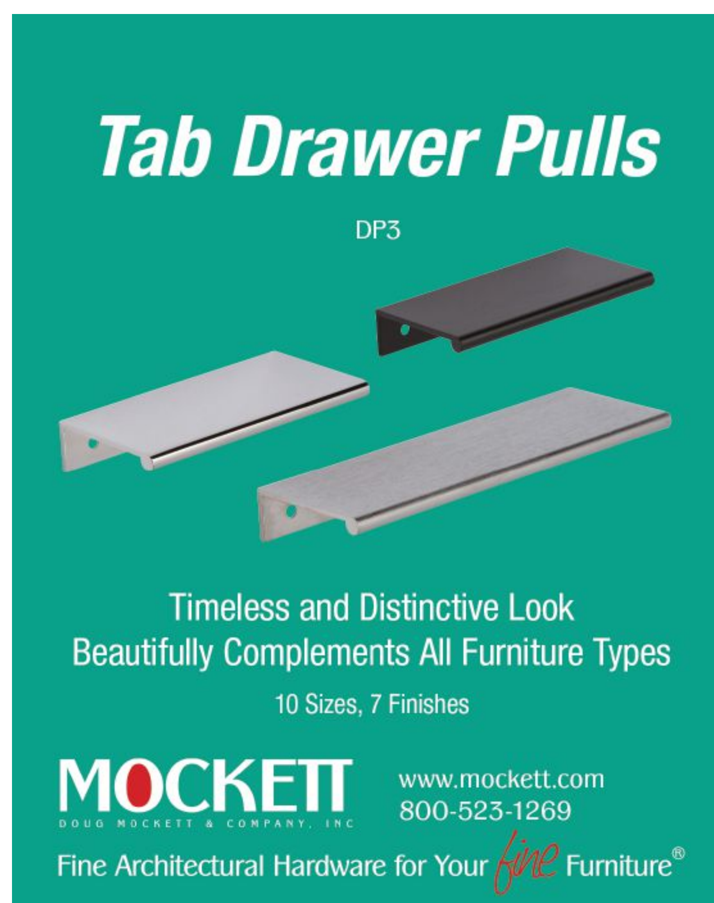

Cities, which is building the homes with backing from the state. "Now," says Holm, "we're switching gears from two-and-a-half years of engineering, regulatory approval, different systems innovations into starting to deliver and ramping up our production scale."

Workers are fabricating some components in-house—steel frames for example—using digitized equipment. They're still finalizing the ways the Bloks connect to the wider world: pipes stick out of the exteriors for plumbing connections and, inside, USB ports await digital ones. And they're especially focused on the joints, how one Blok meets another Blok. "So, when we look at the building," Del Rio told me, "we walk through every bolt and every joint and where water is placed, where electrical is placed, and ask, 'If and when it fails, how is it repaired?'"

I admit to being disappointed by the prosaic appearance of the Blok prototypes. But something Del Rio told me early in our conversation started to make sense: "It's not the box. It's the process." He was speaking in part about manufacturing the Blok: designing it so it can move smoothly down an assembly line. But he's also deeply concerned with that list of tasks that most modular home vendors treat as afterthoughts: how to get a given type of Blok inspected and signed off on by, say, the state of California, so that it's not subject to local building inspections and approvals, and how to eliminate the work of the army of subcontractors that might ordinarily be required to connect even the best-designed module to the local infrastructure.

A Return to Modernism's Social Mission

When we were just about done touring the production floor, and I thought my visit was coming to a close, Del Rio started talking equity. "If we can get dirt cheap enough," he told me, referring to land costs, "if we can develop houses in the most efficient way possible … " He speculated that one of these little houses could "amortize at $500 a month or $800 a month." (Consider that in Seattle, a one-bedroom apartment rents for about $2,000 a month.) "If we produce a home for $200 a square foot," Del Rio continued, "even in a crash, that's affordable." The most up-to-date Blok prototypes include a 300-square-foot studio and a 400-square-foot one bedroom—$60,000 and $80,000, respectively, according to Del Rio's aspirational math. (Holm puts the actual price at "$125,000 a door.")


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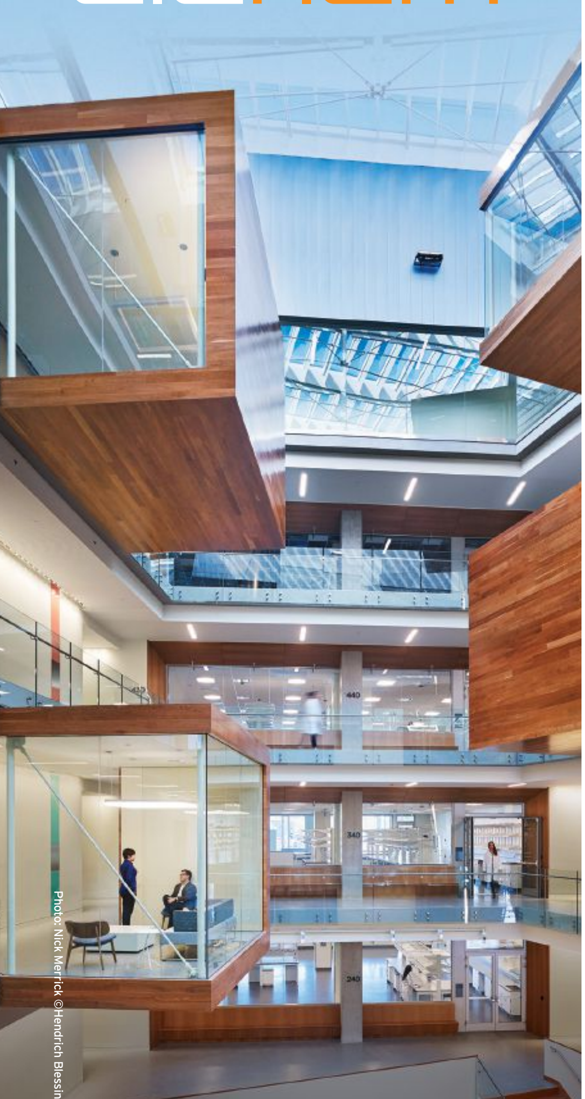
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"Until you solve the production problem you'll never solve the financing problem," Del Rio told me. I asked him to clarify: "So you're saying that if you can push building costs low enough in a systematic way, all the other societal problems and chronic inequities will fall by the wayside?"

"Not necessarily fall," Del Rio responded, "but if you look at the root of education and health, living environment is key. If I'm living in a trailer or a tent or just in a sleeping bag, I can't possibly be raising a family who's healthy and prosperous. It's just, there's no way. The reason I'm in this company is because if I can solve this piece of it … it's the linchpin."

Of course, there are a host of other problems to solve. How to you change zoning laws to allow more multi-unit housing? How do you get the federal government to directly subsidize housing that is permanently affordable? But to Del Rio, the answers

Blokable is returning to the moment when Gropius asked that simple yet vexing question: "How Do We Build Decent, Beautiful, and Inexpensive Housing?"

to those questions become much easier when housing costs less to produce. "How do we build working class neighborhoods? I think it's a chicken and egg thing. They can't make that policy until you can actually produce it cheaper."

Over the years, I've had any number of conversations about different approaches to prefabricated housing, and most of them wound up being about how to supply architectural style to people who couldn't otherwise afford it. But this is a different conversation. It's about the basic need for affordable shelter. It's about using architectural skills and technological chops to circle back to the original social mission of Modernism. What Blokable is doing is returning to that moment, circa 1926, when Walter Gropius asked that simple yet vexing question: "How Do We Build Decent, Beautiful, and Inexpensive Housing?"

Holm's response, when I suggested that he's living the Bauhaus dream, betrays a hint of tech sector smugness: "True, but we've taken it into the execution phase." I'm not convinced that Blokable intends to crack the "beautiful" nut. But the upshot on the other two fronts is pretty clear: If you build housing cheaply enough, more people can afford homes. And that, as my friend suggested, could change the paradigm.


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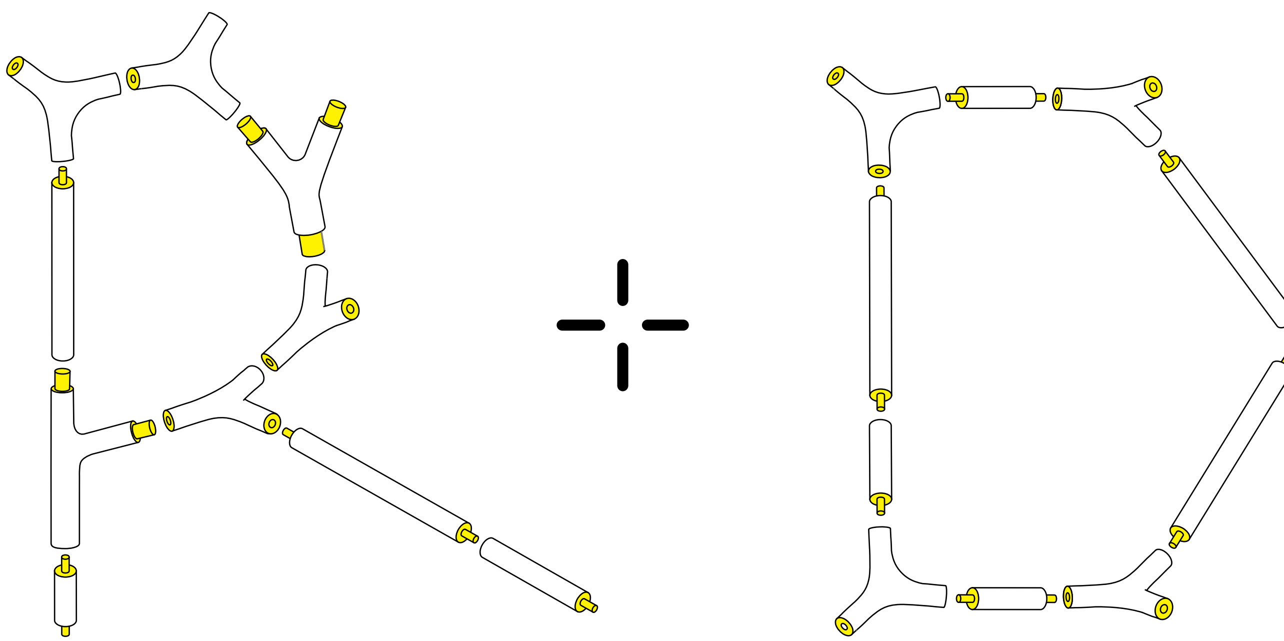


JURY
Jackilin Hah Bloom and **Florencia Pita**, founders and partners, Pita & Bloom
Tom Chung, AIA, principal, Leers Weinzapfel Associates
Randy Deutsch, AIA, clinical associate professor and associate director for graduate studies, University of Illinois Urbana-Champaign

AWARDS

EDITED BY WANDA LAU
DESCRIPTIONS BY CLAY RISEN

For this year's R+D Awards jury, it was not enough for prospective winners to ask the right questions, divest their savings, lose sleep, try, fail, and try and fail again in order to finally—finally!—reach a viable solution. Indeed, says juror Randy Deutsch, AIA, "if the result is not beautiful and/or elegant, even if it's really good for the environment and good for people, it hasn't gone quite far enough."

