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THE 15TH

R+D Awards

Design breakthroughs transforming architecture at all scales


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Luxury wellness design is changing. What's next?

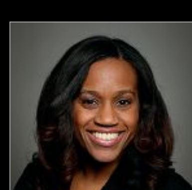
Designing for wellness has drawn increasing attention during the past decade.

BUT THAT INTEREST HAS UNDERSTANDABLY SKYROCKETED DURING THE GLOBAL COVID-19 PANDEMIC, especially among high-end clients, who want their homes to protect and nurture their families' physical and mental health.

How will luxury residential design morph to create even healthier environments as a result of the pandemic? What existing trends will evolve to contribute to healthy homes?

WATCH THE ON-DEMAND WEBINAR "Redefining the High-End Healthy Home," produced by Hanley Wood University and sponsored by Gaggenau. In this roundtable, recorded during a live virtual event in May 2021, facilitator Jennifer Castenson leads a discussion of the emerging and evolving trends in healthy home design. **She's joined by a panel of residential architects:**

Kevin Alter
Partner, Alterstudio



Danielle Tillman,
Managing Principal, bKL

Noah Walker
Principal, Walker Workshop

Takashi Yanai
Partner, EYRC

hanley wood UNIVERSITY

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ON-DEMAND WEBINAR:

REDEFINING THE HIGH-END HEALTHY HOME

How luxury single- and multi-family residential design is responding to a post-pandemic need to maintain and improve the health of inhabitants.

CONTINUING EDUCATION COURSE CREDIT: AIA 1 LU | HSW, IDCEC 0.1 CEU | HSW, Canada Potential 1 Learning Credit

Visit go.hw.net/wellness to view the webinar and complete the quiz. Courses are free of charge once you create a new learner account. Returning users log in as usual.

This webinar is approved for AIA and IDCEC continuing education credit. In addition, course registrants will gain access to a white paper on the same topic.

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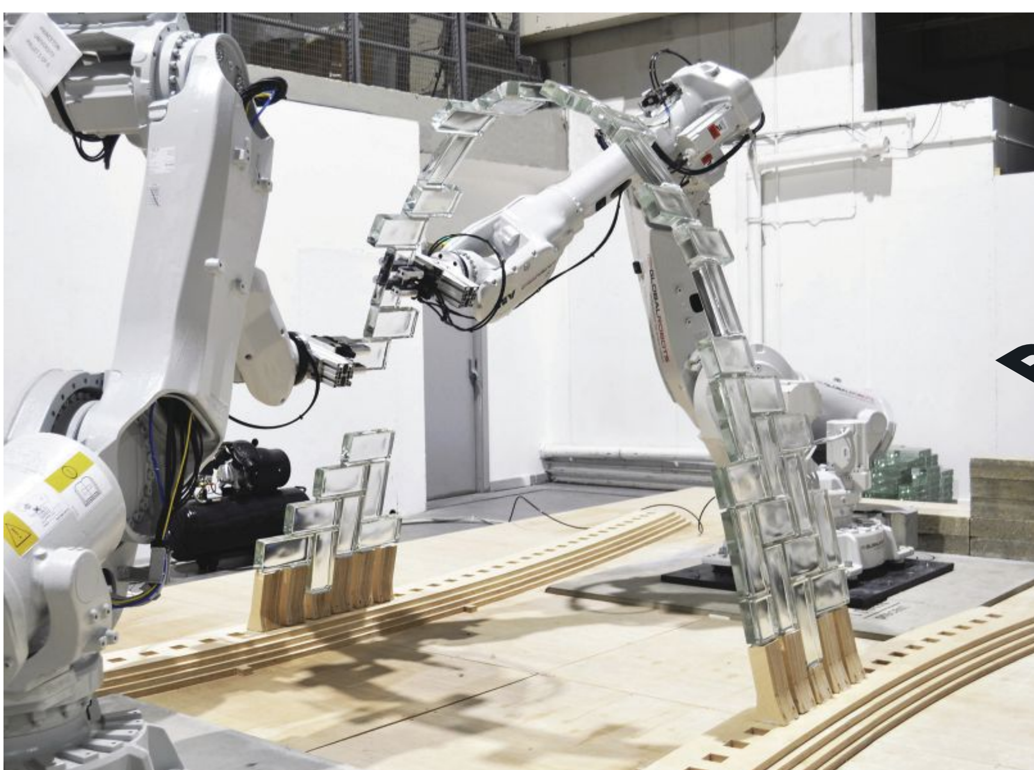
Volume 110, number 05. July/August 2021.
On the cover: R+D Award winner Robotic Construction: The Glass Vault; photo by Maciej Grzeskowiak/SOM.
Below: Robots construct the initial arch of the Glass Vault in tandem; photo by Maciej Grzeskowiak/SOM.



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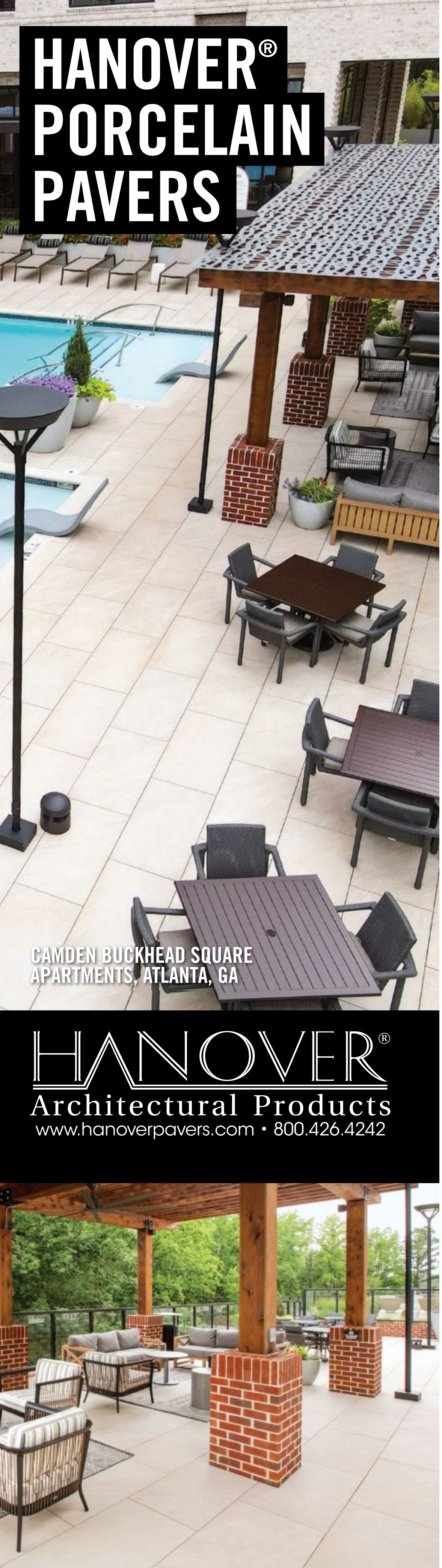

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The Journal of The American Institute of Architects

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BEFORE THE JOB STARTS,
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THE ULTIMATE NOISE RESISTIVE BARRIER

Silence roadway clatter and extend development with this proven building solution.

The corner of Market and Merrimack Streets in Newburyport, Mass., endures more than its fair share of traffic noise. For starters, it's barely 50 feet from the town's only major highway. Merrimack Street fronts the parcel and serves as the town's popular waterfront roadway. Noise? It's constant. If you're planning a mixed-use development there, you better have a solution for the nonstop clamor.

Scott Brown and his associate, Matt Langis, have one. In fact, some say it's the gold standard for sealing off outdoor noise pollution.

Brown is principal of Scott M. Brown Architects, a 20-year-old practice based in Newburyport. Langis is a project architect there, part of a team of six.

55 STC RATING

"It's a very busy intersection," Brown explains. "We designed five premium two- and three-bedroom residential units with ground floor retail. We're looking forward to seeing how it handles street noise."

The 'it' Brown refers to is ICF (insulated concrete forms). ICF is a wall system formed by stacking foam-framed blocks Lego-like to create a cast-in-place concrete wall. The concrete mass creates a nearly soundproof enclosure with a 55 STC rating. (By comparison, the average STC rating for wood-frame structures is just 38.)

It's one of an assortment of structural advantages now in play as the three-story, 9,570-square-foot mixed-use development rises from the excavation site. Completion is expected later this year.

EARLY CHALLENGES

When the building owner approached the firm with an ICF-only requirement—the practice's first—Langis admits to some initial jitters. Those nerves quickly faded thanks to the support of the project's general contractor, Groen Construction of Rochester, N.H., and structural engineer, both ICF veterans.

One challenge was a four-foot drop off from left to right and a 10-foot drop off from back to front. "It's a difficult site to work with," says Langis. "We struggled with the grade."

AESTHETIC INTEGRITY

Another concern was aesthetic. Could the Brown design team preserve the town's historic seaside character with traditional forms and building materials? The building location is a downtown gateway, destined to be

a landmark for arriving tourists. Brown says no worries. "This building proves you can create high quality design with ICF. The building skin is extraordinarily important." The finished exterior will be a sand texture stucco finish in an off-white taupe, consistent with a coastal aesthetic.

The building only has electric heat, another interesting twist given the perception that it's not enough to keep up with cold New England winters. "MEP engineers looked into it and were insistent ductless mini-splits were sufficient because of the building's mass." The units are quiet, efficient, and comparatively easy to install.

POSITIVE BUZZ

Even the permitting was a bit of a surprise. Whatever pushback they expected gave way to rapid recognition of a superior construction method true to the town's architectural heritage. "The permitting process was pretty straightforward. When even the building inspector is excited by the project, you know there's a good buzz going on around town," adds Langis.

Now that construction is well underway, the two architects can relax. "We were uncomfortable at the start," concedes Brown. "The owner pushed us, forcing us to think outside our comfort zone. I'm grateful for that."

Learn more about how ICF can help you extend development opportunities with noise resistive concrete at https://buildwithstrength.com.

Produced by Hanley Wood Strategic Marketing Services Group
hanleywood.com

Products: Outdoor Hospitality

TEXT BY PAUL MAKOVSKY

With outdoor living more desirable than ever, many people are using their exterior spaces as an extension of their interiors, whether for work, relaxation, or play. These 15 products span a range of applications—from residential backyards and commercial settings to public spaces—aiming to increase productivity, creativity, and happiness.

Mediterrània Lamp, Bover
This LED pendant fixture, created by Spanish designer Alex Fernández Camps, pays homage to the light of the Mediterranean. When turned on, the bright LED lamp casts light upward while also sending beams of direct light that peek out through openings in its curving fabric shade. *bover.es*

Weatherproof Custom Cabinets, DeepStream Designs
This pool-towel issue and return cabinet is built with waterproof, recycled HDPE plastic with a birch-wood color and grain, anodized aluminum extrusions, and 316 grade stainless steel hardware and feet. With no paint or powder coating to fail, users can pressure clean the cabinet for sanitation, and all parts are replaceable—backed by a lifetime structural warranty and Deepstream's Core Replacement Program. *deepstreamdesign.com*

Flex Neon, PureEdge Lighting
Suited for both indoor and outdoor use, this versatile lighting system is composed of IP65-rated, up-down-bending or left-right-bending silicone extrusions. The flexible LED strips are ideal for illuminating pools, patios, outdoor structures, interior walls, and coves with straight lines or curves. Made of fade-resistant silicone, Flex Neon is optically clear and available with a flat or rounded lens in seven static white color temperatures, and RGB and RGB+W diodes. *pureedgelighting.com*

>

Typology Collection, Landscape Forms
This sculptural collection of outdoor seating and lighting was designed in partnership with the BMW Group's Designworks studio. It includes a concrete ribbon bench—made of modular segments that allow the bench to meander seamlessly through a space—and LED path lights, in addition to ring lights and stick lights to round out the options. *landscapeforms.com*

The Bruselas Collection, Porcelanite Dos
Ceramics inspired by traditional building materials such as marble have been modernized to adapt to the contemporary styles of 2020. Porcelanite Dos, a Tile of Spain manufacturer, has created a glazed stoneware tile with Bruselas that emulates marble with a convincing intensity and can be used for floors, walls, and façades. *porcelanite.es*

Essentials Collection, Brown Jordan Outdoor Kitchens
Inspired by recent art and design trends, this collection of steel finishes comprises 13 powder-coated colors for Brown Jordan Outdoor Kitchens. The palette spans from bright hues—including chili (shown here), mint, and cotton candy—to supporting neutrals and more. *brownjordanoutdoorkitchens.com*

Site-Sizable Linear Drain, Infinity Drain
Infinity Drain's Site Sizable linear drains can be cut on-site to create custom lengths for outdoor and indoor applications. Available in threaded and non-threaded outlets, 90° angle joiners, straight joiners, and custom fabrication, the channels and grates can be ganged together by designers to create custom installations. *infinitydrain.com*

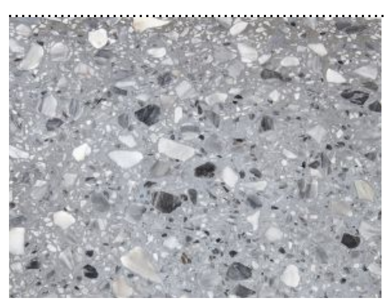
Flindt Garden Bollard, Louis Poulsen
This sculptural bollard was originally created by Danish designer Christian Flindt for a park next to the Kunsthal Brænderigården in Viborg, Denmark, but it works in any outside living space. The light fixture is scalable in height and available in three different mounting options and two finishes: natural painted aluminum or powder-coated corten colored. *louispoulsen.com*

**Products:
Outdoor Hospitality**

Sunbrella Contract Collection, Wolf-Gordon
Wolf-Gordon's two Sunbrella collaborations, Riley and Stella, are woven in a blend of acrylic and polyester, with UV-stable pigments that are resistant to fading and the degrading effects of sunlight. The playful Riley pattern is inspired by the Op art style of English painter Bridget Riley, and Stella adapts the bold graphics and colors of Frank Stella's 1968 *V Series*. *wolfgordon.com*

Gendai Black Wood, Nakamoto Forestry
This sleek, all-black siding features wood-grain details and is the most commonly specified of Nakamoto Forestry's *yakisugi* cladding for exterior applications. A light brushing process knocks down the heavy soot layer, leaving a smooth, silky appearance. The burnt fiber crevasse shadows are subtle, and users can install Gendai Black Wood with or without an oil prefinish. *nakamotoforestry.com*

Wind Pendant, Vibia
Created by Spanish lighting designer Jordi Vilardell, this pendant is made with a hand-woven fiberglass, drum-shaped shade in brown, green, or ochre red. The delicate fixture emits light from a diffuser that peeks through the webbing. Also available as a floor lamp, Wind is suitable for wet environments. *vibia.com*



Fragments Terrazzo Collection, Walker Zanger
This collection, offered in large 24"-square tiles, combines the composite characteristics of classic terrazzo tiles seen in 16th- and 17th-century Venetian palazzos with modern shades of gray, white, and black. *walkerzanger.com*

Equinox Cabana With Automated Louvered Roof, Tuuci
Made of marine-grade, corrosion-resistant aluminum and stainless-steel components, the Equinox Cabana has an automated louver system that can offer shelter for optimal outdoor comfort. The continuous 135° range of the louvers provides the desired amount of shade and ventilation throughout the day. The cabana roof automatically closes when an optional rain sensor detects precipitation, and opens to protect against excessive snow loads when a built-in temperature sensor detects temperatures below 32 F. *tuuci.com*

Products:
Outdoor Hospitality

Costa Outdoor Chair, Andreu World
This lightweight, stackable chair features a tubular metal structure with a four-leg base and double woven banding on the seat and backrest, which provide comfort and evoke classic designs. The Costa Outdoor collection includes chairs and lounge chairs, all with or without arms. The frame is available in either white or earth brown, and the woven band fabric comes in four complementing colors. *andreuworld.com*

Artforms Panel System, Belgard
This budget-friendly, flexible modular concrete panel system can be configured to create customized outdoor layouts with various shapes and volumes. Made of high-quality concrete, the panels install horizontally or vertically, making them ideal for benches, barbecues, counters, fireplaces, planters, and privacy walls, among other projects. As the interior is hollow, lighting can be installed within the system, and the 6"-wide cap includes a dovetail where wiring can be run. *belgard.com*

Residential:

Nesika Illahee
Portland, Ore.
Carleton Hart

TEXT BY MADELEINE D'ANGELO

Set apart by its vibrant façade, Nesika Illahee is the first affordable housing project in Portland, Ore., with units reserved for Native American residents.