Which is to say that the bar was set extremely high for this year's slate of five citation and five honorable mention recipients. Beyond communicating their purpose and process to near perfection, the multidisciplinary teams tackled a range of topics—from material health to automation and ecology—and showcased, as juror Tom Chung, AIA, put it, "what value architects and designers bring in this world."

This project shows how something so simple can be done in order to achieve maximal design finishes.

Juror Florencia Pita

Opposite, Top:
Automated tab rotation in action

Opposite, Bottom:
South elevation

• HONORABLE MENTION

Functional Façade, Emma and Georgina Bloomberg Center

Rainscreens have long helped to protect buildings from water infiltration and, in colder climates, heat loss. But on structures with large wall expanses, they can look monotonous. To break up the façade of the Bloomberg Center at Cornell Tech, on New York's Roosevelt Island, the project team turned the building's rainscreen into a functional work of art.

The need for the rainscreen, says **Morphosis** principal Ung-Joo Scott Lee, AIA, came from Cornell University's request that the project be energy neutral. "The client said, 'What if instead of giving you a dollar budget, we gave you an energy budget?' " Lee recalls.

Morphosis reached out to metal fabricator **A. Zahner Co.**, in Kansas City, Mo., for help in conceiving a rainscreen that would fulfill its conventional functions but also make an aesthetic statement. The team hit on the idea of using 4,000 2-foot by 10-foot metal panels, each punctuated by laser-cut, 2-inch-diameter circular tabs. Each tab would be rotated from the vertical plane by a precise degree in order to reflect a specific amount of light such that, when viewed from afar, the 337,500 tabs and perforations would morph into images: on the building's west elevation is the Manhattan skyline, just across the East River; on the east, are the gorges around Ithaca, N.Y., Cornell University's hometown. The images are somewhat abstract—more "inspired by" than anything literal—because the designs have to balance aesthetic, energy conservation, and light distribution requirements.

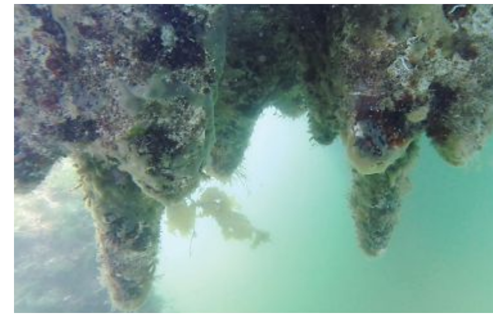
Accurately turning each of those hundreds of thousands of tabs to its particular angle, however, would take workers about a month—not accounting for potential errors in finesse. As an alternate, Zahner proposed reprogramming a spare welding robot to push and rotate each tab as specified. The completion time? A few days.

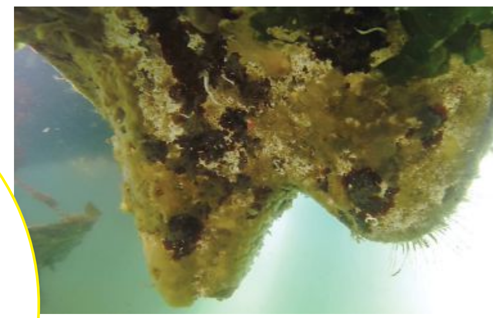
And while this was a site-specific, one-off solution, Zahner engineer James Coleman says it demonstrated how well fabricators can work with architects to realize ideas that once would have stayed on the drawing board. "The message," he says, "is to come with the wildest ideas and we'll shape our manufacturing process around that."

OPPOSITE AND TOP: COURTESY A. ZAHNER CO.; BOTTOM: MATTHEW CARBONE

CITATION

Buoyant Ecologies Float Lab





Climate change and coastal erosion are growing challenges to waterfront communities, and not just human ones: Rapidly changing ecosystems are wiping out indigenous plant and animal habitats. In an effort to combat this loss, the **Architectural Ecologies Lab** (AEL) at the California College of the Arts (CCA), in Oakland, Calif., turned to a bane of many boat owners: biofouling.

Though biofouling, the phenomenon in which surfaces placed underwater will quickly attract plankton, fish, and other sea life, can slow down boats and eat away at structures, AEL leveraged it into an approach to replenishing coastal ecosystems, creating the Buoyant Ecologies Float Lab.

According to CCA associate professor of architecture Adam Marcus, AIA, the idea grew out of a partnership with Autodesk Pier 9, the fabrication and innovation center of the software company. Autodesk asked Marcus and his students to design a floating building that could sit just offshore from its center, across the Embarcadero. But during their research, the students became fascinated with how the structure would look below the waves, and whether a design that mimicked natural underwater surfaces could better promote aquatic life.

AEL worked with scientists at the Moss Landing Marine Laboratories, in Moss Landing, Calif., to develop a vocabulary of eco-friendly shapes and geometries; and with Kreysler & Associates, a composite-materials fabricator based near Napa, Calif., to build a set of 2-foot-square, fiber-reinforced polymer plates. Made of the same high-performance material used for sailboat hulls, the structures are noncorrosive and strong enough to float for decades without degradation. As the team experimented with different shapes, testing nearly two dozen prototypes since 2015, they discovered that flat-bottom surfaces tended to promote homogeneous populations, meaning whichever plant and fish species already dominated the surrounding waters. By increasing the surface area with the addition of irregular swells and valleys, the team could promote a wider variety of plant and animal life. For example, narrow valleys provide refuge for small fish, away from predators.

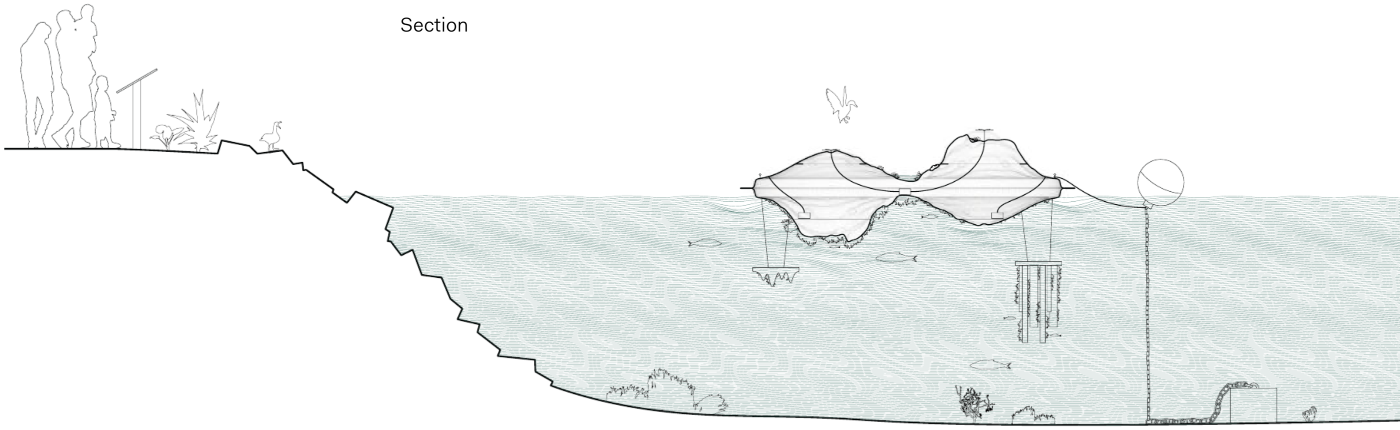
Within a few days of placing two of these prototypes in the water, diaphanous green algae had attached themselves to the undersides, creating "a hanging, underwater forest," Marcus notes. The plates' undulating above-water surfaces were also critical, channeling rainwater into small depressions that became artificial tidal pools.

As an added benefit, the structures act as wave-attenuation devices—an "artificial mangrove," Marcus says. Scaled up, he says, "We imagine they could be connected in a chain, like a necklace just offshore to act as a breakwater."

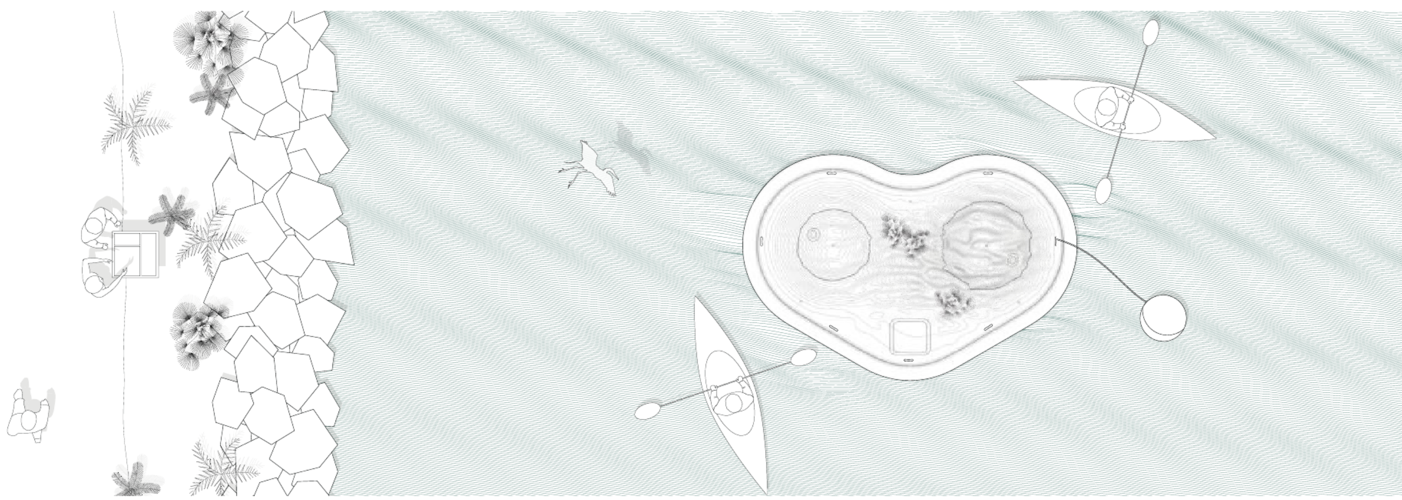
This fall, Marcus and his team will launch a full-size prototype into the San Francisco Bay. Out of the water, the approximately 14-foot-long by 9-foot-wide and 5-foot-thick (on average) plastic float is a manifestation of advanced computer modeling. But in the water, the futuristic buoy will become an inviting home for a diverse range of aquatic flora and fauna.