JOSH PARTEE

Nesika Illahee was designed to send a message. With a name that means "Our Place" in the Chinook language, this affordable housing development in the Cully neighborhood of Portland, Ore., honors the city's Native American community. Twenty of the project's 59 units are reserved for members of federally recognized tribes, and the building itself features colorful cladding and prominent artworks, including an intricate mural by Yakama Nation artist Toma Villa and a basalt sculpture by Lillian Pitt, a Native American artist from the Pacific Northwest. Thanks to funding from the Confederated Tribes of Siletz Indians, the 53,024-square-foot, $10.1 million project marks the first time that an Indian Housing Block Grant—the U.S. Department of Housing and Urban Development's funding for affordable housing in Native areas—has been used for off-reservation housing.

Designed by the local firm Carleton Hart, Nesika Illahee was developed in partnership with Portland's Community Development Partners, the city's Native American Youth and Family Center (NAYA), the Native American Rehabilitation Association of the Northwest (NARA), and the Confederated Tribes of Siletz Indians. The project builds upon Generations, a 40-unit affordable housing low-rise, completed in 2017, that the firm designed with NAYA. We learned "the importance of bringing the community to the table early in the process," says Brian Carleton, AIA, the firm's co-founder and principal.

For Nesika Illahee, Carleton Hart held weekly meetings with community representatives from NAYA and NARA through the schematic design and design development phase and bi-weekly meetings through the construction documents phase. The firm incorporated feedback—such as the importance of supportive spaces for tenants—that was carefully gathered "by a Native consultant who has a ton of experience working directly with clients," says Oscar Arana, NAYA's director of community development.

Carleton Hart based its design on organic forms, drawing inspiration from Northwestern salt outcroppings for the building's interior and exterior massing. "It's about the community, about the context, and about connections ... with each other, but then also connections with the land," says Julia Mollner, AIA, an associate and project architect.

Hoping to ensure that the project was "open to multiple tribes and multiple cultures," the firm favored neutral tones and natural materials, avoiding colors and patterning that might show "preferential treatments to

> *To see more images and project credits for Nesika Illahee, visit bit.ly/ARnesika.*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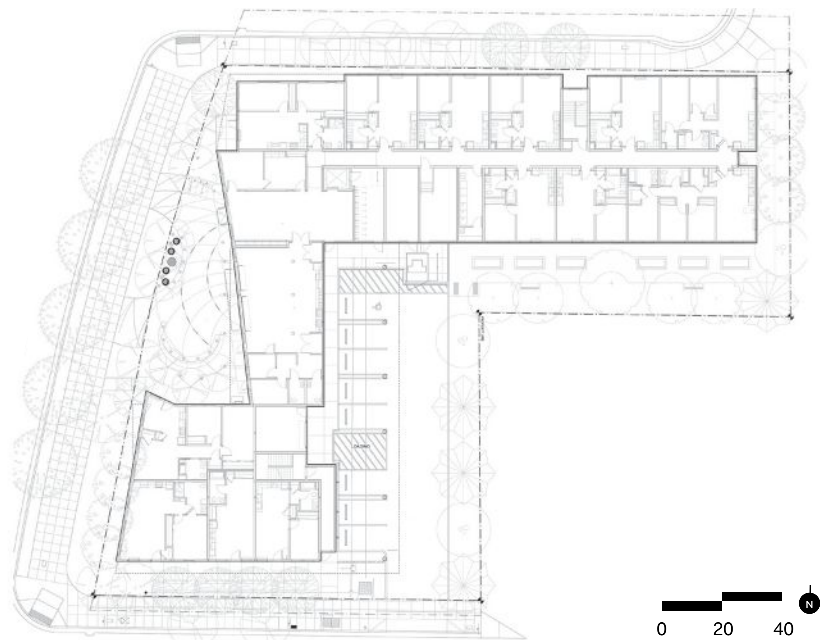
Residential: Carleton Hart

Ground Floor Plan



Chinook, Siletz, or anyone else," says Martin Segura, AIA, an associate and project manager at the firm.

Inside, the design team tailored the wood-framed project to formerly unhoused residents and those in recovery from addiction, designing wellness rooms for private counseling and an airy community room on the ground floor. Accordion doors in the room blur the line between interior and exterior, emphasizing a connection with the outdoors. The team organized the community areas carefully, placing the resident services coordinator's office near the front entrance. "We were trying to create spaces where the resident services coordinator has to engage with the tenants as they come in," Arana says. One of the questions was, "How do we create a space where folks are constantly seeing each other, running into each other, talking to each other, and communicating with each other?"

On the upper floors, birch-panel signs with room numbers adorn the individual units, which cater to intergenerational families. The design team included the framework for communicating doors between multi-bedroom units and neighboring studio apartments, allowing for an easy connection between adjoining rooms.

Since its completion last year, Nesika Illahee has filled, with 93% of its households headed by residents identifying as members of the Native American community. "What we've learned through this work with NAYA is the success of bringing a culture to be visible and tactile," Carleton says.

1. A wooden slat ceiling adds an organic element to the community room, which also includes a teaching kitchen. **2.** A basalt sculpture by Lillian Pitt—a Native American artist from the Pacific Northwest—and natural herb gardens anchor the entry plaza. **3.** Individual apartments include clear-finished wood cabinets and trim, and thermal control.

JOSH PARTEE


GLASS HAS A NEW DAY JOB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NEW
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Dryer Vent with Flapper Damper
Model: SFB-P
Dryer Vent with Flapper Damper
Model: SB
Dryer Vent with Flapper Damper
Model: KX
Vent Cap
Model: SFZC
Dryer Vent with Butterfly Damper

CarbonPositive: Accelerating the 2030 Challenge to 2021

TEXT BY EDWARD MAZRIA, FAIA, AND VINCENT MARTINEZ, HON. AIA

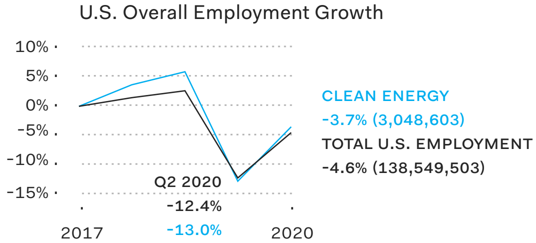
In 2005, Architecture 2030 issued the 2030 Challenge. The initiative comprised incremental carbon-reduction goals over a 25-year timeline that were consistent with those called for by the global scientific community at the time. Meeting the targets would mean that all new buildings and major renovations would be carbon neutral by 2030. That is, the projects would use no on-site fossil fuels, including natural gas and heating oil; instead, they would be 100% powered by on-site and/or off-site renewable energy.

However, current data from the scientific community has made it clear that 2030 is too late. To meet the 1.5°C carbon budget, all new buildings and major renovations must be designed to be carbon neutral *today*.

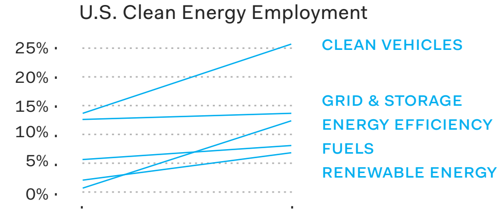
U.S. 2020 Employment and 2017–2019 Growth by Occupation

OCCUPATION	EMPLOYMENT	GROWTH
Heavy and Tractor-Trailer Truck Drivers	1,797,710	6.18%
Clean Energy Sectors	3,048,603	6.01%
Customer Service Representatives	2,833,250	5.47%
Lawyers	658,120	4.58%
Engineers	1,673,440	3.93%
Registered Nurses	2,986,500	2.60%
Retail Salespersons	3,659,670	-2.79%

U.S. Overall Employment Growth



Fastest Growing Sectors in U.S. Clean Energy Employment



The Significance of a Half-Degree

The 2015 Paris Agreement established the goal of keeping planetary warming to below 2°C while pursuing efforts to limit it to 1.5°C. Since then, the world has been quickly depleting this 1.5°C carbon budget. Limiting planetary warming to 1.5°C rather than 2°C is critical. That additional 0.5°C difference in warming means that 1.7 billion more people will be exposed to severe heat waves every five years, 100 to 400 million more people will be at risk of hunger, and 1 to 2 billion more people will no longer have adequate water. The world can also expect more extreme droughts, precipitation, flooding, and vector-borne diseases, among other catastrophic effects.

The Future Is Here

In its strongest warning yet, the International Energy Agency called for the world to *stop all new gas, oil, and coal development this year* to have a chance at meeting the Paris Agreement 1.5°C limit. For that to happen, we need an immediate and fundamental global shift in the way we plan and design the built environment.

For architecture, engineering, and planning (AEP) professionals, this means designing and renovating buildings and developments to operate with only renewable energy produced on-site and/or procured off-site. No on-site fossil fuels are allowed.

Achieving carbon-neutral new buildings today is not as difficult as it may have once seemed. The knowledge and technology are available in all climates, and the health, economic, and environmental benefits are well documented. Carbon-neutral buildings are even supported by current building energy codes—namely the national and international ZERO Code (which uses ASHRAE 90.1-2019 as its base energy efficiency standard) and the 2021 International Energy Conservation Code. Both yield highly efficient buildings that, when coupled with renewable energy for building operations, result in zero CO_2 emissions.

The global AEP community has an extraordinary opportunity to lead efforts on mitigating climate change. It is, in short, the ultimate design project for the common good.

SOURCE: "CLEAN JOBS AMERICA 2021," ENVIRONMENTAL ENTREPRENEURS, APRIL 2021

> *To read more articles by Architecture 2030, visit bit.ly/ARcarbonPos.*

ROOFING SHINGLES THAT

Reduce Roof Heat with Solar Reflective Technology

Roof cooling colors reflect ultraviolet (UV) rays to help reduce solar heat entering the home, supporting efforts by the Cool Roof Rating Council, (CRRC) Climate Resolve, and the State of California to conserve energy and improve air quality.

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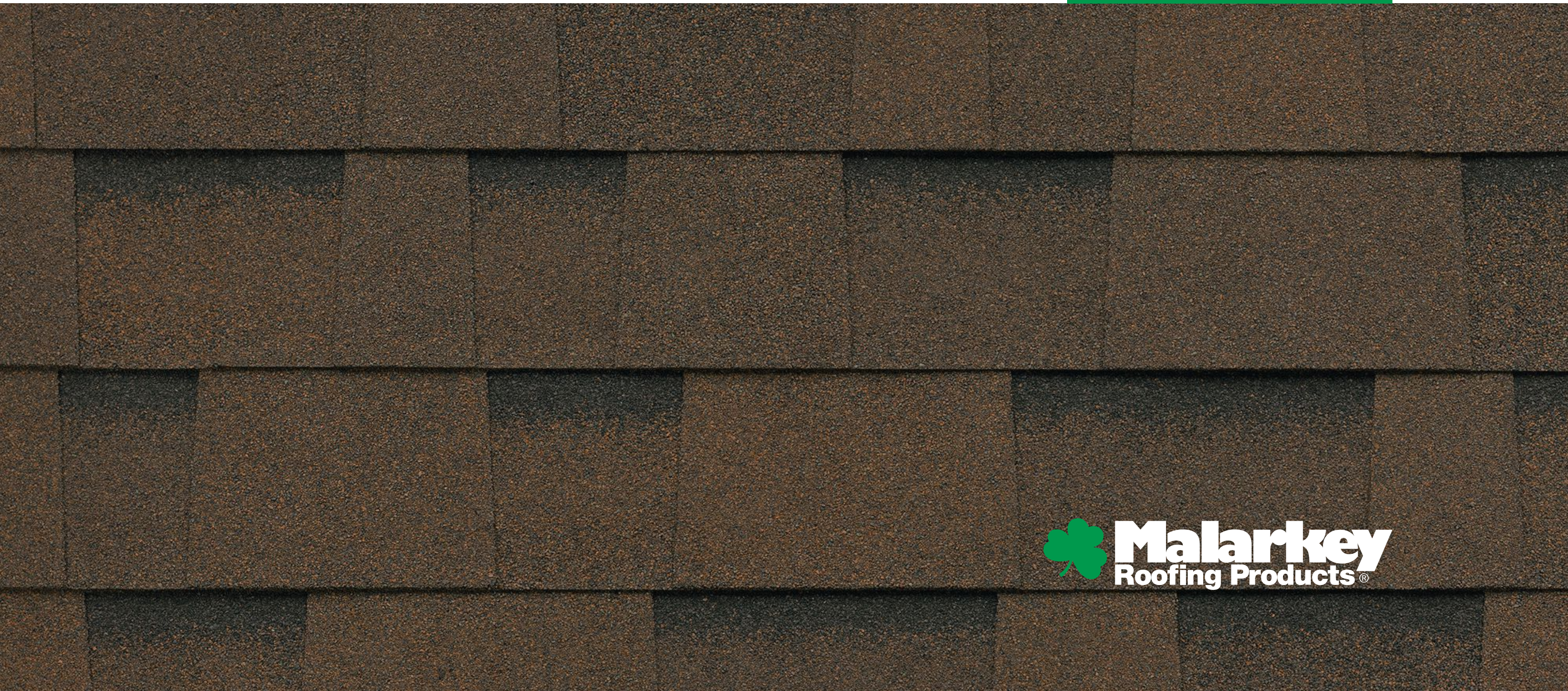

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Next Progressives: Precht

EDITED BY ERIC WILLS

Location:
In the mountains of Austria near Pfarrwerfen

Year founded:
2016 (originally founded as Penda in 2014)

Firm leadership:
Fei and Chris Precht

Education:
Chris: Master's degree from the Technical University Vienna;
Fei: Master's degree from the University for Applied Arts Vienna

Experience:
The Beijing office of Graft

Firm size:
6, like a small band

What led to the founding of the firm:
The typical architectural love story. Meeting in an office, falling in love, founding our own office.

Defining project and why:
I would say Bert, the tree house. Three years ago, we started the journey of designing Bert without a client. After a round of publications, we found our first client, with whom we realized the first four Berts. This allowed for an open and transparent process, because we had fully developed the project beforehand, and when the client came on board, everything was in place to move forward. We knew the details, the project costs, the timelines. As it is a modular build, we can adapt it to a client's wishes within hours. That flips the usual business model of an architect on its head.

Another important project:
The Farmhouse, a modular building system that combines living and gardening, started in a similar way to Bert, with three years of self-funded development until a client came on board. Now we are developing the first Farmhouse for Montreal. With increasing obesity and diabetes, a healthy diet is crucial and this starts by knowing where your food comes from and how it was grown. With the Farmhouse, we make this process visible in the city.

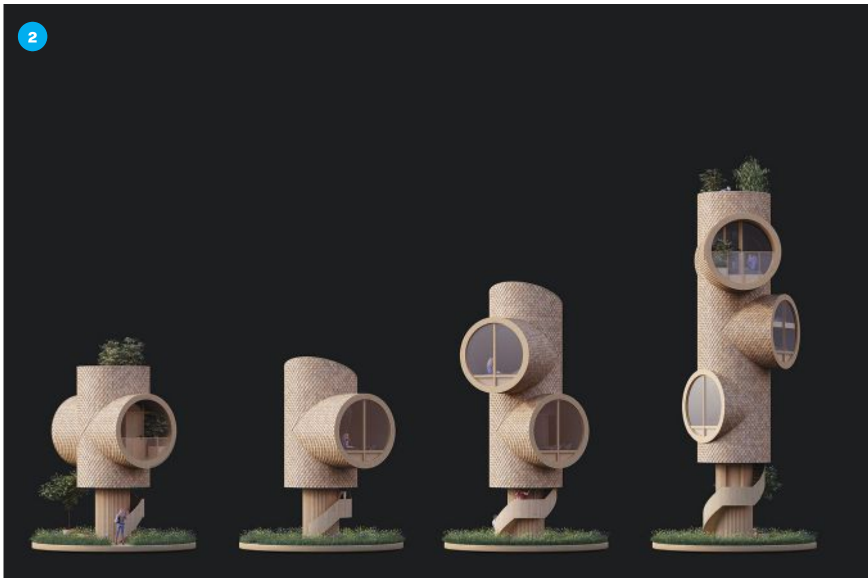
Personality of the practice:
Nature and the impact of a building are always on the forefront of our design process. I think that was shaped by my [Chris's] father. My dad was a free-solo climber and I basically grew up with him on the mountains. A love for our natural environment and a respectful dialogue with nature profoundly influenced me. The question of how we can create something artificial like a building but also respect nature at the same time is a key element in our work. We try to create buildings that connect people to nature—buildings that connect to all our senses with ecological materials we want to touch. With gardens and plants, you can eat and smell. Buildings you can hear because bees and birds are part of their ecosystem. We try to create sensible buildings that make you feel alive.

Ambitions for the firm in the coming five years:
We started under a different name in Beijing and moved our studio to the mountains a few years ago. I have learned in the countryside that success is a matter of definition. In Beijing, success meant for me to grow my team, the size of projects, and our fame. But a constant growth brings a growing responsibility and that made me feel like a hamster in a running wheel. The last three years, I've defined success differently. I don't need to be a rich architect, nor do I need to be a famous architect or the one with the biggest projects. My goal is to be a happy architect instead. For us, that means to work with a couple of great people on a couple of good projects and focus on a healthy work-life balance.

COURTESY PRECHT

> *For more about Precht, visit bit.ly/PrechtNextProgressives.*

Next Progressives:
Precht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1


2

1, 3, 4, 5, 6: COURTESY PRECHT; 2: CHRISTIAN FLATSCHER

1. The Hongkun Art Auditorium in China, located next to the neighboring Hongkun Museum of Fine Arts, also designed by the firm, is centered around an "art box" that includes an auditorium adorned by arches and mirrors. **2.** Bert, a modular housing system based on the design of a tree house, fosters a connection to nature with its leaf-like shingles and large circular windows. **3.** Rice Pad, located on the rice terraces of Guangxi in China, puts a modern twist on traditional stilt buildings. **4.** The Prechts, who grow most of their own food on an Austrian mountainside, designed the Farmhouse to create a similar reality in the city. The modular design uses cross-laminated timber and recycles wastewater that can irrigate crops in the building's greenhouse, with the basement used as a composting station. **5.** The Tree Tower in Toronto, an 18-story modular design inspired by the Habitat 67 project in Montreal by Moshe Safdie, FAIA, favors wood over steel and concrete, relying on prefabricated CLT panels to help reduce carbon emissions. **6.** The Tel Aviv Arcades, an 18-story condo tower, features private and communal arched terraces that help shade the interiors and also open them up to the city outside.

Opinion: Everyone Wants to Be a Savior

TEXT BY CRUZ GARCIA

In their 2012 article "Decolonization Is Not a Metaphor," Eve Tuck and K. Wayne Yang reference "settler moves to innocence," in which people will do gestures to make them feel better about themselves without actually giving any power in exchange. There need to be real, fundamental, and structural changes to the economy and education.

We need solidarity and anti-hegemonic, anti-capitalist, and anti-racist discourses and practices. Marginalized groups are in the most precarious state because of employment issues and lack of accessibility. People who are running the institutions are not going to give power away voluntarily. That has never happened in history. Who of us are allowed to fight? In this country, we have seen little improvement other than sugarcoating the grim reality and the usual declaration: "Yes, we are committed to diversity, equity, and inclusion"—three abstract terms that could mean anything and address nothing in particular.

On one hand, there need to be an institutional reflection and a true commitment to change, where we say this doesn't work and we have to change the way that we operate. That's fundamental. We're talking about tuition fees, licensure processes, who gets to be called what, who is allowed to dream of a better future, who can afford it.

On the other hand, there needs to be self-criticism. What's most dangerous are people who think that they're doing good, but they're not. People who see no problem taking a commission from a Black designer for something that they shouldn't be doing because, 99% of the time, they don't even need those projects—they already have other projects. They are central to these systems of exclusion.

If you're openly racist, it is quite easy to know that we completely disagree. But the problem comes when we are allies trying to dismantle this together and then find we are actually perpetuating these systems through "moves to innocence" that reconcile the security of the settler, white supremacy, and heteropatriarchy without acknowledging our role in it.

In the public discourse, everybody says, "I'd like to move forward." But when you see how they act and operate in architecture studio or in school—there's no space for Blackness or Indigeneity or anything that doesn't fit the white-heteropatriarchal and capitalist gaze. And then it's up to us to figure out how we change it. There's no power being conceded. That's our current situation: Everybody wants to be a savior, but nobody wants to give power away.

Working for institutions can be counterproductive, even for me and my partner, Nathalie Frankowski. But we are also within a system that makes it almost impossible to operate in any other way. Now legislation is being passed against critical race theory. At the same time, a bunch of anti-abortion laws are happening too. We cannot look at them as separate issues. They are part of the same beast.

We can talk about form, representation, humor, and theory too—ideas central to our work—but institutions sometimes just want us to talk about oppression and marginalization without recognizing the additional emotional labor that goes into it.

In a way, this forces us to do a certain type of work at the expense of being free, which is what white men can mostly do. Nobody's asking them, "What are you doing today to dismantle white supremacy?" They can just go about their lives.

When people don't have to deal with pressing issues, they have a luxury of ignorance and a luxury of irresponsibility. That's where the power dynamics are really reflected: Even if you don't care, everything you do affects somebody else. And sometimes if you care a lot, everything you do doesn't affect anybody.

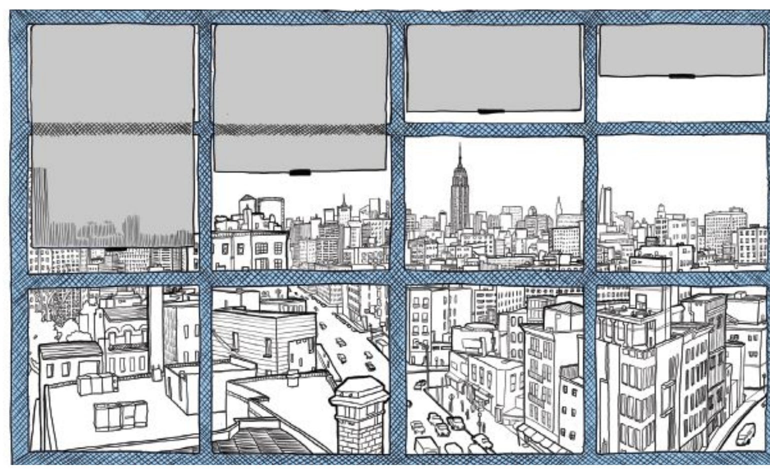
Cruz Garcia is a co-founder of WAI Architecture Think Tank and an associate professor at Iowa State University.

CAT PIPER AND WAI ARCHITECTURE THINK TANK

> *Read the full text of Cruz Garcia's essay "Everyone Wants to Be a Savior—Without Giving Up Power" at bit.ly/ARgfWAI.*

Architectural Lighting: *Visual Delight in Architecture* Review

TEXT BY DAN WEISSMAN, AIA



Views from National Audubon Society office in New York

GARTH VON AHNEN FROM PHOTOGRAPH BY LISA HESCHONG

Humans are innately programmed to observe their surroundings from a protected location of elevated perspective. Buildings can offer this opportunity, yet they often do the opposite, enclosing us in an environment mediated by mechanical systems. What is a view worth? And, importantly, who is allowed to reap the view's benefits?

These inquiries have practical and political implications, which Lisa Heschong, AIA, explores in *Visual Delight in Architecture: Daylight, Vision, and View* (Routledge, 2021). The architect and co-founder of Heschong Mahone Group writes that throughout her career, she has sought to answer two questions: "What are the potential cognitive benefits of looking out a window? And, how might exposure to natural daylight, either via a window view or as part of the ambient illumination of a space, interact with those effects?"

In some respects, *Visual Delight* serves as a follow-up to Heschong's seminal text *Thermal Delight in Architecture* (The MIT Press, 1979). However, unlike its predecessor, *Visual Delight* casts a wide net across many subtopics, diving deep with anecdotes that illustrate Heschong's penchant for interdisciplinary study. Written in a manner accessible to a layperson, the text is both a meditation on innate biological desires and experience and a practical bridge between architectural practice and research in vision, perception psychology, social sciences, mathematics, and building science from the last three decades.

The exploration of *who* is allowed access to daylight and views emerges as one of *Visual Delight*'s most striking undercurrents. Access to these amenities—and ultimately to quality architecture—is enmeshed with social status and equity. The consequences of limited access, whether it be from sitting in a poorly designed school or working in back-of-house space for a 12-hour shift, are consistently and disproportionately felt by people of color.

In the early 1990s, windowless classrooms had been standard practice for decades, kicked off by questionable studies conducted by the University of Michigan in the early 1960s where, as Heschong explains, mostly white male school administrators conjectured that reducing or eliminating classroom windows would compel students to focus on the work rather than the view. Disregard of testimonials from teachers—mostly women—combined with the lack of stakeholders of color in the decision-making process, resulted in decades of windowless classroom construction and ultimately affected generations of Americans.

HMG, dismayed with structural roadblocks precluding daylight from entering educational buildings that it encountered in its own work, set out to upend school design and understand the impact of daylight and views on students. Its landmark 1999 study "Daylighting in Schools" found significant, quantitative performance improvements when students had access to both. The study made huge

> *To read more stories about lighting design and to access the* ARCHITECTURAL LIGHTING *archive, visit bit.ly/ArchLighting.*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Architectural Lighting: *Visual Delight in Architecture* Review

GARTH VON AHNEN

waves in the architectural community. "It was a remarkable achievement to put the social impact of architectural design into this wider context," Heschong writes in *Visual Delight*.

On the other end of the economic spectrum are populations who have exploited society's belief that one can "own" a view, either through prohibiting development within a viewshed from a property or in the act of building taller. Many urban skylines have changed as the ultrawealthy seek ever-grander views and access to daylight, at the direct expense of the quality of light and views attainable from below. "Perhaps part of this intense sense of ownership of use is predicated on the fact that it is … possible to permanently block a view, i.e., to physically restrict access to who is allowed to partake of a particular view … ," Heschong writes. "[F]ew other environmental pleasures are so entwined with our system of property rights."

Visual Delight is also part solarpunk nonfiction. The book offers road maps for deploying architectural research as a bridge to a more sustainable future while critiquing cyberpunk concepts emerging in architecture's present-day, such as artificial windows made of high-resolution digital screens. Heschong questions the validity of such technological alternatives to real daylight and views access not merely as a philosophical quandary but also as a scientific one. While studies have found digitally created windows are marginally better than no window access, she writes, the faux versions simply do not offer the same brain stimulation as the real thing.

Visual Delight is at home in the library of a student, emerging architect, or seasoned practitioner. It offers a fresh take on topics explored in William Lam's *Perception and Lighting as Formgivers for Architecture* (McGraw-Hill, 1977) and *Sunlighting as Formgiver for Architecture* (Van Nostrand Reinhold, 1986). (Lam was the founder of my current employer, Lam Partners.) Architects will learn of worthy precedents for post-occupancy research. The book may also find utility with non-architects, including stakeholders making financial or programmatic decisions for building construction or renovation; academic administrators seeking research to support the optimization of daylighting and views for their students; and companies wanting to understand the benefits for their employees or their product sales.

Reading *Visual Delight* is like experiencing Heschong sharing stories around a campfire. The book imbues the next generation of solarpunks with her knowledge while regaling lay readers with the sublime phenomena of our universal experience of the world through our visual system, and the relationship between high-order mathematics and the structural qualities of views. It is these contemplative ponderings that truly elevate the book.


Brick Color: Manganese Ironspot
Paul and Linda DeBruce Hall
Kansas City, MO

ARCHITECT
The Journal of The American Institute of Architects

Brands Architects Use

The latest ARCHITECT BRAND USE STUDY reveals the manufacturers and products that are specified the most by architects.

The second ARCHITECT BRAND USE STUDY gauges the attitudes of U.S. architects toward the products they recognize, use, and trust, as well as the factors influencing brand selection. More than 1,300 respondents from across the country shared their brand use practices and perspectives, allowing us to shed light on the year's leaders across 51 categories. The study also asked architects about new construction and renovations they were billing for as well as the kinds of project types they were working on, and even the percentage of LEED-certified projects they've worked on. Read on to discover the top-ranked brands architects use the most in each product category.

Top three typologies by each region

- **South**
  - RELIGIOUS
  - GOVERNMENT
  - HEALTHCARE
- **West**
  - HOTEL/LODGING
  - PUBLIC SAFETY
  - RESIDENTIAL
- **Northeast**
  - RESIDENTIAL
  - EDUCATION
  - OFFICE
- **Midwest**
  - MANUFACTURING
  - HEALTHCARE
  - RELIGIOUS
- **Not in the U.S.**
  - HOTEL/LODGING
  - RESIDENTIAL
  - RECREATION/AMUSEMENT

> A full breakdown of the study's product preferences is available at ARCHITECTmagazine.com.

Zonda Media

A

Architectural Trim/Decks/Railings
- James Hardie 33.7% ◁
- CertainTeed 18.9% ◀◁
- C.R. Laurence Co. 12.9%

Cable/Rail Systems
- C.R. Laurence Co. 36.2% ◀◁
- Feeney 8.3%
- HDI Railing Systems 7.3%

Carpet/Carpet Fibers
- Shaw Floors 21.7%
- Mohawk Group 18.0% ◀
- Interface Inc. 14.3% ◁

Ceiling Systems
- Armstrong 47.9% ◀◁
- USG Corp. 22.3%
- Fry Reglet 6.2%

Commercial Plumbing Products/ Washroom/Hardware
- Kohler 26.1% ◀◁
- Bobrick 14.0%
- American Standard 12.2%

Concrete
- W.R. Grace & Co. 15.2% ◁
- Laticrete 12.6% ◀
- Sika Corp. 12.1%

Daylighting/Solar Control
- Lutron Electronics 16.6% ◁
- Velux 12.1%
- MechoShade Systems 10.3%

Design Software
- Revit 41.8% ◁
- AutoCAD 35.0% ◀
- SketchUp 8.6%

Dishwashers
- GE Appliances 26.5%
- Bosch 11.1% ◁
- Whirlpool 9.4%

Door Hardware & Locksets
- Assa Abloy 23.6% ◁
- Allegion (Schlage Lock) 18.4%
- Emtek 6.6%

Doors: Wood
- Assa Abloy 25.4% ◁
- Pella Corp. 13.7% ◀
- JELD-WEN 11.7%

EIFS/Stucco
- Dryvit Systems Inc. 34.9% ◀
- Sto Corp. 21.7% ◁
- Quikrete 12.3%

Elevators/Lifts
- ThyssenKrupp Elevator 34.1% ◁
- Otis 18.8% ◀
- Schindler Group 15.9%

Entrances/Storefronts
- Kawneer 48.5% ◀
- C.R. Laurence Co. 6.3%
- EFCO Corp. + NanaWall 6.3%
- Oldcastle BuildingEnvelope 5.8%

Exterior Cladding
- James Hardie 36.0% ◀◁
- Owens Corning 12.7%
- Oldcastle APG 6.1%

Fans: Commercial/Industrial
- Big Ass Fans 38.6% ◀◁
- NuTone 14.9%
- Panasonic 10.9%

Faucets
- Kohler 34.8% ◀◁
- American Standard 15.7%
- Delta 8.1%

Floor Tile
- Daltile 31.7% ◀
- Armstrong Flooring 14.4%
- Porcelanosa 6.7%

Floors: Resilient & Wood
- Armstrong Flooring 24.5% ◀
- Shaw Floors 12.8%
- Johnsonite/Tarkett 10.2%

Furniture/Systems Furniture
- Herman Miller Inc. 18.6% ◀◁
- Steelcase 18.0%
- Knoll Inc. 17.0%

LEGEND
- ■ Brand used the most by architects
- ■ Second most popular brand used
- ■ Third most popular brand used
- ◀ Top brand familiarity
- ◁ Brand with the highest overall quality rating

Glass
- PPG Industries 23.4% ◂
- Vitro Architectural Glass (PPG Industries) 10.6%
- Viracon 10.1%

Glazed Curtain Walls
- Kawneer 46.4% ◂◂
- C.R. Laurence Co. 7.7%
- YKK AP America 5.6%

Heating/Ventilating/Air Conditioning
- Trane Technologies 20.6%
- Carrier 13.1% ◂
- Mitsubishi Electric 11.6% ◂

Insulated Concrete Forms
- Fox Blocks 9.9% ◂
- Logix 9.9% ◂
- Nudura 7.3%
- Syntheon 4.2%

Interior Walls/Partitions
- Kawneer 22.9% ◂
- Steelcase 17.2% ◂
- C.R. Laurence Co. 14.6%

Lighting: Controls
- Lutron Electronics 39.9% ◂◂
- Leviton Mfg. Co. 10.6%
- Philips Lighting Controls 7.1%