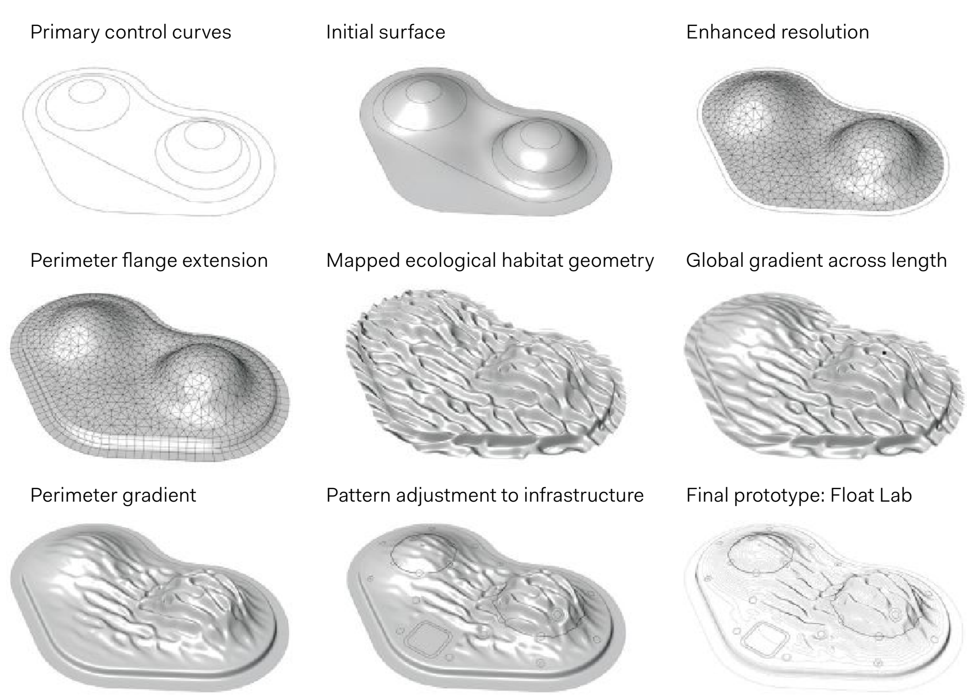
DANIEL GOSSARD

Section



Plan





Opposite: Promising biofouling on three prototypes—dubbed the juicer, mounds, and pyramids (from top to bottom)—after 8.5 months of being submerged

Right: Evolution from initial control curves to final prototype form

> ***The research that this team took was in-depth, interdisciplinary, multidisciplinary, and collaborative. That and how they displayed the results over time was over-the-top impressive.***
>
> ***Juror Randy Deutsch, AIA***

1. Flanges adhered with structural epoxy
2. Cleat (typ.)
3. Latch for removable lid at each mound (typ.)
4. Fiber-reinforced polymer hull
5. Battery
6. Irrigation pump
7. Plywood shelf
8. Bilge pump (typ. 2)
9. Poured concrete weight (totaling approximately 600 pounds)

ADAM MARCUS

Longitudinal Section

FILTER BY

Project Area
(base building or interior)

MasterFormat
(Divisions 03–32)

Products
(acoustic ceilings, grout, millwork, etc.)

Health Regards
(skin irritation, carcinogenicity, etc.)

Environmental Hazards
(flammable, persistent, reactive, etc.)

The Precautionary List is a great catalog not just for architects to have for themselves, but also for architects to have clients look at.
— Juror Jackilin Hah Bloom

Overview + Health
- Trade Names & Synonyms
- GreenScreen Score
- GSPI Six Classes of Chemical Concerns
- Health Hazards
- Environmental Hazards
- Pathways of Exposure

Building Products
- Where It's Found

Government + Industry
- Restricted Lists

Substance Description
- Physical Description
- Consumption & Industry Use

DATA POINTS

• HONORABLE MENTION

Precautionary List

*

- Antimicrobials
- Bisphenol A (BPA)
- Chloroprene
- Formaldehyde
- Urea-Formaldehyde
- Flame Retardants
- Antimony Trioxide
- Decabromodiphenyl Ether (DecaBDE)
- Hexabromocyclododecane (HBCDD)
- Tricresyl Phosphate
- Tris(2-chloro-1-methylethyl) Phosphate (TMCPP)
- Isocyanates
- 2,4-/2,6-Toluene Diisocyanate Mixture (TDI 80/20)
- 4,4'-MDI Homopolymer
- Diphenylmethane-2,4'- Diisocyanate (2,4'-MDI)
- Diphenylmethane Diisocyanate (MDI) - non isomer specific
- Hexamethylene Diisocyanate (HDI)
- Methylene Bisphenyl Diisocyanate (Pure MDI)
- Polymeric MDI (PMDI)
- Polymeric TDI
- Maleic Anhydride
- Methyl Methacrylate (MMA)
- Monoethanolamine
- N,N-Dimethylethanolamine
- Orthophthalates
- Butyl Benzyl Phthalate (BBP)
- Dibutyl Phthalate (DBP)
- Dicyclohexyl Phthalate (DCHP)
- Di(2-ethylhexyl) Phthalate (DEHP)
- Diisodecyl Phthalate (DIDP)
- Di-(C10-rich branched C9-C11 alkyl) Phthalate (part of DIDP)
- Diisoheptyl Phthalate (DIHP)
- Di-(C9-rich branched C8-C10-alkyl) Phthalate (DINP-1)
- Diisobutyl Phthalate (DIBP)
- Diisononyl Phthalate (DINP-2)
- Di-n-Octyl Phthalate (DnOP)
- Di-n-Pentyl Phthalate (DnPP)
- Pentachlorophenol
- Perfluorinated Compounds (PFCs)
- Perfluorooctanoic Acid (PFOA)
- Perfluorooctane Sulfonate (PFOS)
- Perfluorobutanoic Acid (PFBA, C-4)
- Perfluorobutane Sulfonate (PFBS, C-4)
- Perfluorohexanoic Acid (PFHxA, C-6)
- Polyvinyl Chloride (PVC) and Chlorinated Polyvinyl Chloride (CPVC)
- Styrene
- Polystyrene
- Toxic Metals and Compounds
- Arsenic and Compounds
- Cadmium and Compounds
- Copper and Compounds (for exterior building materials)
- Hexavalent Chromium and Compounds
- Lead and Compounds
- Mercury and Compounds
- Organotin Compounds
- Dibutyltin Dilaurate

Increasingly, manufacturers offer products that purport to support sustainability, performance, and wellness initiatives. But in many cases, these so-called wonder products still contain an array of chemicals—some of which are toxic—that the presence of which is often obscured from end users. Architects can turn to existing databases that detail information about the environmental and health risks of building products, but the information tends to be cluttered and overwhelming.

That's why Mary Dickinson, ASSOC. AIA, a senior associate based in the Dallas office of **Perkins+Will**, developed the Precautionary List, a free, online database of materials and chemicals—no login required—that is a part of the firm's greater, ongoing effort to make the construction process more transparent. Using the website's simple interface, architects and contractors with a list of a particular product's ingredients in hand can search by chemical compound to find an objective description of associated health and environmental risks, written mostly in laymen's terms. The site also lists which building products it commonly appears in, including their corresponding MasterSpec divisions, and, where applicable, the government and industry organizations, such as the International Living Future Institute, recommending against its use. Users can also search by product type—such as gypsum-based acoustic panels—to find what chemicals it likely contains.

Dickinson is less interested in proscribing materials outright than she is in giving architects and their clients information to help make intelligent, safe choices. At a project onset, she says, "designers can have a dialogue with their team about which chemicals are in which products, and then ... have a dialogue with the clients to discuss which products can work."

At the same time, she adds, the database allows users to find less toxic alternatives that perform equally as well as conventional products. "We needed to be able to show that just because someone recommends switching materials, doing so doesn't change the performance," she says.

The database, which is updated regularly and peer-reviewed, works both upstream and downstream. Not only does it explain how materials might affect users' health over a building's operation, but it also shows whether their production process has negative effects on the health of the workers who make them, Dickinson says: "We want people to understand the full life cycle of a product."

• HONORABLE MENTION

Here East Gantry

As the eastern districts of London gentrify, architects, developers, and residents are doing their best to repurpose existing structures, which are often industrial. In the city's Stratford neighborhood stands a three-story, 66-foot-tall, 984-foot-long, and 52-foot-deep steel gantry that originally housed mechanical units for a massive air conditioning plant for nearby facilities. Though those units are long gone, local real estate developer Delancey wanted to turn the site into a creative hub, lining up prospective artist tenants. For this project, called Here East Gantry, the local office of **Hawkins\Brown Architects** opted to retain the plant frame and slot in 23 studios, creating a human-scale cabinet of curiosities.

Though every studio would have either a 270- or 860-square-foot footprint, or "plot," Hawkins\Brown wanted each module to be a singular, self-enclosed entity, complete with a distinct form, roofline, and room partitions—and custom-built to meet each artist's unique requests. But the firm also wanted to build the studios using a kit of standard—and thus budget-friendly—parts.

Hawkins\Brown architect Jack Stewart said the team began devising a toolkit of joints and other building elements using WikiHouse, an open-source, parametric design program created in 2011. The program allowed them to adjust each unit to different specifications, down to the angles and widths of each member and joint. Then, with the push of a button, they sent the cutting files generated from the program to a remote CNC-milling machine, which churned out the puzzle-like plywood pieces for the 23 building chassis.

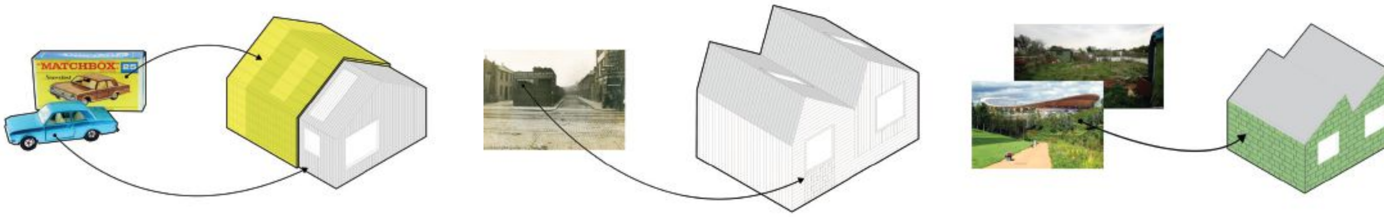
"As a firm, we were able to hand the data directly to a milling contractor, who could then deliver the kit of parts to the assembly team on site," Stewart says.

The studios were erected in a matter of hours, and without any specialized equipment or labor. The tenants then chose their own cladding and other finishes.

Beyond the ability to customize multiple environments at a relatively low cost, the digitized, streamlined workflow offered another benefit, Stewart adds: "Much more certainty in the design process."