Lighting: Indoor
- Lightolier (Signify) 12.7% ◂
- Halo Commercial 7.4%
- Juno 6.3%

Lighting: Indoor/Outdoor
- Lithonia Lighting 14.0% ◂
- Juno 4.7%
- Focal Point 4.1%

Lighting: Outdoor
- Assa Abloy 23.6%
- Allegion (Schlage Lock) 18.4%
- NONE OF THE ABOVE 6.6%

Manufactured Stone
- Caesarstone 25.4% ◂◂
- Eldorado Stone 18.0%
- Cultured Stone 11.1%

Metal Coatings
- Sherwin-Williams 53.8% ◂
- PPG Coatings 23.1% ◂
- Valspar 5.4%

Metal Frames/Doors
- Kawneer 19.6% ◂◂
- Assa Abloy 15.6%
- JELD-WEN 7.8%

Metal Walls/Roofs
- Fry Reglet 11.7%
- Alucobond 10.0% ◂
- PAC-CLAD 7.8%

Paints/Finishes
- Sherwin-Williams 52.2% ◂◂
- Benjamin Moore 22.5%
- PPG Architectural Coatings 7.3%

Product Directory/Specifications
- AIA MasterSpec 47.8% ◂◂
- Sweets/McGraw-Hill 12.6%
- ARCAT 9.9%

Range Hoods
- GE Appliances 19.4% ◂
- Wolf Appliance Inc. 10.0% ◂
- Viking Range 9.4%

Ranges/Cooktops
- GE Appliances 23.7% ◂
- Wolf Appliance Inc. 10.8% ◂
- KitchenAid 7.5%

Refrigerators
- GE Appliances 24.9%
- Sub-Zero 18.6% ◂◂
- KitchenAid 9.0%

Roofing Membrane
- Firestone Building Products 19.9%
- Carlisle SynTec Systems 12.2% ◂
- CertainTeed 10.5% ◂

Skylights
- VELUX America 28.7% ◂
- Andersen Windows 16.9% ◂
- Marvin Windows & Doors 12.4%

Solid Surfaces
- Wilsonart 21.3%
- DuPont Corian 19.1% ◂◂
- Silestone 12.6%

Tensile Fabric Structures
- Birdair 17.3% ◂◂
- Fabritec 8.0%
- Tensile Fabric 6.2%

Thermal Moisture: Gypsum
- USG Corp. 59.0% ◂◂
- National Gypsum Co. 13.5%
- James Hardie 7.9%

Thermal Moisture: Insulation
- Owens Corning 28.1% ◂◂
- CertainTeed 17.4%
- Dow Corning 17.4% ◂

Thermal Moisture: Roof Insulation/ Underlayments
- Johns Manville 27.1% ◂
- GAF 20.3%
- GCP Applied Technologies (Grace) 15.8% ◂

Weather Barrier/Wrap
- Tyvek (DuPont) 40.2% ◂
- Huber Engineered Woods (ZIP System) 8.6%
- Henry Co. 5.7%

Window/Wall Treatments/Blinds
- MechoShade Systems Inc. 33.3% ◂
- Hunter Douglas 20.1% ◂
- Levolor 13.8%

Windows: Commercial
- Kawneer 39.8% ◂
- Marvin 11.9%
- Andersen Windows 8.5% ◂

Windows: Vinyl
- Pella Corp. 15.4% ◂
- Kawneer/Traco 14.9% ◂
- Milgard Mfg. 11.4%

Windows: Wood
- Marvin Windows and Doors 20.9% ◂
- Andersen Windows 20.3% ◂
- Zeluck Inc. 17.4%

Understanding Sealants and Their Impact on a Residential Structure in 2021 Using an LCA

Presented By:

covestro

LEARNING OBJECTIVES

1. Understand polyurethane, silicone, and silane-terminated polymer sealants and their use on residential structures, including chemistry and application.
2. Explore the concept of life cycle assessments (LCAs).
3. Review the methodology used in assessing the life cycle of a polyurethane sealant on a residential structure.
4. Examine the results and conclusions of this life cycle assessment.

CONTINUING EDUCATION

This course is approved for AIA Learning Unit Credit.

AIA Continuing Education Provider

Use the learning objectives to focus your study as you read this article. For details on the learning units or credit information, and to earn credit and obtain a certificate of completion, visit http://go.hw.net/AR08213 to view the entire CEU and complete the quiz. If you are new to Hanley Wood University, CEU courses are free of charge once you create a new learner account; returning users log in as usual.

By: Jay Johnston, Senior Scientist, Covestro LLC

UNDERSTANDING CAULKING AGENTS, SEALANTS, AND ADHESIVES

This continuing education unit will explore polyurethanes, silicones, and silane modified polymers, as each have properties that make them attractive as raw materials for adhesives and sealants. Sealants need to be flexible and durable, and each of these chemistries is widely recognized to provide these attributes, but with different sets of physical properties.

Before moving any further, let's define the primary differences between high performance sealants, adhesives, and caulking agents. Sealants and adhesives have been used for centuries, with the earliest incarnations made of natural materials such as tree sap, beeswax, and tar. Later, processed natural products, such as animal protein, resin, and natural latex, were used. The American Society for Testing and Materials (ASTM) defines a sealant as: "A material that has the adhesive and cohesive properties to form a seal." A sealant prevents something from passing through the seal—for example, air or water. ASTM D907-06 defines an adhesive as "a substance capable of holding materials together by surface attachment." Bonding is the joining of two substrates using an adhesive. Essentially, sealants should move with the substrate, while adhesives should hold the substrates tightly together. That being said, many adhesive technologies can be reformulated into sealants, which can improve a sealant's bonding performance.

High performance sealants fall between higher-strength adhesives at one end of the spectrum and extremely low-strength putties and caulks at the other. Putties and caulking agents serve one function: to fill a void. They have limited expansion and contraction properties. High performance sealants, on the other hand, fill a void or joint, bond to and move with the substrate, and prevent something from passing the seal. Polyurethanes, silicones, and silane modified polymers are examples of resins used to manufacture high-performance sealants.

Despite not having great strength, sealants do convey a number of desirable properties, and are particularly effective in keeping moisture in or out of the structures in which they are used. In addition, they provide thermal and acoustical insulation, may serve as fire barriers, and can also be used for smoothing or filleting. Sealants are often called upon to perform several of these functions at once. Sealants with strength properties are called structural sealants. Structural sealants transfer the load between substrates, seal the substrate at the bond line, and move with the joint to form a seal that prevents substances from passing beyond the seal such as air, water, and chemicals.

Besides the fact that sealants form a seal and adhesives bond substrates together, the main difference between adhesives and sealants is their physical properties. Sealants typically have higher maximum elongations, lower strengths, and lower modulus than do adhesives. When sealants are used between substrates having different thermal coefficients of expansion or differing elongation under stress, they must have adequate flexibility and elongation. Sealants generally contain inert filler material and are usually formulated like an elastomer to provide the required flexibility, elongation, and modulus.

Since the main objective of a sealant is to seal assemblies and joints, sealants need to have sufficient adhesion to the substrates and resistance to environmental conditions to remain bonded over the required life of the assembly. They may have a paste consistency to allow filling of gaps between substrates and low shrinkage after application is often required. Sometimes sealants are self-leveling to fill a depression flat or self-level to the height of the surrounding substrate.

No matter what the application, a sealant has three basic functions:

- It fills a gap between two or more substrates.
- It forms a barrier through the physical properties of the sealant itself and by adhesion to the substrate.
- It maintains sealing properties for the expected lifetime, service conditions, and environments.

PERFORMANCE TESTING OF SEALANTS

The desired physical properties of sealants are different than those of adhesives. In fact, they are exactly opposite. Sealants should have lower hardness (Shore A), greater elongation at the breaking point, a lower modulus, greater weather/UV resistance, and greater flexibility. Having a low modulus is one of the most important properties for a sealant. Modulus is the force required to elongate the sealant. The greater the stress required, the more force the sealant must endure without breaking, and the greater the adhesion required for the sealant to the substrate.

Sealant requirements extend beyond these physical properties. They must have excellent adhesion to a wide variety of substrates, such as metals, concrete, glass, and certain plastics. Sealants should be water resistant, paintable, have a fast skin over time (rain ready time), have no staining of porous substrates, and have low-VOC content to meet new regulations. It is also desirable for sealants to have low residual tack, and therefore low dirt pickup, and that they are easy to tool.

ASTM C834 and ASTM C920 are standards that sealants are typically designed to meet. ASTM C834 is the Standard Specification for Latex Sealants and covers latex sealants used for sealing joints in building construction. The specification outlines different types and grades of sealants, the physical properties to which the sealant must conform, and the specified requirements according to type and grade. Manufacturers should perform the following tests to ensure sealants meet the ASTM C834 Standard: extrudability after aging, artificial weathering, volume shrinkage, low-temperature flexibility, extension-recovery and adhesion, slump, staining, and tack-free time.

ASTM C920 is the Standard Specification for Elastomeric Joint Sealants. This specification covers the properties of a cured single- or multicomponent cold-applied elastomeric joint sealant for sealing, caulking, or glazing operations on buildings, plazas, and decks for vehicular or pedestrian use, and types of construction other than highway and airfield pavements and bridges. Manufacturers should perform the following tests to ensure that sealants meet the ASTM C920 Standard: extrusion rate, hardness, cracking, staining, adhesion and cohesion after cyclic movement, adhesion-in-peel, adhesion-in-peel after ultraviolet exposure, accelerated weathering effects, and exposure to continuous immersion (if chemical specified).

There are also ways to test the weatherability of sealants. The accelerated weathering tester simulates the damage caused by sunlight, rain, and dew. In a few

GLOSSARY

Adhesive—A substance capable of holding materials together by surface attachment

Functional unit—Defines the primary function fulfilled by a product system and determines the reference flow for calculating inputs and outputs

Life Cycle Assessment (LCA) —A compilation and evaluation of inputs, outputs, and potential environmental impacts of a product system throughout its life cycle

Polyurethane sealants—One component, moisture cure polyurethane sealants are typically known for their excellent durability, recovery, tear resistance, and chemical resistance; the polyurethane prepolymer reacts with moisture in the air to cure

Sealant—A material that has the adhesive and cohesive properties to form a seal

Silane terminated polymers—Polymers with a silane group at the end of the polymer chain; the backbone of the polymer is typically polyurethane-based, polyol-based, or silicone-based

UV accelerated tester —Exposes materials to alternating cycles of UV light and moisture at controlled, elevated temperatures; it simulates the effects of sunlight using special fluorescent UV lamps and simulates dew and rain with condensing humidity and/or water spray

Structural sealants—Sealants that transfer the load between substrates, seal the substrate at the bond line, and move with the joint to form a seal that prevents substances from passing beyond the seal such as air, water, and chemicals

Thermoplastic sealants—Thermoplastic sealants are comprised of a polymer dissolved or dispersed in solvent (including water) and there is no additional crosslinking

Thermosetting sealants—Thermoset sealants have a three-dimensional cross-linked network like an elastic fishing net and there are two types: one component (1K) and two component (2K) in which the components react together days or weeks, the UV tester can mimic the damage that occurs over months or years of outdoor exposure. Accelerated weathering testers simulate the primary weathering conditions that degrade adhesives and sealants outdoors, allowing manufacturers to simulate dozens of potential failure modes, including cracking, chalking, color change and fading, yellowing, loss of adhesion, shrinkage, and blistering.

To simulate outdoor weathering, the UV accelerated tester exposes materials to alternating cycles of UV light and moisture at controlled, elevated temperatures. It simulates the effects of sunlight using special fluorescent UV lamps and simulates dew and rain with condensing humidity and/or water spray. The UV accelerated weathering tester for adhesives and sealants is the weathering device relied on most by the sealants and adhesives industry because of its simulation of the critical short-wave UV portion of sunlight and aggressive moisture functions.

Since the main objective of a sealant is to seal assemblies and joints, sealants need to have sufficient adhesion to the substrates and resistance to environmental conditions to remain bonded over the required life of the assembly.

TYPES OF SEALANTS BY CHEMISTRY

Not all high-performance sealants are created equal, so this section will go over the key elements of each type by its chemistry. The chemical structure of sealants affects their performance and is the foundation for most sealant properties. Physical properties affected by structure include maximum elongation, tensile strength, tear strength, and modulus. Weathering resistance properties affected include UV, water, and temperature cycling. The structure also affects durability (movement under stress) and chemical resistance.

Thermosetting sealants have improved properties versus thermoplastic sealants. Thermoplastic sealants are comprised of a polymer dissolved or dispersed in solvent (including water) and there is no additional crosslinking during cure. Imagine separate strands of cooked spaghetti: these include solvent-based butyl sealants, solvent-based polyurethane sealants, and water-based acrylic sealants. Thermoset sealants, on the other hand, have a three-dimensional cross-linked network like an elastic fishing net and there are two types: one component (1K) and two component (2K) in which the components react together. 1K thermoset sealants simply react with ambient moisture (moisture cure = MC) and include 1K polyurethane, 1K silicone, 1K silane terminated polyol, or 1K silane terminated polyurethane sealants. 2K thermoset sealants include polyurea and polyurethane sealants, and will not be discussed in this article.

1-k Moisture Cure (MC) Polyurethane Sealants

One-component, moisture-cure polyurethane sealants are typically known for their excellent durability, recovery, tear resistance, and chemical resistance. The polyurethane prepolymer reacts with moisture in the air to cure the sealant. Polyurethane sealants can be formulated into long-lasting sealants with low volatile organic compound (VOC) content.

ADVANTAGES	DISADVANTAGES
Paintable	Moisture sensitive in the package
Very little shrinkage	Cures slower in low humidity conditions and cold conditions
Good UV resistance	Aromatic versions may yellow on exposure to UV light
Typically meets ASTM C-920	
+/- 25 % to +/- 50 % movement	
Good flexibility (down to -54 C)	
Elasticity not lost with aging	
Excellent recovery	
Excellent durability	
Excellent tear resistance	
Excellent chemical resistance	

Silicone Sealants

Resins used to manufacture silicone sealants are derived from inorganic materials such as silicates or sand. Manufacturing of a silicone sealant from silicates or sand requires a large amount of energy. There are various types of silicones that are characterized by their end groups; acid, neutral, and basic. Subtypes of these groups include, but are not limited to, acetoxy, oxime, silane, alkoxy, aminoxy, amino, etc. The subtype indicates what type of VOC is released during cure. Silicone sealants have a wide variety of physical properties depending on their structure.

Silicones are one of the only sealant solutions that meet the requirements for structural glazing. However, paint does not adhere to silicone sealants which limits color matching and post application color changes in architectural applications.

ADVANTAGES	DISADVANTAGES
Excellent UV resistance	Not paintable
Typically meets ASTM C-920	VOC released during cure
High temperature stability	Difficult to tool
Little shrinkage	High moisture vapor transmission

Understanding Silane Terminated Polymers and Why We Need Them

There are several types of silane terminated polymers, which are polymers with a silane group at the end of the polymer chain. The backbone of the polymer is usually polyurethane-based, polyol-based or silicone-based.

- Silane terminated polyols have an intermediate amount of silicon atoms, estimated at 3.2% to 1.6%.
- Silane terminated polyurethane prepolymer (STP) has a low amount of silicon atoms, estimated at 0.8% to 0.4%.

- Silane terminated silicone resins have a high amount of silicon atoms. They have a silicon atom in each repeat unit of the polymer.

Note that silicon refers to the atomic composition, while silicone refers to the technology or final product.

The amount of silicon in the sealant determines the surface energy of the cured sealant. High amounts of silicon lead to a very low surface energy and affects the ability of a sealant to be painted. Therefore, silane terminated polyols and silane terminated polyurethanes are paintable, but silane terminated silicon sealants are not paintable.

Silane Terminated Prepolymers vs. Silane Terminated Polyols

Silane terminated polyols contain no polyurethane groups. They are polyether polyols with silane groups on the ends instead of hydroxyl groups. Sealants made from silane terminated polyols have more surface tack, and therefore greater dirt pickup. Their properties are typically more thermoplastic.

This article continues on http://go.hw.net/AR08213. Go online to read the rest of the CEU course, complete the corresponding quiz for credit, and receive your certificate of completion.

SPONSOR INFORMATION

QUIZ

1. Which of the following does ASTM define as "a substance capable of holding materials together by surface attachment?"
   a) Caulk　b) Sealant
   c) Adhesive　d) Structural sealant

2. What are the basic properties of a sealant?
   a) Fill a gap between substrates　b) Form a barrier
   c) Maintain sealing properties　d) All of the above

3. Which of the following is a benefit of structural sealants?
   a) Transfer the load between substrates　b) Seal the substrate at the bond line
   c) Prevent substances from moving beyond the seal　d) All of the above

4. _________ sealants have improved properties versus _________ sealants and include 1K moisture curing and 2K sealants.
   a) Thermoplastic, thermosetting　b) Thermosetting, thermoplastic
   c) Silicone, polyurethane　d) Polyurethane, silicone

5. Which of the following is not a performance benefit of silane terminated polyurethane prepolymer sealants?
   a) Paintability　b) Low-VOC content
   c) Good low temperature flexibility　d) Good adhesion to glass
   e) Slower cure in low humidity and cold conditions

6. What tool was used for quantification in the case study presented here?
   a) Life cycle assessment methodology　b) Blower door testing
   c) Heat loss equations　d) All of the above

7. For the study presented in this article, the sealant service life was expected to be _______ years, assuming no maintenance.
   a) 5–10　b) 10–15
   c) 10–20　d) 15–20

8. The air flow was reduced _______ after sealing with a polyurethane sealant.
   a) 15%　b) 25%
   c) 35%　d) 45%

9. The _______ efficiency system saved the energy equivalent to operating a 60W incandescent light bulb for a period of 12.7 years.
   a) Low　b) Middle
   c) High　d) None of the above

10. The study concluded that over a 10-year period, installation of the sealant will save approximately ________ times the amount of CO_2 from being emitted into the air versus the amount of CO_2 used to manufacture the sealant.
    a) 100　b) 150
    c) 200　d) 300

10 Hearth Innovations Architects Must Know

Presented By:

HEAT&GLO

No one builds a better fire

LEARNING OBJECTIVES

1. Understand how fireplaces have evolved from an essential aspect of living to a decorative heating appliance with multiple uses, and understand what innovation means in relation to the hearth category.
2. Define venting and heat-management concepts, and describe how modern fireplaces can improve occupant experience and thermal comfort.
3. Examine innovations in fireplace aesthetics such as no-glass gas fireplaces, indoor/outdoor fireplaces, and those that are ideal retrofit solutions.
4. Explore features of smart, connected fireplaces and how they provide safety, sustainability, and convenience for users.

CONTINUING EDUCATION

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THE EVOLUTION OF FIREPLACES

Fire was never invented. It was discovered. Discovered, then harnessed. Harnessed and applied in ways to benefit our lives, our cultures, and our built environments. Innovation is a multifaceted concept, even from a strict definition standpoint. Depending on the audience you are talking to, the industry in question, or the situation in which it's applied, the term can have various meanings. The Oxford Dictionary provides this definition for "innovation": "to make changes in something established, especially by introducing new methods, ideas, or products."

Humankind innovated with the element of fire to achieve numerous benefits. Harking to the Oxford definition, one of the ways this was accomplished was developing methods that would allow us to leverage fire for heat, cooking, and light. These methods evolved into products that comprise what we know as the hearth category today.

The hearth itself evolved from a centrally located heating and cooking element in the home to being placed on the outer walls (circa 1100 A.D.). This coincided with two-story structures becoming a standard part of societies. These early masonry fireplaces were vented (without much success) horizontally, but soon came the invention of the chimney, allowing for wood-burning fires to safely be fueled and vented while incorporated into the structural envelope of the dwelling.

Masonry fireplaces evolved into factory-built hearth products that are much easier to install, are more economical, and can leverage multiple fuel types. The fireplace and hearth category now includes appliances that can provide the warmth and/or ambiance of a fire in several ways, including:

- Classic wood-burning hearth products
- Hearth products fueled by natural gas
- Hearth products fueled by bio-mass or pellets
- Alcohol- or ethanol-fueled hearth products
- Electrically powered hearth products

Some of these early innovations for the fireplace and hearth category are likely familiar. However, research from The Hearth, Patio & Barbeque Association (HPBA) has found that most consumers, builders, and design professionals are not aware of the industry's innovations from a solution/benefit standpoint or how expansive the category is. The demands of today's discerning clients, building codes, environmental regulations, and other factors make specifying any material a dedicated process.

The 10 innovations we will discuss in this course are hearth category solutions to help you meet those goals head-on and exceed your client's expectations.

INNOVATION 1: DIRECT-VENT GAS FIREPLACES

A fireplace system consists of the appliance, its fuel source, venting systems, accessories, and optional design components. In this section, we will discuss venting systems and, more specifically, direct-vent gas fireplaces. Gaining in popularity since the middle of the 20th century, natural gas is the fuel responsible for the largest portion of home space heating in North America, according to an analysis of several studies completed by James E. Houck, Ph.D, a consultant in energy, biomass, and the environment, that was published in a 2017 issue of Hearth & Home magazine.

Gas fireplaces can be vented one of three—technically two—ways:

- Direct-vent technology: A sealed combustion system protects indoor air quality by drawing outside air for the fire and expelling 100 percent of combustion exhaust and byproducts outside the home.
- B-vent or "natural" venting technology: This system is not sealed; it draws air from a room into the combustion chamber and exhaust must be routed through the roof via a pipe.
- Vent-free or ventless technology: This method actually relies on a higher burn temperature—rather than physical venting like in the cases of direct vent or B-vent—to rid the air of combustion byproducts.

Direct vent is by far the most common venting method and is the newest form of venting, invented by the founders of Heat & Glo in the 1980s; it remains a popular choice because of its efficiency, safety, flexibility, and the fact that it does not require an existing chimney.

In the 1970s, gas fireplaces were rapidly gaining in popularity, but their main limitation at the time was the venting. Direct venting changed this limitation. Prior to this innovation, gas fireplaces were either vent-free (or "room vented") or a strictly vertical system known as a B-Vent.

Vent-free gas fireplaces do not require venting at all. With no glass fronts these

Direct-vent gas fireplaces are a popular choice because of their efficiency, safety, flexibility, and the fact that they do not require an existing chimney.

GLOSSARY

Direct-Vent Gas Fireplace—Direct-vent systems incorporate a sealed glass front and co-linear vent pipe; the outer chamber brings outdoor air for combustion, and the inner chamber carries the exhaust byproduct (carbon monoxide, nitrogen dioxide and excess moisture) outside the home or building

Gas Fireplace Insert—A retrofit solution that fits inside an existing masonry or manufactured wood-burning fireplace, providing an instant upgrade that performs better, is safer, and is more convenient

Heat Management—Used to redirect heat generated from the fireplace to a different space or pull heat away from the surrounding fireplace wall and glass viewing area; there are two types of heat-management systems: mechanical and natural draft, or passive, systems

Indoor/Outdoor Fireplace—A type of hearth product that offers warmth and fireside views from two sides; these types of fireplaces can act as a window and are tested to the same standards as other fenestrations

LED Simulated Flames—Electrically powered fireplaces that deliver flames without any fire or combustion

Mechanical Heat-Management System—Typically work in tandem with a direct-vent system, with the fireplace acting as the "engine" and a series of duct systems and heat registers redirecting the generated warmth; some mechanical heat-management systems are designed to redirect heat to another room in the home

Passive-Heat/Natural Draft Heat-Management System—A nonmechanical system that disperses heat naturally throughout the room and reduces surface temperatures near the fireplace; it works by venting heat into the room through one front discharge, two side discharges, or an open-top discharge while the fireplace is in operation

Power Vent—A fan-powered accessory that essentially assists in "pulling" and "pushing" the air through when the vent run reaches a certain length or complexity, allowing for lengthy, multi-elbowed, or zig-zagging vent runs

Refractory Ceramics—Materials designed to withstand very high temperatures (exceeding 1,000 degrees Fahrenheit)

Zone Heating—The concept of redirecting heat to rooms that are physically occupied, instead of using forced air, which heats the whole house regardless of whether it is being used models take in fuel air right through the exposed viewing area and expel by-product the same way. The benefits of vent-free gas fireplaces are that they can be installed anywhere in the home and are generally less expensive than vented fireplaces. Gel, propane, and ethanol can be used in vent-free fireplaces, in addition to natural gas.[1] The technology prevents anything but trace amounts of combustion fumes from being released into the home, yet some local code authorities do not permit them.

Natural draft vents, or B-vents, are terminated through the roof using an approved metal liner. Typically used with existing chimneys, natural draft venting is the least energy-efficient at 35–50%.[2] For the specifier, the B-Vent caused a design limitation. And, as local building codes quickly began putting strict guidelines on vent-free models, a solution-gap was identified and then filled in the form of direct-venting.

Direct-venting technology, regarded as one of the top 25 breakthroughs in residential construction, was patented in 1987 by brothers Ron and Dan Shimek, and provided a fire solution that was safe, convenient, and consistently beautiful. Direct-vent gas fireplaces are well-suited for projects requiring optimal indoor air quality and a real fire. They also provide design versatility for fireplace placement and vent runs (vertical, horizontal, or mixed venting runs).

Direct-vent fireplaces remove 100% of combustion exhaust and odors outside of the home. Because they are sealed, they provide optimal heat; conserve energy; and ensure clean, safe indoor air quality. Direct-vent systems incorporate a sealed glass front and co-linear vent pipe. The outer chamber brings outdoor air for combustion, and the inner chamber carries the exhaust byproduct (carbon monoxide, nitrogen dioxide and excess moisture) outside the home or building.

Direct-vent fireplaces are the easiest to install because they do not require installing a chimney structure. Most gas fireplaces utilizing direct-vent technology are vented to the outdoors horizontally, directly through the wall. However, they can also be routed vertically or can even accommodate mixed venting runs.

Because the sealed system in direct-vent gas fireplaces provides higher efficiency and better indoor air quality, they are preferred for green building programs such as LEED. From an end-user standpoint, a direct-vent fireplace offers the most ease of operation and maintenance. Moreover, from a design standpoint, a direct-vent gas fireplace can be installed nearly anywhere in a home or building.

Note: Venting requirements should be considered early in the design process to ensure the venting system works with the desired location of the fireplace.

DIRECT-VENT GAS FIREPLACES ARE A SOLUTION FOR:

- Projects requiring optimal indoor air quality and real fire
- Projects requiring design versatility with fireplace placement
- Projects needing vent run versatility (vertical, horizontal or mixed venting runs)

Power venting allows direct-vent fireplaces to be installed anywhere in the building, including interior walls and other central spaces.

INNOVATION 2: POWER VENTING FOR GAS FIREPLACES

An innovation related to direct-vent technology is power venting for gas fireplaces. As direct-vent gas fireplaces became the standard in residential and commercial properties, it became apparent there were limitations. A power vent is a fan-powered accessory that essentially assists in "pulling" and "pushing" the air through when the vent run reaches a certain length or complexity, allowing for lengthy, multi-elbowed, or zig-zagging vent runs. It is installed either in line with the venting or at the termination point, helping to pull in fresh air for combustion and push the fireplace exhaust through the venting.

When this innovation came to market, the options on where a designer could potentially place a hearth feature expanded exponentially. Power venting allows direct-vent fireplaces to be installed anywhere in the building, including interior walls and other central spaces.

POWER VENTING IS A SOLUTION FOR:

- Fireplaces that can be installed and vented from any room in a building
- Hearth applications requiring long or complicated vent runs

Integrated heat-management systems are what make modern gas fireplaces such an attractive option for homeowners who want the ambiance of a fireplace with the convenience and practical benefits of an energy-efficient, secondary heat source.

INNOVATION 3: HEAT MANAGEMENT

While today's venting technology has revolutionized how a fireplace can be placed in a building, heat-management systems have reshaped how we define comfort control for end-users regarding their hearth system. Integrated heat-management systems are what make modern gas fireplaces such an attractive option for homeowners who want the ambiance of a fireplace with the convenience and practical benefits of an energy-efficient, secondary heat source.

Research shows that homebuyers, builders, and architects are buying and specifying gas fireplaces as much for the ambiance and decorative nature of the fireplace as for their need or desire for additional comfort or heat in their home. In fact, with the emergence of modern fireplaces, these products are often purchased primarily for their decorative interiors, media, flames, and lighting effects; sometimes, limited or zero heat output is desired.[3]

Effective heat management, or the systematic control of air temperature, is critical in preventing energy loss and maximizing heating strategies. The ability to choose when, where, and how heat is managed and design versatility are two primary benefits. Gas fireplaces are an excellent means of transferring heat, whether the goal is to heat a single room or move the warm air to multiple places in the house (zone heating).

Modern gas fireplaces can effectively transfer heat thanks to upgraded technology. Heat-management systems can be leveraged to redirect heat generated from the fireplace to a different space or pull heat away from the surrounding fireplace wall and glass viewing area. There are two types of heat-management systems: mechanical and natural draft, or passive, systems.

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SPONSOR INFORMATION

QUIZ

1. Direct-vent fireplaces remove _______ of combustion exhaust and odors outside of the home.
   a) 25% b) 50%
   c) 75% d) 100%

2. Which of the following is a benefit of power venting?
   a) Energy efficiency
   b) Utilizes less interior air
   c) Can be used in applications requiring long or complicated vent runs
   d) Allows installation of direct vent fireplaces anywhere in a building
   e) All of the above

3. Gas fireplaces with heat zone technology can redirect up to ______ of the fireplace's heat, reducing the wall temperature immediately surrounding the fireplace.
   a) 10% b) 15%
   c) 25% d) 50%

4. Refractory ceramics are an energy-saving firebox technology, producing up to _______ more radiant heat than metal fireboxes to heat rooms faster while using less fuel.
   a) 10% b) 15%
   c) 20% d) 25%

5. When selecting an open gas fireplace, which of the following is a critical consideration?
   a) Make-up air will have to be supplied to the home b) Exposed flames
   c) An auto-damper is required d) They have limited heating value
   e) All of the above

6. Which hearth innovation allows the fireplace to function as fenestration?
   a) Indoor/outdoor fireplace b) Direct-vent gas
   c) Heat management d) Refractory ceramics

7. _______ can provide an interior retrofit solution without compromising exterior profiles or sightlines.
   a) A gas fireplace insert b) An indoor/outdoor fireplace
   c) Zone heating d) A mechanical heat management system

8. Fireplace apps provide smart control of a fire; which of the following functions is NOT possible with a fireplace app?
   a) Turning fireplace or insert on/off b) Increasing or decreasing flame height
   c) Setting and changing temperature d) Robotic loading of wood
   e) Turning interior lights on/off

9. A _________ appliance means that a wood-burning fireplace meets clean air standards, emitting less smoke than a noncertified stove and using less wood to generate heat.
   a) HPBA-certified b) EPA-certified
   c) Clean Air-certified d) CARB-certified

10. EPA-certified, non-catalytic or secondary combustion stoves are typically less expensive and have an average efficiency of _________.
    a) 63% b) 71%
    c) 78% d) 84%


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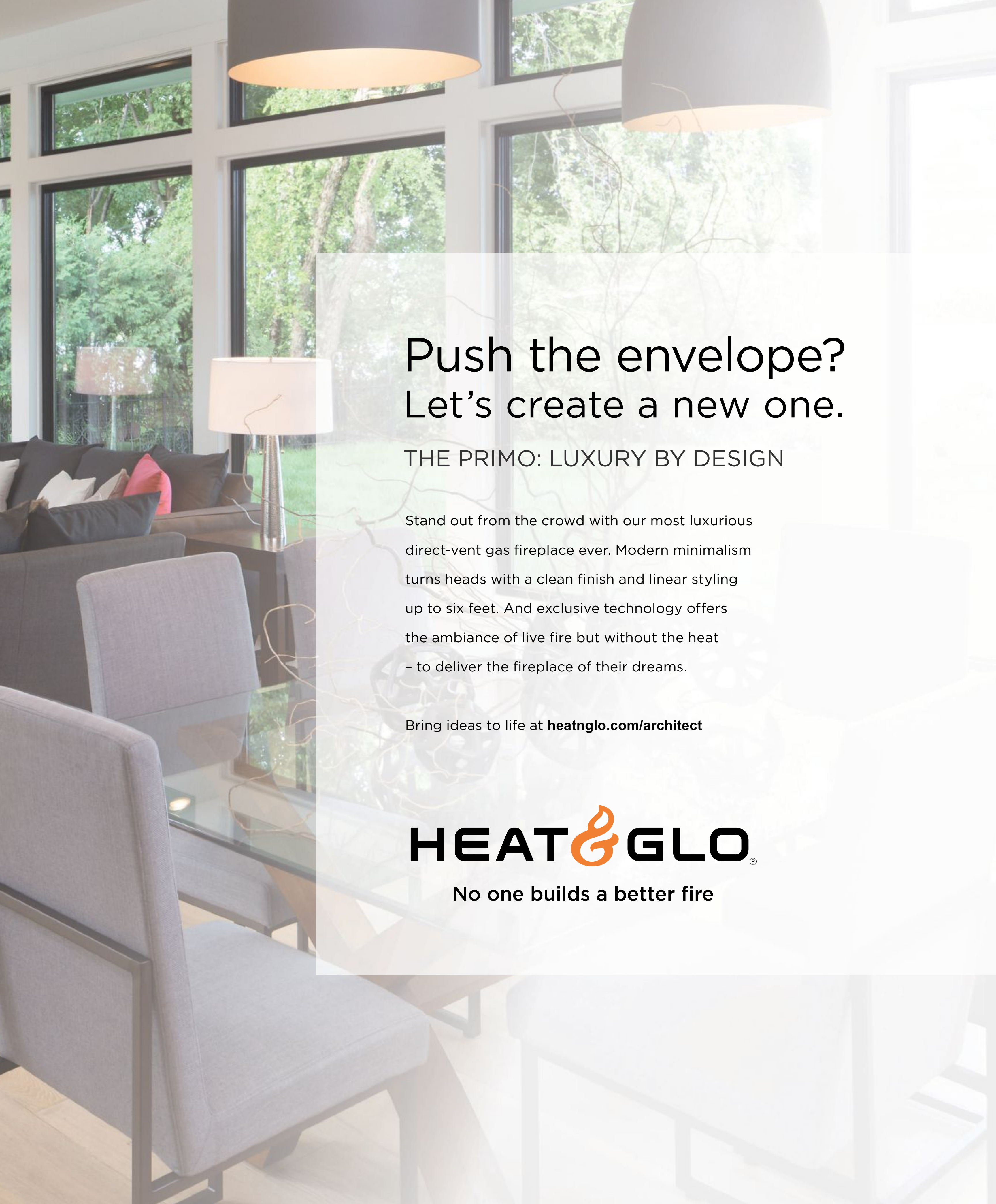
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Presented By:

Concrete Pathways to Net Zero

PART 2, OPERATIONAL CARBON

Richardsville Elementary School is the nation's first zero energy school. Photo courtesy of Sherman Carter Barnhart Architects.