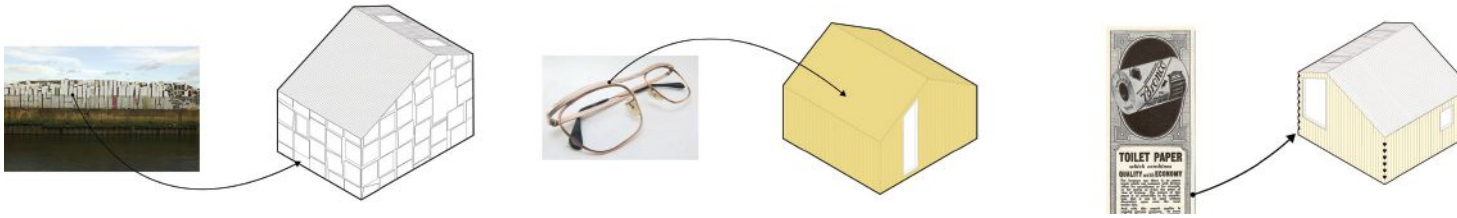
The elevations of plot 15 at Here East Gantry draw from the vibrant Refreshers candy wrappers by confectioner Trebor Bassett (formerly known as Clarnico)

ROSS KINGHORN/PYPR



> ***This project has a narrative: It looks at a method of fabrication, which is flat packing, and then it looks at [crafting] an assembly that you can send it in a box, like an IKEA house.***
>
> ***Juror Florencia Pita***

MIDDLE: LEISURE TECHNIQUE; ROSS KINGHORN/PYPR

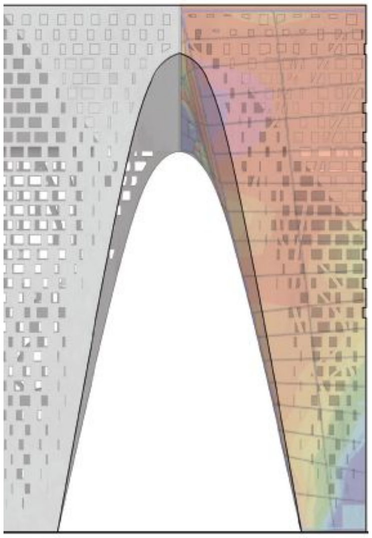


Top: For design inspiration, Hawkins\Brown looked to local makers and inventions in history, including (left to right): Lesney Matchbox toys; Deason & Son timber yard; green space created for the London 2012 Olympics; Fridge Mountain, a former, beloved dump of white goods; glasses frames made by Algha Works; and Bronco toilet paper

Opposite, Middle: Organizing building elements in preparation for assembly

Opposite, Bottom: East elevation

This Page: Plot 13, Fridge Mountain



• CITATION

Thinness

Concrete is a wonder in many ways: easy to make, easy to form, and strong upon cure to boot. Its mass and bulkiness, however, means it can be passed over for wood or steel. But what if concrete could be rendered lightweight?

Collaborating with the research and development department of global concrete manufacturer **Cemex**, headquartered outside Monterrey, Mexico, Julie Larsen, ASSOC. AIA, and Roger Hubeli, who teach at Syracuse University and run the design firm **Aptum Architecture**, explored this postulation with Thinness, a concrete pavilion that stands 10 feet tall, wide, and long, but with walls that are a mere 2 centimeters thick.

The structure's secret lies in its highly fluid concrete mix, which uses glass beads for aggregate and 1.5-centimeter-long steel fibers and fiberglass fibers that provide tensile strength while cutting the weight of the mix almost by half that of the conventional formulation.

Thinness comprises 12 tapered hollow columns and four skylight, or light well, units. The project's modularity allows for easy assembly and portability while the columns are perforated to allow light into the pavilion and to cut down further on their weight—to 200 pounds each.

While architects have been pushing the structural limits of concrete for decades, much of it has been in the form of shells and arches, which work solely in terms of compression, Larsen says. Hubeli adds: "The perception of concrete [versus] the reality of its capacity is quite huge. Concrete is extremely advanced, but the understanding of the material is very limited. That gap allows for innovation."

The pavilion's concrete is self-consolidating and self-compacting, but the designers and fabricators still had to experiment with how the mix and its fibers would distribute themselves around the many sharp angles of the columns' wax formwork delineating the rectilinear perforations. If the fibers clumped and intertwined, the walls would lose strength.

Larsen, Hubeli, and Davide Zampini, head of Cemex Research Group, say the project was as much about the structure itself as it was about demonstrating the potential of interdisciplinary coordination—in this case, between academia, architecture, and concrete manufacturing. Though the pavilion is, at this stage, just a test bed, they predict that superthin concrete will soon begin to appear in conventional construction—even, in some cases, as load-bearing elements. "The material has all sorts of possibilities," Zampini says, "but people don't know about them."

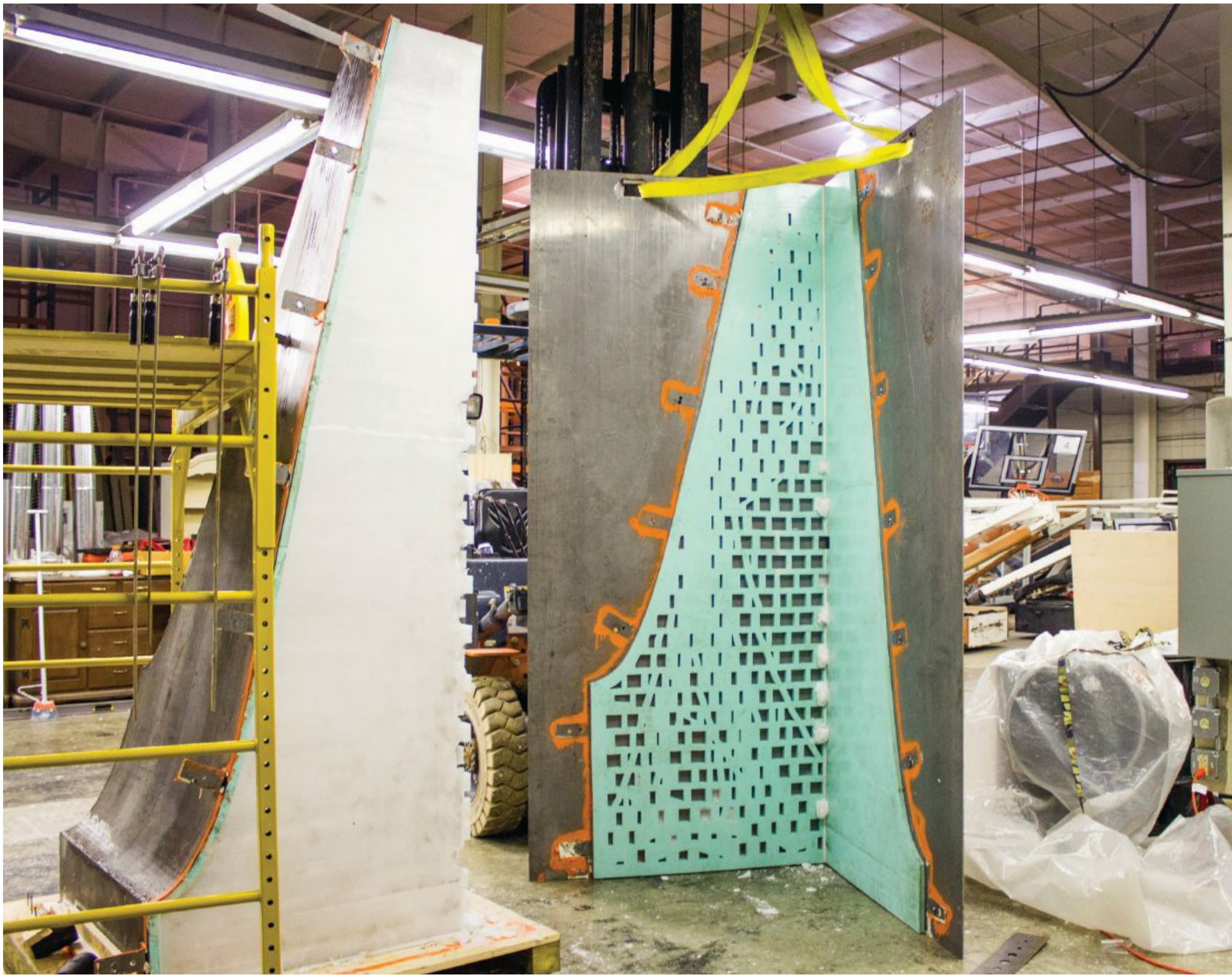
For example, the ultrathin concrete modules could theoretically be scaled up or stacked to create a vertical wall. "The idea," Hubeli says, "is to make us think about an entire light building."

COURTESY APTUM ARCHITECTURE

MIKE CAMPOS/AERIALSHOTZ

Opposite: Grasshopper overlay of a column's perforation pattern in conjunction with its stress map

This Page: Thinness comprises 12 exterior column modules and four interior light well modules



Top: Outer and inner steel forms support waterjet cut silicon inlays (green) against which lost-wax inverse columns (white) were cast

Above, Left to Right: The silicon inlays were removed from the lost-wax formwork, to be replaced by poured-in-place concrete; a mock-up of how the fibers in the concrete mix will distribute around the column perforations; the light wells and perforations afford a high quality of light inside the pavilion

COURTESY APTUM ARCHITECTURE

Thinness merges craft, fabrication, and the digital realm. It's compelling to go through the images and the researchers' process and see how those three areas were combined.

Juror Randy Deutsch, AIA

Extrapolating the potential of ultrathin concrete from pavilion to skyscraper

This project opens new territory for a material that has connections to art, to architecture, and to the domestic space. This is a novel way of working with felt and it has many applications.

Juror Florencia Pita

This Page: Quilted acoustic panels

Opposite: Robotic head and end effector applying felt in a shiplap technique onto a curved substrate

• CITATION

Robotic Needle Felting

Binding thermoplastic textiles was already familiar territory for **Tsz Yan Ng**, an assistant architecture professor at the University of Michigan, so she turned to the newfound possibilities offered with needle felting, the age-old process whereby a barbed needle pushes through layers of fabric and, as it pulls back, entwines the threads and thus the layers, uniting the plies.

Ng wondered whether she could integrate this low-tech process with robotic manufacturing to create a more efficient way to produce complicated needle felting. But getting the robotics to execute the inherently simple actions was deceptively difficult. "A lot went in to tuning the process, and making the needle bind correctly," she says. "We went through a lot of trial and error."

The result, developed by Ng and her team at the Taubman College of Architecture and Urban Planning's Digital Fabrication Lab, directed by Wesley McGee, is an additive process somewhat analogous to 3D printing: A robotic head equipped with a needle is fed a strip of felt that it then lays out and attaches onto a foam substrate.

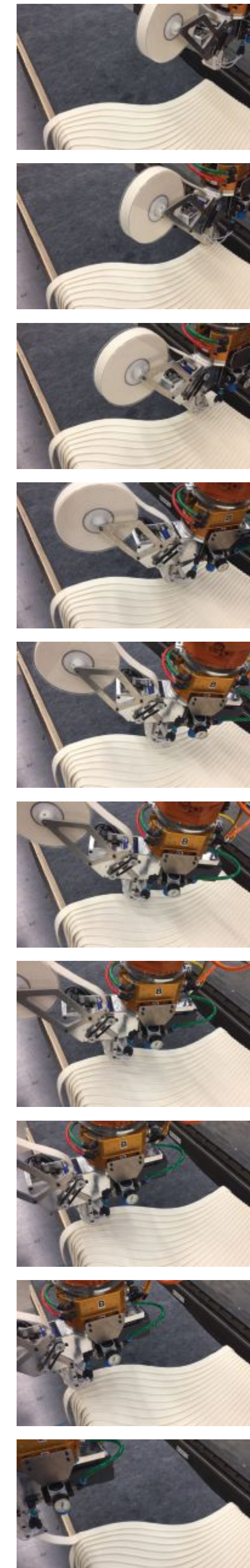
"Integration into a robotic process not only enables precision and speed in manufacturing but also extends needle felting as a 3D process, especially for surfaces with complex geometries," Ng and her team wrote in their submission. Because the robot arm can move in multiple directions and angles, it can create complicated fabric topographies all without thread or glue, making the process environmentally friendly and visually captivating.

Ng focused on three methods of needle felting: quilting, or the binding of two similarly sized felt sections; shiplap, in which entire felt strips successively overlap; and shingling, in which individual felt pieces are laid down, each partially over the previous. Depending on the method deployed, the robot can complete up to several inches a second.

Even without glue or thread, the binding between each layer is incredibly strong. "There are hundreds of fiber interactions per square inch," Ng says.