LEARNING OBJECTIVES

1. Evaluate the changing nature of U.S. energy consumption and the role various initiatives, such as Net Zero Carbon Buildings Commitment, Race to Zero, and Architecture 2030, play in lowering consumption.
2. Assess the ways in which design decisions can impact concrete's ability to support sustainability initiatives.
3. Analyze various strategies to net zero energy buildings.
4. Understand the role Passive House plays in achieving net zero.

CONTINUING EDUCATION

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INTRODUCTION

From 1995 to 2005, U.S. building sector operational energy consumption spiked steadily from just under 33 quadrillion British thermal units (QBtu) to a little over 39 QBtu. However, between 2005 and 2018, the architecture, engineering, and construction (AEC) community managed to flatten the curve, levelling out operational energy consumption to approximately 39.4 QBtu throughout that time. This takes into consideration the fact that the U.S. "continues to add 3 to 4 billion square feet per year to its building stock."[1]

In large part, stopping the increase of operational energy consumption is due to various initiatives, including those undertaken by the World Green Building Council (WorldGBC), as well as the United Nations (U.N.) and Architecture 2030. These initiatives were discussed in detail in the course *Concrete Pathways to Net Zero: Part 1, Embodied Carbon* and will therefore be covered briefly here.

The WorldGBC's Commitment

The WorldGBC launched its Net Zero Carbon Buildings Commitment in 2018. Organizations and businesses, as well as cities, states, and regions, can all become signatories of what the WorldGBC terms "the Commitment." The WorldGBC states the organizations and businesses that have "signed up to the Commitment now cover nearly 6,000 assets, over 32 million m² of total floor area, and USD 100 billion in annual turnover." The goal for all signatories is to achieve net zero operational carbon emissions by the year 2030. Overall, doing so will save "approximately 3.4 million tonnes of CO_2" in 2030 alone. For perspective, "this is the equivalent to the emissions from energy used to power 400,000 homes for one year."[2]

The U.N.'s Race to Zero

Like the World GBC's Commitment, the U.N.'s Race to Zero seeks "support from businesses, cities, regions, [and] investors" as it strives toward "a healthy, resilient, zero carbon recovery that prevents future threats, creates decent jobs, and unlocks inclusive, sustainable growth."[3] Entities joining the Race to Zero must pledge, among other requirements, to reach net zero carbon emissions "in the 2040s or sooner, or by mid-century at the latest."[4]

Architecture 2030

In part, Architecture 2030 focuses on existing building stock, noting "nearly two-thirds of the building area that exists today will still exist in 2050." Currently, cities, where most of this building stock is located, "are responsible for over 70 percent of global energy consumption and CO_2 emissions." Architecture 2030 maintains that to meet the requirements of the Paris Agreement to prevent global temperatures from rising more than 2 degrees Celsius, "a significant increase in the rate and depth of existing building energy efficiency renovations and procurement of renewable energy (energy upgrades) is required." To help those in the AEC industry achieve these goals, Architecture 2030 has undertaken a number of initiatives. These include collaborating with the WorldGBC in a new project titled Advancing Net Zero, as well as 2030 Districts, which is a collaboration with building districts across North America that seeks "to achieve significant energy, water, and emissions reductions within [...] commercial cores." Additionally, Architecture 2030's Zero Tool can help stakeholders ascertain a building's energy use intensity (EUI).[5]

In 2019, the American Institute of Architects (AIA) more formally committed to addressing climate change by backing a "resolution for urgent and sustained climate change." The resolution "calls upon the AIA 'to prioritize and support urgent climate action to exponentially accelerate the "decarbonization" of buildings, the building sector, and the built environment.'"[6] In part, this resolution was made in accordance with Architecture 2030's 2030 Challenge, which strives for "all new buildings, developments, and major renovations [to be] carbon-neutral by 2030."[7]

As existing global building stock is renovated to meet the goals of climate initiatives and new building stock is being designed and constructed to more sustainable standards, the resiliency and durability of building materials become increasingly more important. Concrete contributes to making the built environment more durable, resilient, and sustainable, and plays a large role in efforts toward carbon neutrality.

NET ZERO, OPERATIONAL EMISSIONS, AND EMBODIED EMISSIONS

Generally speaking, operational energy is that consumed by the operation of a building and includes heating, cooling, ventilation, and lighting. More specifically, operational energy is not solely "dependent on the function of a building" but is also determined by myriad other factors, including the "climate of the region, building configuration, building material characteristics, and [...] occupancy characteristics."[8] Overall, operational energy "can constitute 80–90% of the total energy associated with [a] structure."[9]

Comparatively, embodied energy "is the sum of energy consumed for the main processes involved in production of [a] material (direct energy input) and the energy spent for procurement of raw materials and other resources required for the main production processes (indirect energy inputs). It is the total primary energy required for extraction of resources, transportation, manufacture, assembly, disassembly, and end of life disposal of a product."[10]

Building operations, or operational carbon, is responsible for 72% of annual greenhouse gas (GHG) emissions from the building sector, and embodied carbon the remaining 28%. Embodied carbon alone accounts for 11% of global GHG emissions, and Architecture 2030 maintains, "Embodied carbon will be responsible for almost half of total new construction emissions between now and 2050."[11] Operating residential and commercial buildings consumes 70% of the electricity load in the U.S.[12] Clearly, both embodied and operational carbon must be addressed to meet climate goals effectively.

In addition to initial embodied energy, recurring embodied energy must also be considered and can be defined as energy in buildings that "represents the non-renewable energy consumed to maintain, repair, restore, refurbish or replace materials, components, or systems during the life of the building."[13] As the U.N.'s Race to Zero initiative points out, in addition to energy use, new building construction should also be resilient against natural disaster to meet the net zero goal. As a result of climate change, the planet will experience more frequent and stronger hurricanes, tornadoes, wildfires, floods, and other natural hazards. Buildings must be designed to meet these increased hazards.

Work at the Massachusetts Institute of Technology (MIT) has demonstrated that the severity and frequency of hurricanes have increased since the 1980s. For instance, "between 1980 and 1989, hurricanes killed 20 [people] per year. Between 2010 and

GLOSSARY

Embodied energy: "The sum of energy consumed for the main processes involved in production of [a] material (direct energy input) and the energy spent for procurement of raw materials and other resources required for the main production processes (indirect energy inputs). It is the total primary energy required for extraction of resources, transportation, manufacture, assembly, disassembly, and end of life disposal of a product."

Insulating concrete forms (ICF): Made from reinforced concrete and expanded polystyrene insulation (EPS); made up of two layers of rigid insulation held together with plastic ties, forming units with a cavity in the center; reinforcing steel is added to the cavity and then concrete is poured into it. The forms remain in place to provide insulation and weather barrier.

Net zero, or zero net carbon: "Zero" refers to greenhouse gas emissions (GHG), and "net" translates as positive emissions (burdens) and negative emissions (benefits or offsets).

Operational energy: Energy consumed by the operation of a building, which includes heating, cooling, ventilation, and lighting; determined by many factors, including climate of the region, building configuration, building material characteristics, and occupancy characteristics.

Passive House Institute (PHI): Founded in Germany in 1996, it is a pioneer in energy-efficient construction and renovation; has led research and development of "construction concepts, building components, planning tools, and quality assurance for especially energy efficient buildings."

Passive House Institute U.S. (PHIUS): Developed cost-effective performance criteria to address the many climate conditions in the U.S.

Recurring embodied energy: Energy in buildings that "represents the non-renewable energy consumed to maintain, repair, restore, refurbish, or replace materials, components, or systems during the life of the building."

Resilience: "The ability to prepare and plan for, absorb, recover from, and more successfully adapt to adverse events."

Tilt-up concrete walls: Concrete panels that are cast horizontally on site on a concrete slab on ground and lifted or "tilted" by crane into a vertical position.

Zero net energy building: "A highly efficient building that produces on-site, or procures, enough carbon-free renewable energy to meet building operations energy consumption annually."

2019, that figure grew to 357."[14] Since 1980, hurricanes have financially cost the U.S. $1 trillion in damages.[15] To mitigate the human and economic costs of hurricanes and other extreme weather events, structures need to be made more resilient. As researchers at MIT note, "one barrier to resilient construction is its perceived cost"; however, "retrofitting a building for resilience costs around 18 to 24 cents per square foot" and can ultimately save significantly more money than hazard repair. In Florida alone, "the state-wide estimated benefits of hazard mitigation quadruple from $5 billion to $20 billion annually."[16] In short, hazard maintenance costs incurred by conventional buildings often exceed initial construction costs.[17] Overall, while designing an "enhanced" building, or building for hazard resilience, might cost more upfront, the long-term savings to owners and governments are substantial.

One financial study on achieving net zero determined, "Advancing net zero policy [...] means advancing economic development, energy leadership, ingenuity, and resilience. Planning for a net zero future creates practical and achievable energy solutions for residents and economic and environmental benefits for a city itself."[18] Achieving net zero means taking into account a variety of factors that influence or impact embodied and operational carbon.

Net Zero: Positive and Negative Emissions

Many of the initiatives listed in the previous section seek to reduce both embodied and operational carbon to reach the overall goal of net zero. Net zero, or zero net carbon, is where "zero" refers to GHG emissions and "net" translates as positive emissions (burdens) and negative emissions (benefits or offsets).

In terms of embodied energy, burdens include the production of building products and structures. By making production more efficient and/or using low-carbon constituents, carbon emissions can be avoided and/or permanently sequestered or captured. Electricity and heat generation are two burdens of operational energy. By making a building's envelope and systems more energy efficient and/or by using on-site renewable energy, lower energy demand can be achieved and both energy bills and carbon emissions can be reduced. Based on this description of burdens and benefits, pathways to net zero buildings must involve materials, specifications, design, construction, building envelope, energy systems, and renewables.

A zero net energy building, as defined by Architecture 2030, is "a highly efficient building that produces on-site, or procures, enough carbon-free renewable energy to meet building operations energy consumption annually." This definition can be applied to both new and existing buildings, including those in dense urban areas, and, generally speaking, can be achieved by first reducing carbon-based energy consumption "through building design strategies and efficiency measures" and next "through on-site renewable energy generation."[19]

This course will focus on operational carbon and concrete's contribution to pathways to net zero energy buildings and the impact of design decisions on net zero operational carbon. Finally, the course will examine several case studies where low operational carbon was achieved with the help of concrete.

CONCRETE'S CONTRIBUTION TO NET ZERO OPERATIONAL EMISSIONS (LO2)

There are many factors that can influence the way concrete is manufactured, designed, built, used, and recycled that ultimately affect the environmental footprint of a structure. Whether one is designing a high-rise building, pavement, bridge, dam, or warehouse, concrete is an important component used as foundation and superstructure, and these structures can have a significant impact on the environment throughout their life cycle. Structural engineers and architects can influence the performance and environmental impact of structures through effective design and specifications regardless of the materials being used. However, concrete is unique in that it is versatile both in terms of physical characteristics (size, shape, appearance, etc.) and mechanical properties (strength, stiffness, permeability, etc.) so that specifiers can influence performance, including environmental impacts, of concrete and concrete structures significantly through design decisions and project specifications.

Influence of Design Decisions

The single biggest influence an architect or engineer can have on the environmental impacts of a structure is through efficient design. While design loads, constructability, aesthetics, and concrete mixtures all play a role in reducing the carbon footprint of a building and can affect the performance of concrete and concrete structures, structural efficiency, durability, resilience, and energy efficiency as they relate to operational carbon emissions will be the focus here.

Energy Efficiency

Concrete buildings are typically more energy-efficient than lighter framed buildings because of thermal mass. Thermal mass is a material's ability to store heat and release it over time. There are three characteristics of thermal mass. First, the time lag between peak heating and cooling loads and outside temperature peaks is greater for massive buildings. This feature can be used in buildings by delaying the need for heating or cooling energy to take advantage of off-peak demand. In an office building, that means heat gain can be delayed until after everyone has gone home. Second, massive buildings have lower peak heating and cooling loads, allowing for smaller, more efficient heating and cooling equipment. And third, massive buildings require less overall heating and cooling energy to maintain the same interior temperatures since temperature swings are moderated.

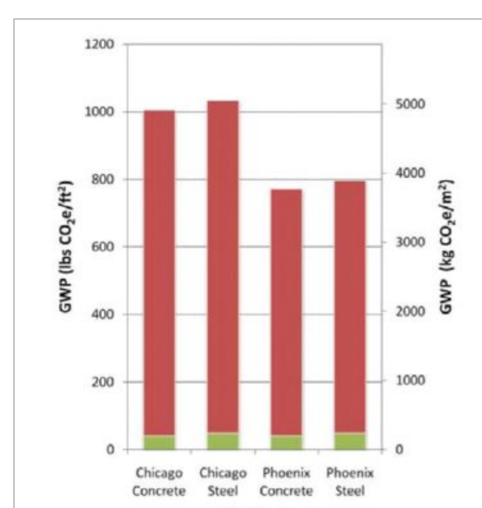

Figure 1. Total Global Warming Potential (GWP) over 60-year lifespan for commercial buildings.

In a research report published by MIT, the effects of thermal mass were explored using life cycle analysis for a 12-story, 46,321 square meters (498,590 square feet) commercial building. The building was analyzed for a 60-year life for two climates (Phoenix and Chicago) and for two different structural materials (concrete and steel). The analysis demonstrated that the greenhouse gas emissions due to operational energy of the building were responsible for 95–96% of life cycle emissions.[20] Figure 1 demonstrates that the concrete building has approximately the same embodied emissions as steel but has lower operating emissions, which can lead to lower life cycle emissions.

The same research evaluated the global warming potential (GWP) of single- and multi-family buildings, demonstrating there are measurable differences between various construction materials and that concrete structures can provide unique benefits compared to other materials over an operating life cycle. By considering a structure's entire operational life, the MIT research uncovered concrete's ability to offer a highly resilient structure while providing thermal mass benefits resulting in energy savings.

- Concrete homes have a higher embodied GWP in the pre-use phase—but this phase accounts for only about 2–12% of the overall GWP for the life of the home.
- For a cold climate, such as Chicago, the energy savings of an insulating concrete form (ICF) house built from average to tight levels of air infiltration saves 23% of total operating energy. ICFs will be discussed in more detail in the next subsection.
- Over a 60-year life cycle, the lower operating GWP (5–8% for single-family, 4.4–6.2% for multi-family) outweighs pre-use emissions.[21]

This article continues on http://go.hw.net/AR08212.
Go online to read the rest of the CEU course, complete the corresponding quiz for credit, and receive your certificate of completion.