Possibilities for the technology abound, she adds. "If you look at most acoustic treatments, they're pretty generic," she says. "So there's a lot of potential there." The process can also bind conventional felt over a substrate of insulation, creating a finished insulative surface. A third application would be the incorporation of needle-felted fabrics into furniture or wall treatments.

And Ng is investigating what happens when different types of felt, bound together, are heated. "Once baked, felt creates a different curvature and form with a slight stiffness—and that has all sorts of potential," she says. "Right now, we're testing it to see how far we can push it as a structural element."



TSZ YAN NG

• CITATION

Limb

Opposite, Top:
Diagramming CNC-milling potential on historical prints

Opposite, Bottom:
Reimagining heavy timber joinery into four structural systems

Sometimes the best innovations are hidden in plain sight—or in the pages of an 18th-century how-to manual for France's navy. Such is the case with Limb, a project inspired by the lost art of using tree crotches in lieu of traditional woodworking joints that is detailed in *Encyclopédie Méthodique: Marine*.

"I have been looking at pre-electric technologies for a while, and what impressed me was the ways that people managed to be very innovative with the materials they had at hand," says Steven Mankouche, head of Ann Arbor, Mich.–based **Archolab** and an associate professor of architecture at the University of Michigan.

Because the crotches—the connection points between a trunk and a limb, or between a main limb and an offshoot—are a single integrated piece, they are stronger than a joint that forces together disparate vertical and horizontal members. "Shipbuilders in particular liked to use tree crotches as joints," Mankouche says. "Especially in a sea battle, you don't want your joinery to fail."

Once Mankouche became aware of tree crotches, he started seeing them everywhere—in construction, furniture, and more. "I was so impressed with the joinery," he says of historical farm buildings. "These barns last forever." Furniture makers, meanwhile, prized such elements for their ability to provide function without drawing attention to the joint.

But precisely because they are organic in nature, tree crotches are hard to replicate, and their use in construction fell off during the Industrial Revolution, which required uniform components for mass manufacturing.

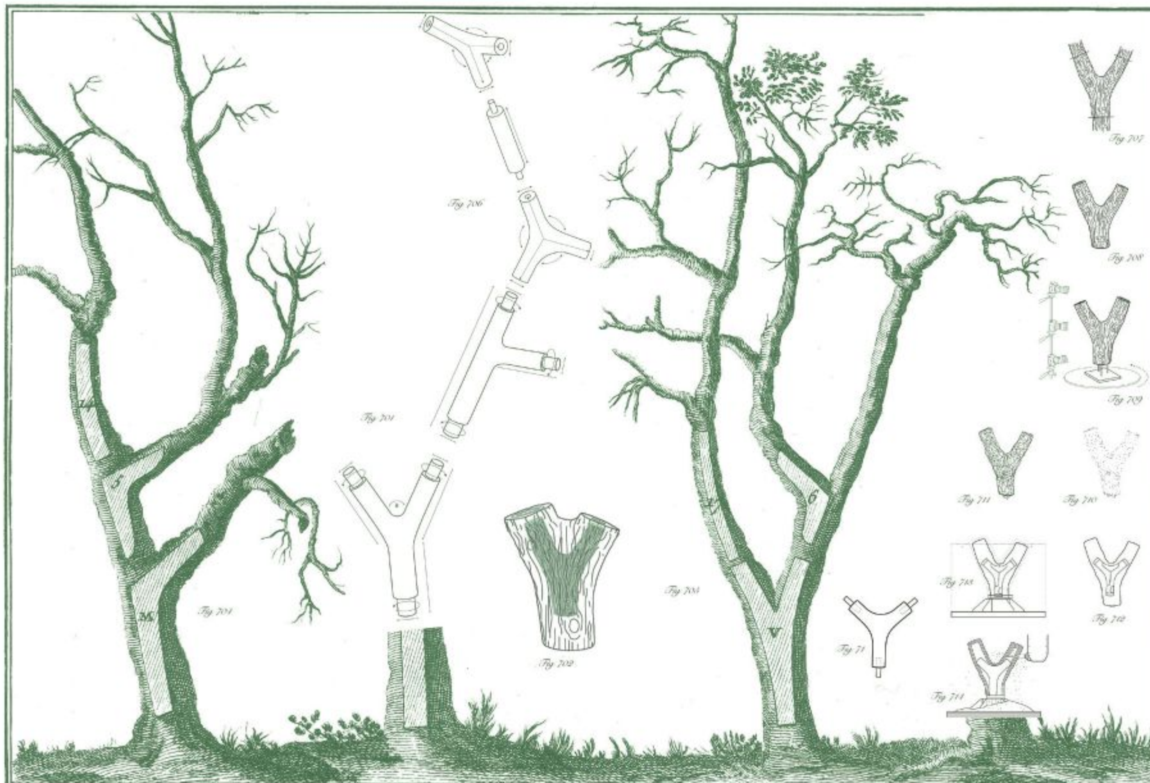
Most large trees have several crotches but, because of the joints' density and complicated grain pattern, they often end up in landfills. Mankouche wondered whether they had a place in 21st-century design.

His first insight was that while every crotch is a little different, most fall within a narrow range of angles—between 20 and 60 degrees—particularly once they have been milled. He and his team then built a database of hundreds of the most commonly found angles. "A lot of digital work is focused on customization," he says. "The idea here is to have a vocabulary of components."

In practice, an architect using Archolab's database would collect a set of tree crotches and then input their angles into their database. An algorithm would then crunch the values into an optimal arrangement for whatever structure the user wants to build. "Our project reduces a number of common angular occurrences, within unique limb bifurcations, down to a set of shared parts that can be 'tuned' to and reused in different structural systems," Mankouche and his team describe in their submission.

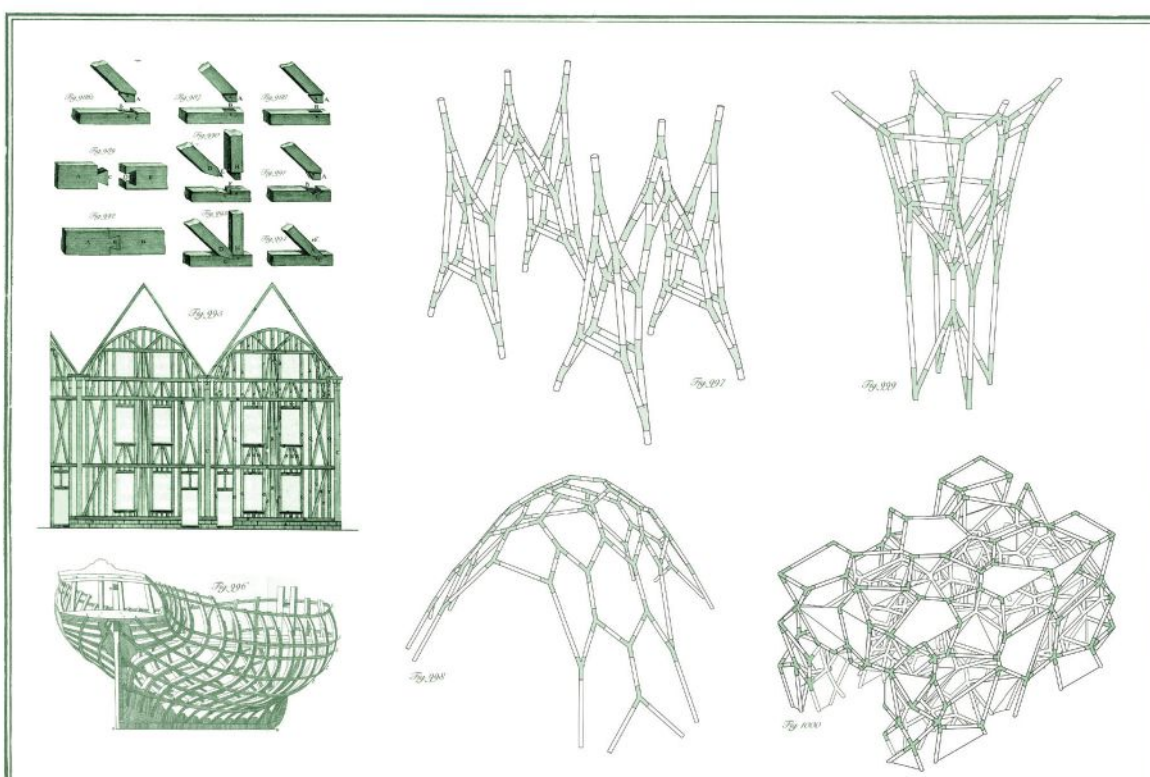
As a start, the Archolab team have identified four potential forms of increasing scale—a frame, a column, a shell, and a semi-rectangular structure they call a "hedge"—and designed prototypes for each, as a demonstration of what the database can do.

Limb, Mankouche stresses, is not about mimicking nature, but rather about drawing on its genius for efficient, strong construction.