QUIZ

1. Each year, the U.S. adds __________ billion square feet to its building stock.
   a. 1–2 b. 2–3
   c. 3–4 d. 4–5

2. Heating, cooling, ventilation, and lighting contribute to which of the following?
   a. Operational energy b. Embodied energy
   c. Recurring embodied energy d. None of the above

3. Operational carbon is responsible for ______ of annual GHG emissions from the building sector.
   a. 28% b. 45%
   c. 60% d. 72%

4. Since 1980, hurricanes have cost the U.S. ___________ in damages.
   a. $1 million b. $100 million
   c. $1 billion d. $1 trillion

5. Which of the following plays a role in reducing the carbon footprint of a building?
   a. Structural efficiency and constructability b. Durability and resilience
   c. Energy efficiency and design loads d. All of the above

6. A research report published by MIT demonstrated that the greenhouse gas emissions due to operational energy of the building were responsible for _______ of life cycle emissions.
   a. 95–96% b. 86–87%
   c. 72–73% d. 67–68%

7. A 6.5-inch concrete wall offers a fire resistance rating of _____ hours or more.
   a. Three b. Four
   c. Two d. One

8. The use of ICF helped Jennings Creek Elementary School to reduce its energy costs by ________.
   a. 25% b. 50%
   c. 75% d. 100%

9. Which of the following is a passive solar strategy?
   a. East/west building orientation b. Daylighting
   c. Compact building volume and thermal mass d. All of the above

10. The first Passive House was built in the U.S. in ______.
    a. 2018 b. 2015
    c. 2003 d. 1996

SPONSOR INFORMATION

Build with Strength, a coalition of the National Ready Mixed Concrete Association NRMCA, 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.

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The concrete industry utilizes **over 26 million metric tons of industrial byproducts** that would otherwise end up in landfills.

AIA Architect

CREDIT: CHONA KASINGER

Nelli stands in front of Wing Luke Elementary School in Seattle, designed by NAC Architecture.

Architects as Provocateurs

As social and environmental issues become more dire, architects must widen their field of focus.

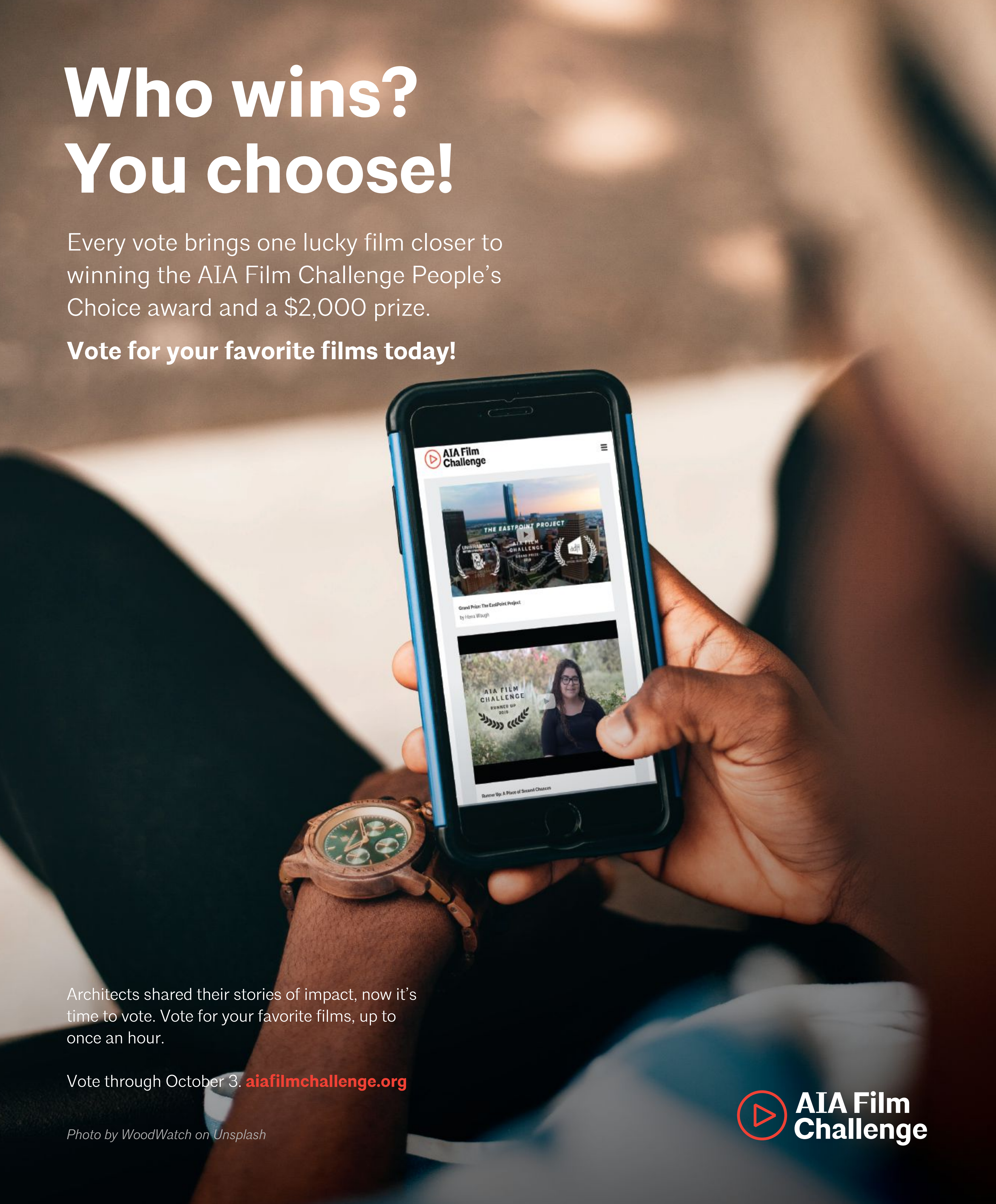
Garrett Nelli, AIA, helped design a water kiosk to serve residents of rural Appalachia as part of a design-build studio during his senior year at the University of Tennessee. He continued to gain experience through a travel scholarship with AIA Seattle, and currently effects change through his role at NAC Architecture. We chatted with him about his passion for public service architecture and how he sees architects' roles and responsibilities developing in the next several years and beyond.

As told to Katherine Flynn

In school, I was interested in the emerging field of public interest design and how architecture firms were repositioning themselves, both from a practice standpoint and from a professional standpoint. In a lot of ways, this meant the architect becoming more of a provocateur, or someone who is facilitating community movements and efforts. So rather than waiting for projects to land on their front porch, these architects are going out there and meeting with the community, talking about their needs, talking about which things are maybe alienating them or are obstacles for them—and then coming up with solutions for how to overcome those obstacles.

Through the AIA Seattle Travel Scholarship, I traveled to six locations, three within the U.S. and three abroad: Los Angeles; New Orleans; Newbern, Ala.; Port-au-Prince, Haiti; Madrid, and Venice. I began to catalog architect efforts in these locations and what sort of participatory design efforts they were doing. Through an exhibition at the end of my scholarship, I attempted to disseminate that information to the public, so that attendees could better understand the profound impact of the built environment and the role that we all play in shaping it, and the role that it plays in shaping us.

At NAC, we host community workshops and we always involve end users throughout the process. It's never just one conversation and it's done—it is a mutual visioning process. It gives us the opportunity to rethink our role as architects within the community, to be provocateurs and facilitators for change—to question the status quo and envision a world that better reflects our collective aspirations. If we're solely focused on building new buildings, it narrows our field of focus and excludes a lot of opportunities for impact. At our heart, we're critical thinkers, we're thoughtful citizens. As COVID winds down in the U.S. and we shape our built environment post-pandemic, these conversations are important—to think about the role that the architect plays in reshaping our cities, schools, and public spaces to ensure that they respond adequately to the needs we realize we have as a community. Being proponents of these conversations can be something profound for the profession. AIA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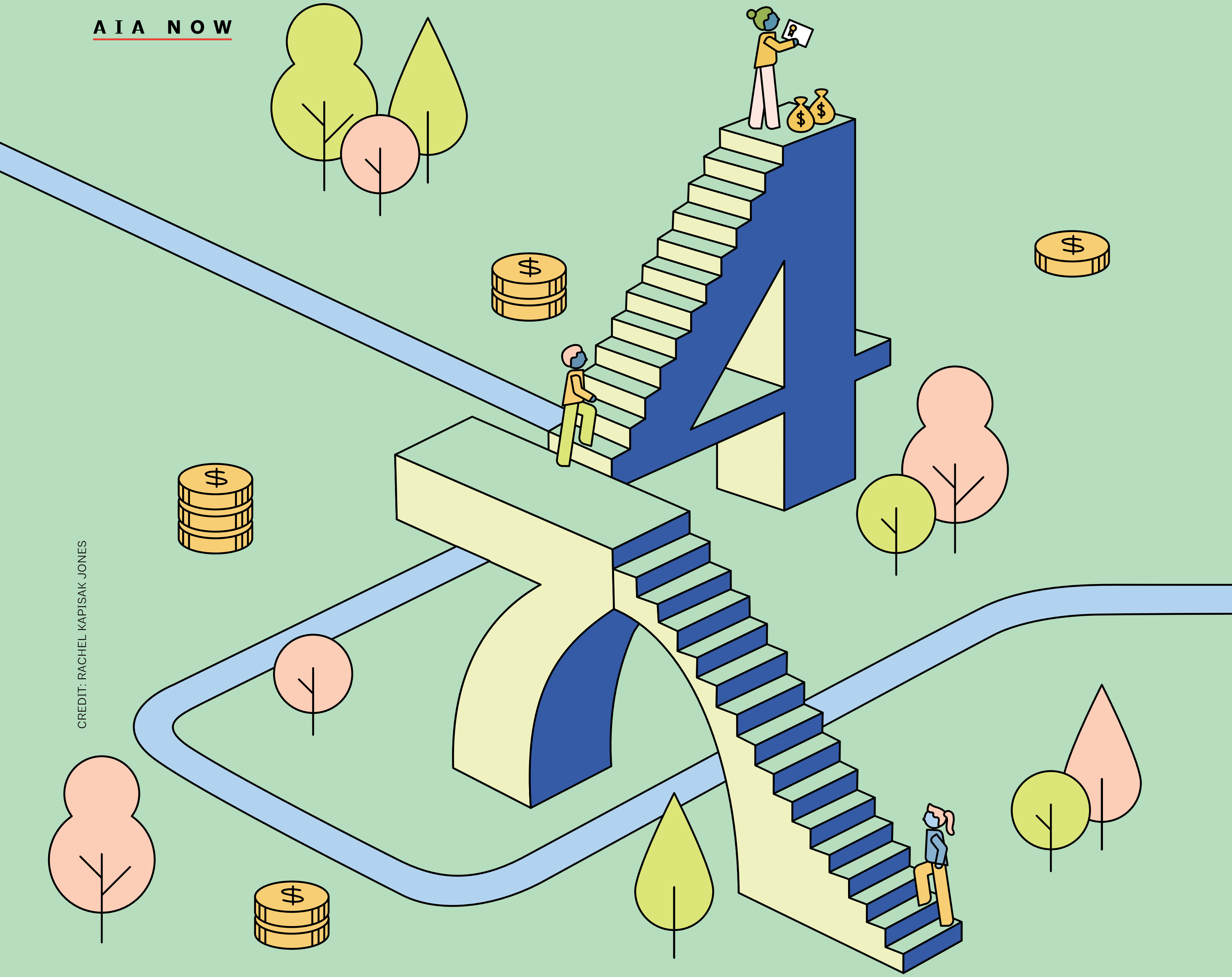
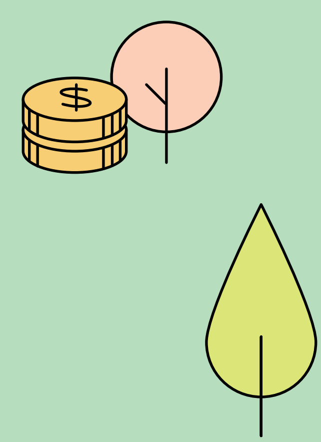


CREDIT: RACHEL KAPISAK JONES

Seventy-Four Percent of Firms Give a Salary Bump for Licensure

For many firms, licensure represents a step forward.

By Michele Russo



Almost three-fourths (74%) of architecture firms reported some level of salary increase to employees upon licensure. That percentage increase varies by firm size, with smaller firms providing larger bumps. For firms with fewer than 20 employees, the bump for licensure was a salary premium of 5% to 9%, while firms with more employees offered premiums of 1% to 4%. AIA

Source: 2021 AIA Compensation Report, aia.org/compensation

Independent Study

COVID safety challenges made classroom flexibility key. Now, architects grapple with the ways it influences educational philosophies.

By Patrick Sisson

CREDIT: ROBIN HILL

The new Perkins + Will-designed STEM building at Florida's Ransom Everglades School (lower right) is a space designed for adaptability.

When Pat Bosch, principal and design director for the Miami office of Perkins + Will, began thinking about school design post-pandemic, her thoughts didn't drift to high-tech learning spaces or indoor-outdoor playgrounds for learning. She went back to the basics: the one-room schoolhouse of the frontier.

"It's a simple building that needs to do a lot of things," Bosch says about the traditional structure, which was an inspiration for a new innovation center and STEM building her team designed for the Ransom Everglades School, an elite Miami prep school, that opened in September 2020. "It was a condenser, adaptable and flexible, a little Inspector Gadget–type space. Everything happened there. That's where we're all going, back to simplification. We don't need to overdesign."

Calamity can produce clarity, and in the case of COVID, architects and designers are increasingly seeing how the scramble to alter or improvise classrooms that functioned during a pandemic—via distancing, temporary barriers, mobile furniture, and air filtration—can turn object lessons into an opportunity for rethinking design.

The look and layout of American schools have always been about a lot more than architecture; their aesthetics are a reflection of politics, power, equity, and our prognostications about the future of the workplace. This pandemic moment may have produced a unique inflection point for school design, one that might focus more on wellness, student choice, and multidisciplinary learning, creating classroom environments as customizable as a set of blocks or Legos.

"The architecture of schools traditionally doesn't really help you learn," said Rosan Bosch (no relation to Pat Bosch), founder of an eponymous Danish design studio known for progressive educational projects. Her fluid design for the Vittra School Telefonplan in Stockholm, which opened in 2011, led to sensationalist headlines about classroom-free schools.

"An old-fashioned type of school, with a corridor and a room where you sit still, where you as a student aren't physically moving very much, doesn't give you many options to become engaged," she says. "A more flexible, open environment allows you to learn in a better way. Schools should be physical frameworks to allow us to learn in the best way."

But flexibility, despite its definitional promise of pliability and impermanence, can mean different things to different administrators and architects. The freedom of COVID-era temporary school design solutions—from a proposal from Skidmore, Owings and Merrill for pop-up, high-pitched, easily sanitized portable classrooms with plug-in air purification, to architect Valentino Gareri's modular treehouse, featuring interlocking pavilions of cross-laminated timber that form a figure eight—suggest a step up from the traditionally ad-hoc modular classrooms, as well as wildly varying degrees of activity and a connection to nature. But as emergency measures, like tent classrooms designed by U.K. studio Curl la Tourelle Head, make way for full-fledged new school concepts and construction premised on more openness and experimentation, there's serious debate around exactly what it even means to foster creativity.