Limb

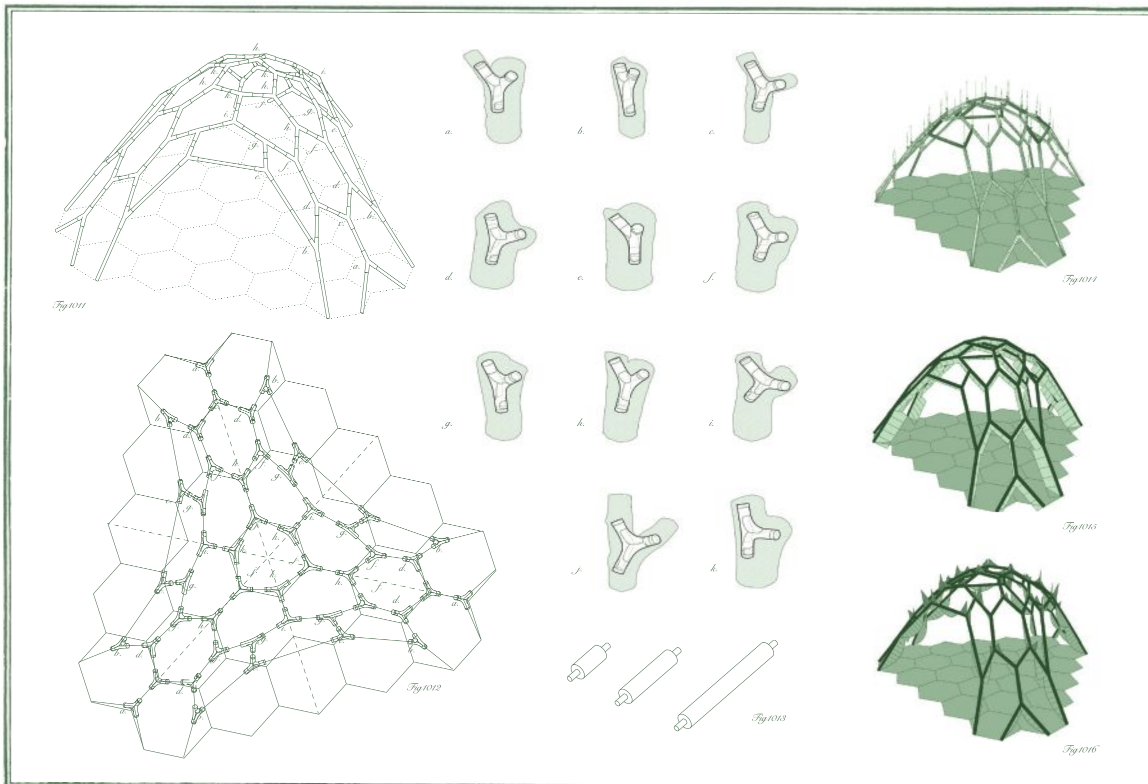
Maukouche Vliet Von Buelow



Limb

Maukouche Vliet Von Buelow

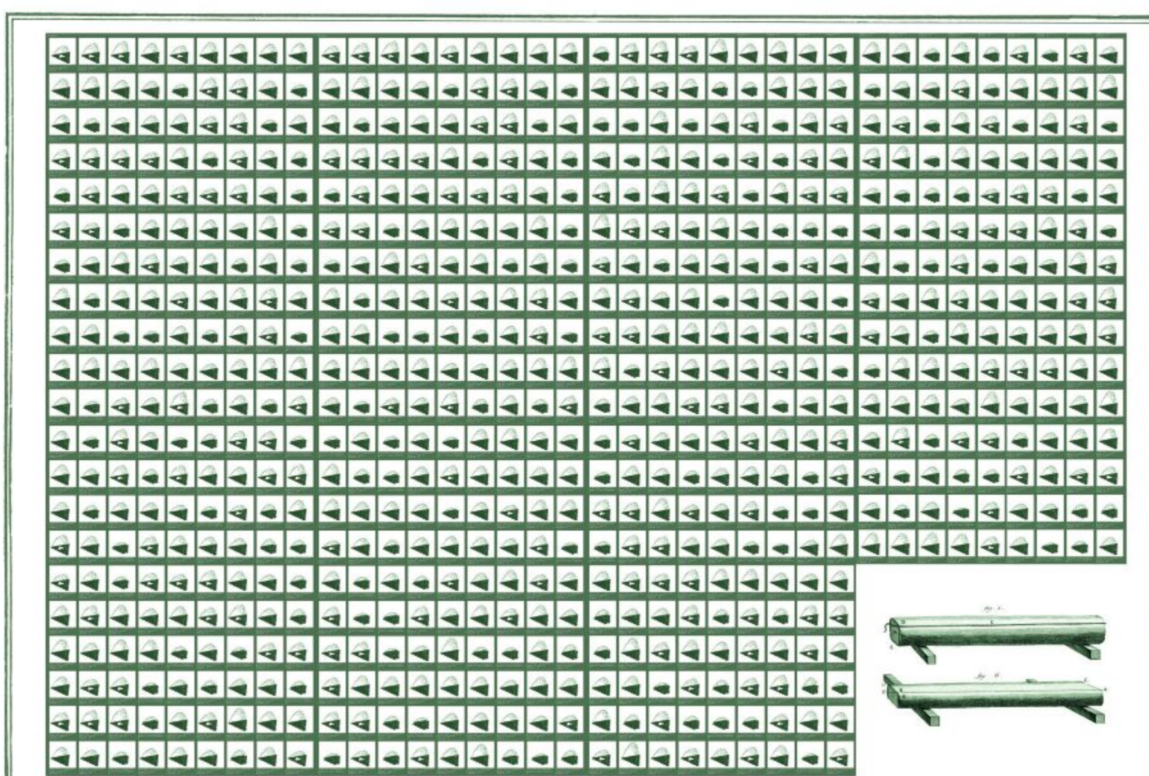
COURTESY ARCHOLAB



Pl.103

Limb

Mankouche Vliet Von Buelow



Pl.104

Limb

Mankouche Vliet Von Buelow

COURTESY ARCHOLAB

> *This project reinterpets a very natural organic form through digital fabrication technology to create new shapes that retain the same sense of tree members, but go beyond that.*
>
> ***Juror Tom Chung, AIA***

Opposite, Top: Three-legged reticulated shell composed of 11 commonly occurring parts

Opposite, Bottom: 702 potential shell forms using 11 common parts

This Page: Full-scale installation of one leg of a three-legged reticulated shell structure

This project tackles the larger issue of architecture not just being a spatial experience, but also a healing experience, and that's so important in the context of today.

Juror Tom Chung, AIA

• HONORABLE MENTION

Social Sensory Architectures

The first time **Sean Ahlquist**'s 8-year-old daughter saw one of his 3D knitted fabric tubes, "she did a nose dive right through it," recalls the assistant professor of architecture at the University of Michigan. Made from elastic yarn and doused in colorful light projections, the inviting, tactile, and pliable environment helped his daughter, who is autistic and nonverbal, overcome her sensory-based anxieties. "She could discover the ways that she wanted to engage with it," unlike with conventional playground equipment, he says.

Ahlquist has long explored both the interplay and distinction between textiles and structures using an industrial CNC-knitting machine. "As soon as I created architecture out of fabric, it became an object," he says. But, in the process of its creation, the resulting object would lose the tactile appeal that, say, a sweater or a blanket may possess.

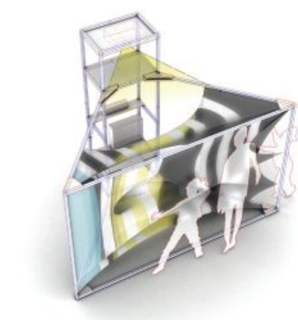
That led Ahlquist to think about his daughter, who uses her hands and eyes to interact with the world. With 3D knitting, he realized he could create complicated play environments, such as seamless tubes, concavities, and open expanses onto which he could project lights and images. Though he has some research for reference, Ahlquist designs the undulating, funicular forms intuitively, guided by a sense of what will satisfy "the diversity of multisensory experiences that the audience of children with autism commands," he says.

In spring 2015, Ahlquist demonstrated his first 7-cubic-foot structure in a school for special needs students in Ann Arbor, Mich. So far, the children, including his daughter, love to play with it. The next step, he says, is to engage researchers to assess and measure its actual impact on the students.

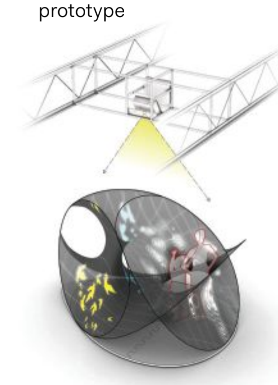
Whatever the results, Ahlquist says he has surpassed his goal of blurring the line between fabric and architecture: "It's about connecting two worlds, two realms of expertise."

2D SensoryPlayscape prototype

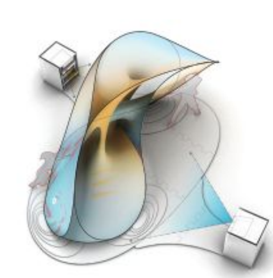
2.5D microenvironment prototype



3D sensory-responsive prototype



SensoryPlayscape with multiple interfaces



SEAN AHLQUIST/UNIVERSITY OF MICHIGAN

Opposite: Each MineralBuilt unit comprises a face shell and perpendicular pier

Left: Full-scale mock-up, showing installation of flashing, bond-beam units, horizontal rebar, and metal furring via stainless steel zip ties

MineralBuilt

• CITATION

For years, Francisco Gomes, AIA, an associate professor and the associate dean for graduate programs at the University of Texas at Austin School of Architecture and co-founder of **Gomes + Staub Architects** (GSA), had looked for a low-cost, reliable construction product that had the strength of masonry and the design flexibility of wood framing. Conventional concrete masonry units (CMUs) still require multiple trades on site at the same time to coordinate electrical, plumbing, insulation, and other systems.

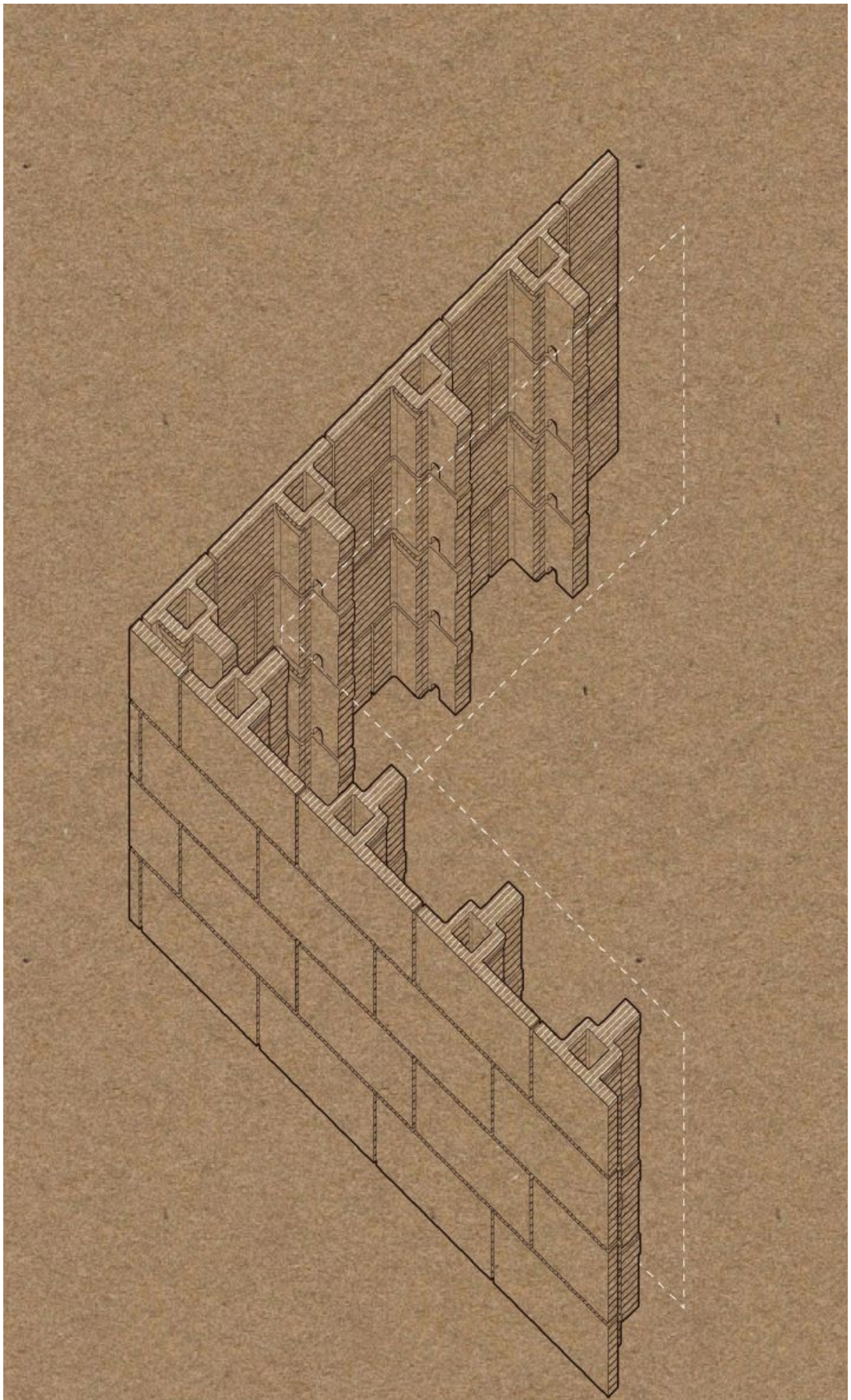
In 2012, Gomes and fellow GSA co-founder Dabney Staub took matters into their own hands to improve upon the CMU. They began by learning everything they could about masonry construction, interviewing block manufacturers and masons. Gomes even spent a week in Michigan at a trade school run by masonry producer Besser, where he learned how to make and work with CMUs.

After several iterations, the pair created MineralBuilt, a modular concrete unit comprising an 18-inch-long by 8-inch-tall face shell and a just off-center perpendicular leg, or pier, for a total depth of 10 inches. Moreover, the wall block accommodates wall reinforcement, insulation, wiring, plumbing, and telecom connections, post-installation. As a bonus, the units can be laid in alternating left-handed and right-handed courses without the need for specially cut end units, corner units, or framing units around windows and doors.

The resulting configuration offers benefits and increased efficiencies in manufacturing, shipping, and construction as well. Gomes said that the blocks use one-third less cement and aggregate than conventional blocks, and can be made 50 percent faster—all on standard CMU production equipment. Meanwhile, a standard pallet shipment of MineralBuilt blocks can fit 33 percent more units than conventional CMUs and subsequently cover 50 percent more wall area. The blocks have handholds at their center of gravity to help shipping and construction workers. Instead of the two hollow openings of a conventional CMU, MineralBuilt blocks create an open cavity on the inboard wall face, with the piers working as supports on which to hang drywall or other finishes. The arrangement means that masons no longer have to wait for other trades before closing off walls; instead, the services and insulation can be added after the masonry walls are up, in the exposed cavity or through strategically located notches and knockouts.

Gomes takes pride in MineralBuilt's simplicity and low maintenance, he says. "It uses the exact same materials and technologies as conventional masonry [and targets] the needs of most buildings as they are actually built."

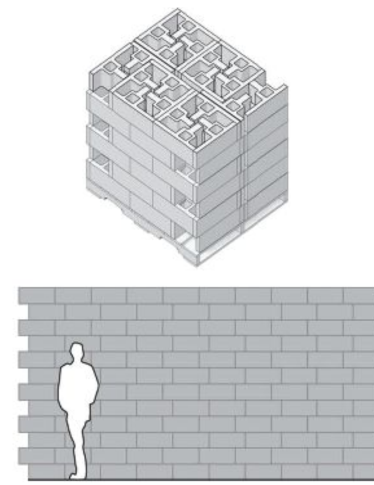
FRANCISCO GOMES



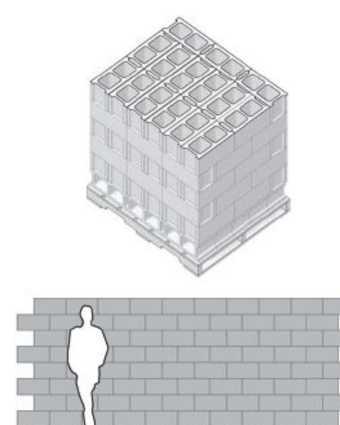
This project treats concrete masonry units like a fabric. It is clever, beautiful, and seductive.
Juror Randy Deutsch, AIA

COURTESY GOMES + STAUB ARCHITECTS

Efficiency Comparison



A standard 40-inch by 48-inch shipping cube fits six layers of 20 MineralBuilt units each, for a total weight of 3,000 pounds, and an installed wall area of 120 square feet



A standard shipping cube fits six layers of 15 8-inch-tall CMUs each, for a total weight of 2,970 pounds and an installed wall area of 80 square feet

Full-scale mock-up

• HONORABLE MENTION

Hydroformed Shading

In designing a six-story, 497,000-square-foot science and engineering complex for Harvard University, **Behnisch Architekten** faced two daunting tasks: how to minimize the energy load of the massive building, conceived as a series of large glass boxes; and how to minimize the enormous structure's scale in Allston, a low-slung, academic and residential neighborhood across the Charles River from the university's main campus in Cambridge, Mass. "We had a scaleless façade cladding, and we wanted to mask all that with a textured façade," says Boston-based Behnisch partner Robert Noblett, AIA.

The solution was the development of a shading system that could pull double duty as a cooling mechanism and as a visual break in the building mass—and be lightweight enough to be installed on the façade with minimal structural support.

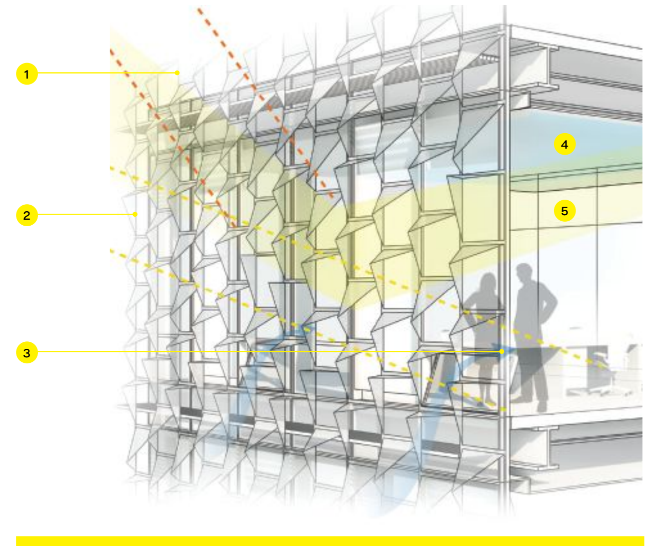
Inspired by the shapes, strength, and thinness of everyday objects like tin cans and soup bowls, Behnisch worked with German fabricator Edelstahl-Mechanik to create the world's first hydroformed tensile façade. Common in the aerospace industry, hydroforming uses water pressure to shape ultrathin metal plates against a mold, creating custom pieces.

At one point, Behnisch considered using the same metal piece across the façade, but making it adjustable. However, Noblett says, that would require a motorized system, which would drain energy and introduce potential maintenance issues.

Instead, Behnisch stipulated 14 different shapes, varying in size and the number of facets, to maximize heat and light reflection at different points across the building façade. Just 1.5mm thick and weighing 10 pounds each, the 12,000 hydroformed plates are also perforated around the edges to allow in diffused light while minimizing heat intake. Despite their thin profile, the panels are strong enough to be connected directly to spring-tensioned steel cables attached to the building at the spandrels, which have auxiliary wind bracing.

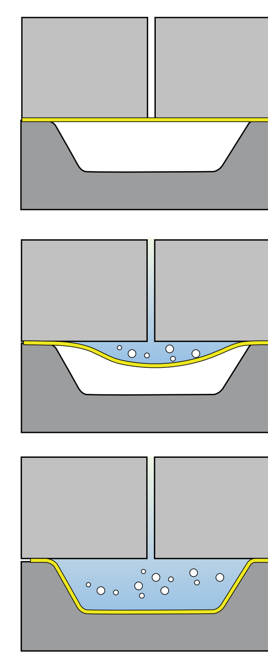
The result, Noblett says, is a shading solution "as flexible and responsive as a motorized system, but fixed in place." The system reduces the building's peak cooling load by 65 percent, reflects natural light deep into the interior, and visually breaks up the building mass.

Façade Performance Diagram



1. Blocks summer sun
2. Lets in winter sun
3. Supports natural ventilation
4. Furthers radiant cooling
5. Redirects daylight

Hydroforming Process



Water pressure drives a metal blank (yellow) into the mold and into its desired shape

JANIS ROZKALNS

> *There's a sense of care and thought in terms of balancing the shade's cost and production with its aesthetics, architectural value, and environmental value.*
>
> — ***Juror Tom Chung,*** **AIA**

JANIS ROZKALNS

Project Credits

Functional Façade, Emma and Georgina Bloomberg Center, page 100
Client: Cornell University
Design Firm: Morphosis, Culver City, Calif. · Thom Mayne, FAIA (design director); Ung-Joo Scott Lee, AIA (project principal); Luke Yoo (project architect); Nicolas Fayad, Edmund Ming Yip Kwong, Jerry Figurski, Jean Oei (project designers); Chloe Brunner, Debbie Chen, Chris Eskew, Stuart Franks, Farah Harake, Clayton Henry, Ted Kane, Hunter Knight, Ryan Leifield, Simon McGown, Brian Richter, Go-Woon Seo (project team); Cory Brugger, ASSOC. AIA, Kerenza Harris, Stanley Su (advanced technology); Fiorella Barreto, Christopher Battaglia, Marco Beccuci, Paul Cambon, Vivian Chen, Tom Day, Justin Foo, Yong Fei Gu, Yoon Her, Sean Kim, Jognwan Kwon, Matt Lake, Sangyun Lee, Haidi Liu, ASSOC. AIA, Eric Meyer, Nicole Meyer, Jason Minor, Michelle Park, Vincent Parlatore, Conway Pedron, Danny Salamoun, Ben Salance, Suzanne Tanascaux, Matthew Tarpley, Ben Toam (project assistants); Stuart Franks, Jasmine Park, Nathan Skrepcinski, Sam Tannenbaum (visualization)
Façade Construction: A. Zahner Co.
Façade Consultant: Arup
Façade Coating: PPG
Structural Engineer: Arup
M/E/P Engineer: Arup
Fire Protection Consultant: Arup
Sustainability Consultant: Arup
Cost Estimator: Dharam Consulting
Geotechnical Engineer: Mueser Rutledge Consulting Engineers
Lighting Design: Arup
Acoustics: Arup
Audiovisual/IT/Security/Smart Building: Arup
Code Consultant: Code Consultants, Inc.
Specifications: Construction Specifications Institute
Waterproofing Consultant: Henshell & Buccellato
Food Services Consultant: Jacobs Doland Beer
Graphics and Signage: Pentagram
Visualization: Kilograph
Collaborating Artists: Matthew Day Jackson, Michael Riedel, Matthew Ritchie, Alison Elizabeth Taylor
General Contractor: Barr & Barr
Preconstruction Construction Manager: AECOM Tishman
Owner's Representative: Forest City Realty Trust

Buoyant Ecologies Float Lab, page 102
Design Firm: Architectural Ecologies Lab, California College of the Arts, Oakland, Calif. · Adam Marcus, AIA, Margaret Ikeda, Evan Jones, Taylor Metcalf, Georine Pierre, Jared Clifton (project team)
Research Partners: Benthic Lab; Moss Landing Marine Laboratories · John Oliver, Kamille Hammerstrom, Daniel Gossard
Fabricator: Kreysler & Associates
Naval Architecture & Engineering: Tri-Coastal Marine · Andrew Davis
Funding: Miranda Leonard, Kreysler & Associates, Ashland, Autodesk Pier 9 Workshop, Port of Oakland
Special Thanks: Jonathan Massey, AIA, Lisa Findley, Stephen Beal, Tammy Rae Carland, Karen Weber
Size: 120 square feet

The Precautionary List, page 106
Design Firm: Perkins+Will, Dallas · Mary Dickinson, ASSOC. AIA, Monica Kumar, Suzanne Drake, Breeze Glazer, Brodie Stephens, French Clements, Max Richter, Robin Guenther, FAIA, Paula McEvoy, FAIA, Phil Harrison, FAIA, John Haymaker, AIA, Joel Register, Murali Selvaraj, Derek Veren, Tina Lam, Kate Doornbos, Dylan Dechant, Veera Kumar, Andrew Salveson (project team)
Researcher: Melissa Coffin
Research Partner: Healthy Building Network · Michel Dedeo, Jim Vallette, Bill Walsh, Tom Lent
Fabricator: Perkins+Will
Funding: Perkins+Will
Special Thanks: All manufacturers that provide transparent disclosure of their product content, all owners that support product transparency as a part of project goals, the design community, users of Perkins+Will's Transparency website

Here East Gantry, page 108
Design Team: Hawkins\Brown Architects, London · Nick Gaskell, Jack Stewart, Andrew Hills (project team); Architecture 00, London · David Saxby, Ryan Mcloughlin (project team)
Partner: WikiHouse · Clayton Prest
Fabricator: Leisure Technique
Structural Engineer: Momentum
M/E/P Engineer: Cundall
Size: 10,800 square feet

Thinness, page 112
Design Firm: Aptum Architecture, Syracuse, N.Y. · Roger Hubeli, Julie Larsen, ASSOC. AIA (project team)
Industry Partner: Cemex Global R&D · Davide Zampini, Alexandre Guerini, Jeremy Esser, Matthew Meyers (project team)
Research Assistants: Sean Morgan, Ethan Schafer
Fabricator: Cemex Global R&D
Structural Engineer: Sinéad Mac Namar
Size: 100 square feet

Robotic Needle Felting, page 116
Design Team: University of Michigan Taubman College of Architecture and Urban Planning, Ann Arbor, Mich. · Tsz Yan Ng, Wesley McGee, Asa Peller (project team); Rachel Henry (research assistant); Jared Monce, Drew Bradford, Carlos Pompeo (production assistants)
Funding: 2018 Taubman College's Research Through Making grant program, University of Michigan, and the University of Michigan Office of Research's Small Scale and Preliminary Projects grant

Robotic Needle Felting

Limb, page 118
Design Team: Archolab, Ann Arbor, Mich. · Steven Mankouche; University of Michigan Taubman College of Architecture and Urban Planning · Peter von Bülow; Kase Studio, Ann Arbor, Mich. · Kasey Vliet
Research Assistants/Partners: Robert Allsop, Kevin Bukowski, Cody Gilman, Andrew Thompson, Omid Torghabehi, Benjamin Wichman, Shaobo Niu
Funding: University of Michigan Taubman College, University of Michigan Office of Research
Special Thanks: 2017–2018 Taubman College's Research Through Making grant

Social Sensory Architectures, page 122
Designer: University of Michigan Taubman College of Architecture and Urban Planning, Ann Arbor, Mich. · Sean Ahlquist (assistant professor)
Project Team: University of Michigan Medicine Department of Psychiatry · Costanza Colombi; University of Michigan School of Kinesiology· Leah Ketcheson; University of Michigan Taubman College · Oliver Popadich
Research Assistants: Shahida Sharmin, Jordan Turkomani; Roujia Bai, Sommer Cade, Yichen "Janet" Dong, Grace Earl, Teruaki "Aki" Hara, James Hartman, Chang Liu, Giovanni Martinez, Mariana Moreira de Carvalho, John Spellman, Peyton Steurer, Mingyang Xia, Yiwen Yan (architecture students); Erika Goodman, Erin Almony (kinesiology students)
Fabricator: Sean Ahlquist
Yarn Supplier: McMichael Mills
Glass Fiber Reinforced Polymer Material Supplier: Goodwinds
Funding: University of Michigan Taubman College, University of Michigan MCubed Third Century Initiative, Michigan Economic Development Corp., Stoll
Special Thanks: Spectrum Therapy Center · Mary Burke, Tabitha Wisecup; Thinkery · Robin Gose; Str.ucture · Julian Lienhard
Size: 25 to 150 square feet

MineralBuilt, page 124
Design Firm: Gomes + Staub, Austin, Texas · Francisco Gomes, AIA, Dabney Staub
Research Assistants/Partners: Hannah Bacon, Hugo Reynolds, Clare van Montfrans, Ryan McKeeman, Shelley McDavid, AIA
Fabricators: Featherlite Building Products, Dynco Manufacturing, W2 MacFab
Funding: National Science Foundation I-Corps, University of Texas at Austin, Gomes + Staub, MineralBuilt
Structural Engineer: Architectural Engineers Collaborative · Charles Naeve
Intellectual Property Attorney: Meunier Carlin & Curfman · Meredith Struby
Special Thanks: University of Texas at Austin Office of Technology Commercialization · Trevor Hrynyk; Besser, World Center for Concrete Technology

Hydroformed Shading, page 126
Client: Harvard University
Design Firm: Behnisch Architekten, Stuttgart, Germany
Collaborators: Knippers Helbig, Josef Gartner, Edelstahl-Mechanik
Façade Consultant: Knippers Helbig
Façade Contractor: Josef Gartner
Fabricator: Edelstahl-Mechanik
Structural Engineer: BuroHappold Engineering
M/E/P Engineer: van Zelm Heywood & Shadford
Civil Engineer: Nitsch Engineering
Geotechnical Engineer: BuroHappold Engineering
Construction Manager: Turner Construction Co.
General Contractor: Turner Construction Co.
Landscape Architect: Stephen Stimson Associates Landscape Architects
Lighting Designers: Bartenbach, Lam Partners
Interior Designer: Behnisch Architekten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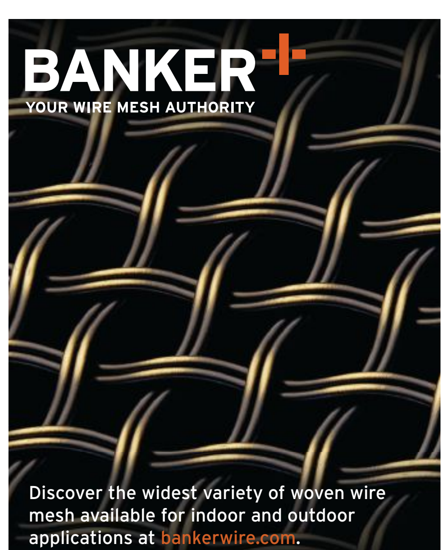
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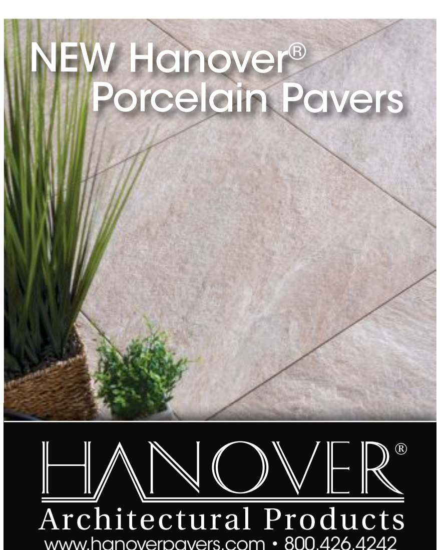

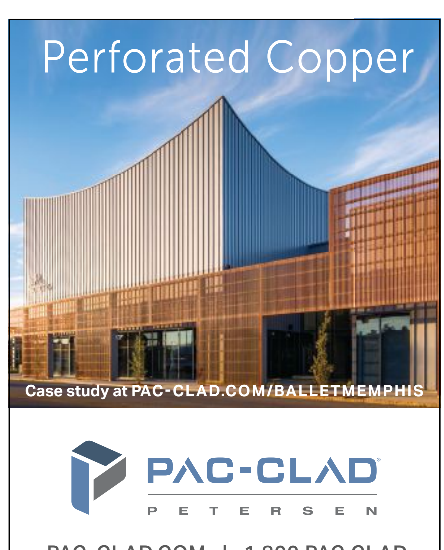

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Editorial: Saving the Glasgow School of Art

TEXT BY NED CRAMER

On June 15, a catastrophic fire engulfed Charles Rennie Mackintosh's Glasgow School of Art, spurring an important debate about the landmark's future. Back in 2014, another fire had ruined the famous library and other interiors, but left the structure "90 percent viable," according to local authorities. This time the destruction is all but total, leaving the building a smoldering shell of dubious stability.

Formal assessment still needs to be conducted, but *The Guardian* reports that a consensus to rebuild is emerging. It hopefully goes without saying that Mackintosh's masterpiece should be stabilized and restored. Less self-evident is how closely the effort should hew to the original. Preservationists have been arguing about that since the dawn of the movement.

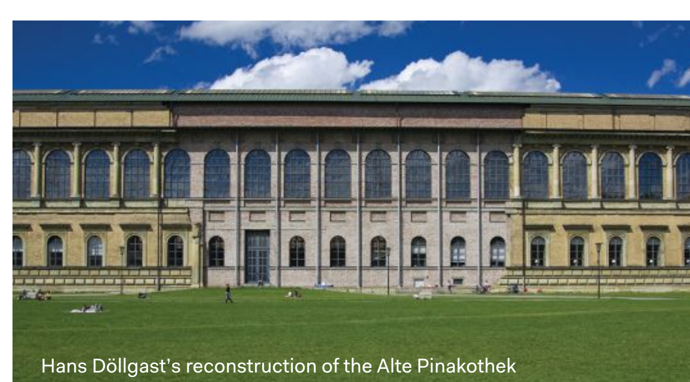
Some European countries, faced with profound losses of architectural heritage after World War II, have pursued wholesale reconstruction as a matter of national pride, as in the heavily restored Romanov palaces outside St. Petersburg and the ground-up re-creation of central Warsaw. The approach may irk someone who puts a premium on authenticity, but I appreciate the commitment it takes. Plus, I'm a sucker for spectacle, ersatz or otherwise.

More in line with contemporary taste is the "honest" approach pioneered in the early 19th century by Giuseppe Valadier, who replaced missing Pentelic marble on the Arch of Titus in Rome with congruent carvings in travertine, subtly distinguishing old from new through the difference in material while remaining formally faithful to the ancient ideal. Architect Hans Döllgast updated the idea with his 1950s reconstruction of the Alte Pinakothek in Munich, using salvaged brick and streamlined details to fill in gaps in Leo von Klenze's war-damaged classical façade.

Determining the suitability and scope of any preservation effort naturally depends not only upon how much historic fabric remains, but also upon how well it has been recorded. Thousands of photographs and recovered fragments helped guide the work at the Russian palaces, whereas the Governor's Palace and Capitol at Colonial Williamsburg in Virginia, for instance, were rebuilt in the 1930s largely on the basis of a single 18th century engraving.

Faced with similarly limited evidence at the Franklin Court complex in Philadelphia in 1976, Venturi and Rauch went conceptual, and brilliantly so, sketching the outline of Benjamin Franklin's long-lost house and print shop in white-painted, square-tube steel. Rebuilding the Glasgow School of Art as a skeletal steel frame, however, would somehow miss the point. Stabilizing the historic masonry shell and taking a more contemporary approach to the rest, like the Alte Pinakothek, would get closer to the mark. But in this case, why not go all the way?

Computer documentation and fabrication hold the promise for a whole new level of accuracy, and fortunately, as University of Edinburgh professor of architectural conservation Miles Glendinning told *The Guardian*, a detailed 3D model of the school had been created after the previous fire, making a full restoration eminently feasible. No, it won't be the same, but it'll be better than nothing at all.



Hans Döllgast's reconstruction of the Alte Pinakothek

DANIEL ETZOLD

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