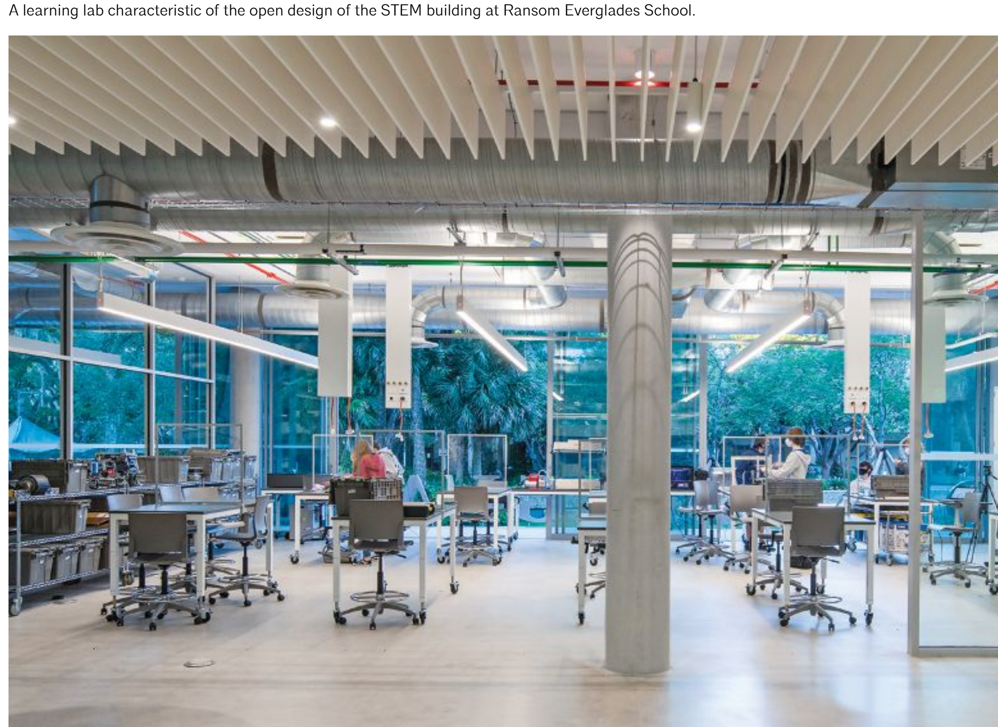
"I'm not trying to create an architecture that can create the model citizen of the future. I don't even think it's possible," says Rosan Bosch. Her recent post-COVID design concept for a new building at Markham College, a private school in Lima, Peru, designed with the firm IDOM, hews closer to the treehouse and open-air vision, with flexible pods and learning areas sheathed in wood, a half-open corridor called the Río Hablador, or Talking River, and even caves carved into the walls for students seeking respite. "We're trying to create the physical framework that allows for development, that gives the students the tools to learn how to learn, and motivates them, giving them positive feelings about learning and bettering themselves."

Students don't dream of coming to school every day and effectively sitting in a cubicle. But over the last century, many people involved in modern school design kept the workplace at the forefront of their thinking. In the early part of the 20th century, philosophies of industrialization and Taylorism informed the efficiency-focused operations of classic brick schoolhouses we think about today, fueled by the education philosophies of progressives like William Wirt, superintendent of schools in Gary, Ind.

In the later half of the century, as technology became more of a focus, new generations of architects would bring both International Style design and a focus on open plans to mid-century schools. As schools have grown in size and assumed more social responsibility in recent decades, the moment is ripe for a wholesale rethinking of where our children learn—a reality accelerated by the school-choice and charter-school movements. The one-room schoolhouse has become crowded and infinitely more complex.

Now, the vision of a modern workplace completely transformed and set adrift by the rapid pace of technology has pushed designers who, already focused on elevating collaboration and soft skills, are using the flexibility mandate that's come from COVID as a means to transform homerooms into tech hubs. Ransom Everglades exemplifies this philosophy—promoted by education "disruptors" like the XQ Institute—of

A learning lab characteristic of the open design of the STEM building at Ransom Everglades School.



resiliency, flexibility, and real world experience as a glide path to student success, one as smooth as the concrete floors of coworking spaces and corporate innovation hubs. Administrators at Ransom Everglades already wanted to move into a more multidisciplinary vision of 21st century learning, so Pat Bosch's office used lessons learned during its design of cosmetics company L'Oreal's new Rio de Janeiro Innovation Center, another waterfront space tilted with Niemeyer-esque curves, for the school's STEM center.

"They chose us because we were the perfect storm; we know corporate, workplace, higher ed, and healthcare," says Bosch. "The way we talk about next-gen is really about an intersection of many elements. We need to think that way, not just [about] how students are thinking, but [about] how buildings behave."

The layout of the innovation hub was steered in large part by resiliency, considering the area's increasing extreme weather and climate change vulnerabilities. Set on the bayfront campus with its glass doors opening onto a lush garden, the building is contextual, opening to the north to decrease solar gain, and built to collect rainwater and harvest solar power with PV panels. It's constructed with a chilled beam cooling system that minimizes ductwork, meaning less particle, allergen, and pollutant accumulation. But the layout inside is plug-and-play and project-based, an evolution of the learning platform, according to Bosch, filled with movable glass partitions and desks on wheels. Even lab gear, like fume hoods, is made to be reconfigurable, the better to reposition everything to approach a lesson or problem in a different way. The environment to think and create was deliberately modeled on what students will see outside of school, to inspire the kind of creative thinking, collaboration, and collusions that you'd hear about in a design thinking seminar.

"Even the most static of rooms, a lab, can completely shift and move to take different forms due to the problem at hand," Bosch says. "It's as simple as that; critical thinking and creativity need to come into the education system."

COVID underscored the value of this approach, she says. Education moved outside when the pandemic hit. Flexible workspaces and collaborative spaces evolved with social distancing and our understanding of the virus. The air exchange and mechanical systems flushed fresh air into the building.

For Rosan Bosch, the Markham project in Peru took two different sources of inspiration: the scenes of schools closing during the pandemic, as well as the ability to get drawn into one's own imagination. Her classroom CV, including a series of Vittra schools for elementary-age students, has always focused on a self-awareness of how to learn. Markham, filled with clusters of classrooms and more interactive common space, attempts to offer a more agile place to learn.

"Spaces are the third teacher," she says. "The right learning landscape allows you to feel how you learn, and empowers students to act on that."

Markham exhibits many of the hallmarks of the Rosan Bosch approach: curved spaces and plenty of indoor-outdoor interaction; small shocks of color (in this case, partially a response to the sensory deprivation of the sameness of so many people's pandemic environments), and lots of flexible structures. The design was made to be experimental; one of the biggest problems inherent in traditional school design is assigning spaces a role, leading to predefined problem solving. Rosan Bosch compares school architecture to that of a prison in terms of its rote nature, but also because of its consequences on behavior and learning. Breaking free from those constraints requires developing a space that allows for rapid and consistent change.

"During COVID, everybody had to be agile and creative in a short period, and we all saw schools were flexible and had a much easier transition to this digital adoption," she says. "Everybody had this experience. Parents saw that the work was changing."

Preparation for the future has always been part of a school's guiding mission, and COVID has given designers a reminder of how important it is for physical space itself to be resilient and responsive to emergencies. What remains to be seen is how a focus on flexibility impacts the way spaces become part of a child's everyday school experience, and how it will ultimately impact a curriculum's effectiveness.

"Children get more and more demotivated by school, and they can't see the relevance of what they're doing," says Rosan Bosch. "We're trying to empower students with this learning landscape." **AIA**

The Lower School at Markham College in Lima, Peru, designed by Rosan Bosch in partnership with IDOM, features open-air hallways.

CREDIT: ROSAN BOSCH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(Re)Building Culture

Positive disruption is at the center of AIA's 2021 Conference on Architecture.

By Zach Mortice

After the social, emotional, political, and economic fissures of a year-plus of pandemic, AIA's 2021 Conference on Architecture is happening in the same place as last year—namely, on your computer. In these fractious times, the virtual conference has a special focus on how to weave continuity and perseverance through a period of unprecedented disruption. It showcases sessions on how to leverage the imperatives of racial and socioeconomic justice—which engulfed our cities with what was likely the largest protest movement in U.S. history last summer—into management strategies that meet moral responsibilities and practice obligations. There's an exhortation to take a client's-eye view of sustainability and to examine how the rest of the world sees architects, with disciplinary critiques grounded in the gap between architects' rhetoric and actions, made ever more apparent as climate change and austerity accelerates racial and socioeconomic inequality.

In architecture professor Bradford Grant's "Architecture, Climate Change, and Society," session, adapted from a Howard University course that he teaches, he urges a merger of architecture with public policy activism, a critique of the profession that begins by recognizing that architects' ability to effect change is often less than they imagine it to be. Quite simply: "Architects are reluctant to take the lead in societal issues and problems," says Grant, and they—and more importantly, the rest of society—suffer because of it.

Architects want to create nurturing, equitable, sustainable communities that imbue material security and a sense of communal solidarity, and that ennoble reaffirmations of people's humanity. But achieving these things requires political will to deliver, and if the developer or client doesn't put them in the brief as explicitly as possible, the building is not going to be constructed that way. What is built, then, is more likely to reinforce existing inequalities and deficiencies, which is why they coninute to be so blatantly omnipresent in the built environment. Architects, in Grant's critique, more often align themselves behind existing policy priorities, for good or ill.

"The historic precedents that I can think of are usually negative examples," he says. Trump's promised border wall is one. "And the architects get excited. That's a big commission! We were salivating on that," he says. Rather quickly, architects pivoted from the punitive and reactionary border wall to advocacy for a Green New Deal, a far bigger commission with a diametrically opposed ethical stance and an infinitely broader moral horizon that could address some of the problems architects are engaged in. But this rapid pivot is further evidence that there's little coherent vision of how architects should wield policy levers to fulfill their own rhetoric.

But there can be. "We need to get to the forefront. We need to be in the leadership positions beyond just following the developers and the business interests," says Grant. "We're moving in the right direction, but we're at the caboose. This is the position we typically find ourselves in."

Architects have been called out before, and the crises of the day demand another polarizing "Whitney Young Moment," if one had not already occurred.

Just as in 1968, architects have the skills to be savvy policy advocates, says Grant. This includes the ability to apply nonlinear design thinking to policy problems and an aptitude for visual communication, especially relevant in today's internet-steeped visual culture.

Diversifying the profession in order to reach better policy consensus is a (relatively) easy first step down this path. The more difficult task will be to integrate progressive, activist values and a proficiency with public policy into the "whole process of becoming an architect," Grant says. Of course, "leadership training, policy making, [and] inclusive pedagogy should happen in the reductional sector, but it should happen in internships, in the firms, it should happen within the accreditation process, it should happen in the architectural examinations. You can become a licensed architect by taking the exams and not really deal with any of the issues I'm talking about," he says. The premise of these exams is to protect the health, safety, and welfare of the public, but they are silent when it comes to public health threats of racism and inequality, all encoded in the built environment.

Even outside of any ethical or moral responsibility to design a more equitable, just, and liberated world for those that need it most, says Grant, there is the disciplinary necessity of setting your own brief and taking ownership of policy, instead of receding as a nearly superfluous add-on serving to aestheticize whatever the great powers of the economy want to do. "If we stay in that status quo, we'll eventually die," Grant says.

But first, firms are beginning to understand that "diversity and activist advocacy might be a way [to] grow and gain prominence," he says.

For Cynthia Shonaiya, AIA, a principal at Hord Coplan Macht (HCM), embracing diversity and progressive practice management is a way to ensure new talent flows in, helping to secure a stable future for firms when leadership transitions occur.

Located somewhere between artists and engineers, with a history of venerating the ideal of a lone genius over collective achievement, architects are often reluctant to consider the legacies of the businesses they found and establish once they have retired or passed on. But "transition is something that's inevitable," says Shonaiya, a panelist on the convention session, "Transitioning Your Firm for What's Next (And Who's Next)."

"Diversification is a way of attracting and keeping new talent," she says. "It's an opportunity to get a deeper, wider talent pool" and "to identify who might be those future leaders."

Planning for leadership transitions, and leadership development, is a way to steer the ship of firm culture in a direction that attracts the best and brightest minds. At HCM, Shonaiya says, young designers are leading cultural change. Recent grads consistently demand an office culture that's more collaborative, less hierarchical, and more mindful of work-life balance. Meeting them where they're at with clearly defined succession processes that reflect their values is a way to "broaden the reach and depth of the firm," she says.

"In some ways, we have separated the idea of ownership of the firm from leadership," says Shonaiya. The ownership pool is made up of dozens of people, spread over the firm's four offices. Employees don't have to be a principal to be an owner. "It's made the transition smoother because ownership does not reside in one person or the three named people on the masthead," she says.

That kind of smooth transition requires soul-searching. One critical place to start is by asking: "What is the essence of this firm?" says Shonaiya. "Is it me as an individual, or is it our work? And if it's the work that we do, is there a way to cultivate the design thinking—that essence—so that it goes beyond the individual and permeates though the firm?" HCM is on its second or third generation of leaders. "But we're still the same firm because we were able to identify the essence of what we do."

The sooner a firm can do this, the better. The breadth and effectiveness of transition plans is directly proportional to how much time is spent developing them. "What you're able to achieve will depend on how much time you have for this transition," says Shonaiya.

In architecture, transitions and ruptures are hardly limited to leadership changes. As the concept of "resilience" has dominated architectural discourse over the last decade or so, much of the analysis of the built environment has pivoted to a study of how to manage sudden and dramatic change, wholly necessary but perhaps never quite sufficient to compensate for an era of cataclysmic climate change. Marc Chavez, Deltek's director of MasterSpec, has seen the concept of resilience undergoing a Cambrian explosion of sorts; a rapid expansion and diversification of meaning.

"It used to be that resiliency was being able to bounce back from problems," he says. Today, "our definitions have expanded, our synonyms for it have grown." This broader definition includes adaptability, flexibility, and preparation for disasters, but also issues of practice management, like staff diversity and engagement with communities.

Chavez's session "Why a Resilient Business Strategy Matters" is all about grafting the design values that help a building withstand shocks and rapid change and applying them to how architecture firms are managed and operated. There's a business case for all of it: More sustainable and disaster-resilient buildings can draw higher rents and stay functional when others cannot. Deeper engagement with stakeholders creates return customers, and diverse teams bring more perspectives to the table and bring about better decisions.

Chavez has an architectural metaphor of choice for the value of diversity. Plywood veneer grains oriented in one direction crumple when confronted with parallel force. But layered veneers set on top of each other with perpendicular grains (representing diverse and opposing viewpoints), as with mass timber systems, "can deal with stress from different directions," he says, and disruption from any front. "So you want as many different directions as you can get."

For these discussions, "it behooves all of us to get a little uncomfortable," he says, to break up "in-group bias" that corrodes resilience by coalescing decision-making around ossified structures and ideas. AIA

AIA PERSPECTIVE

Learning to Learn

By Peter Exley, FAIA, 2021 AIA President

My first two jobs as a young architect were amazing experiences. The first, in the London office of Skidmore, Owings and Merrill, was a baptism by fire in rigor, excellence, and mostly good habits. I was surrounded by fascinating, capable, and competitive colleagues, who (owing to the hours we kept) also represented my entire social circle. The second, at Venturi Scott Brown Associates (VSBA), was an additional notable initiation where I became a citizen of a spectacularly fun studio where models were made, Pantone sheets adhered, and Prismacolor pencils sharpened under the watchful gaze of Steven Izenour. Today, we might characterize it as a place of admirable work-life balance. We had rubber-band fights. We had mentorship. We had a boss who knew our kids' names.

For me, and for many, this balance is one of the great legacies of that workplace. When I speak about AIA's Guides for Equitable Practice, I have these memories to draw upon. I believe the Guides are one of the finest roadmaps we have for ensuring that architectural practices vault beyond convenient minimum standards and strive to be exemplars for all professions, not just architecture. As architects addressing injustice in our communities, we must first hold ourselves accountable. The VSBA office aspired to be the paragon I see in the Guides, and represented values that still inspire me every day.

Denise Scott Brown and Bob Venturi were great polemicists—their words are often privileged over their buildings in the lecture hall—but their ideas were anchored by their ethics. I consider Denise's essay "Planning the Powder Room," which first appeared in *AIA Journal* in April 1967, an ingenious manifesto for accessibility and equity. She speaks directly to the fact that being conversant in a spatial typology is no substitute for experience. In case it needs to be said, the vast majority of architects in 1967 were men who had never used half the bathrooms they had designed. They presumed that if it was good enough for the gander, then it was good enough for the goose. I'd like to think we have moved beyond this position, even if the ratio of women to men in architecture remains woefully imbalanced.

I like to think that words mean something—that Denise's words, in particular, still mean something. Her argument in the "Powder Room" extends far beyond the places we live, work, play, and learn, of course, and into scales of magnitude that touch every aspect of our built environment—affordable housing, public transportation, and school districts, not to mention access to jobs, healthcare, and nutritious food. Her point can magnificently resonate in the process of scaling up. Accessibility and equity might be our strategies and superpower when we design, yet empathy must be our only underlying motive. AIA

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JURY

June Grant, design principal, Blink!Lab Architecture
Mónica Ponce de León, AIA, dean and professor of architectural design, Princeton University; founding principal, MPdL Studio
Bradford Prestbo, FAIA, director of operations, Placetailor

D

+ AWARDS

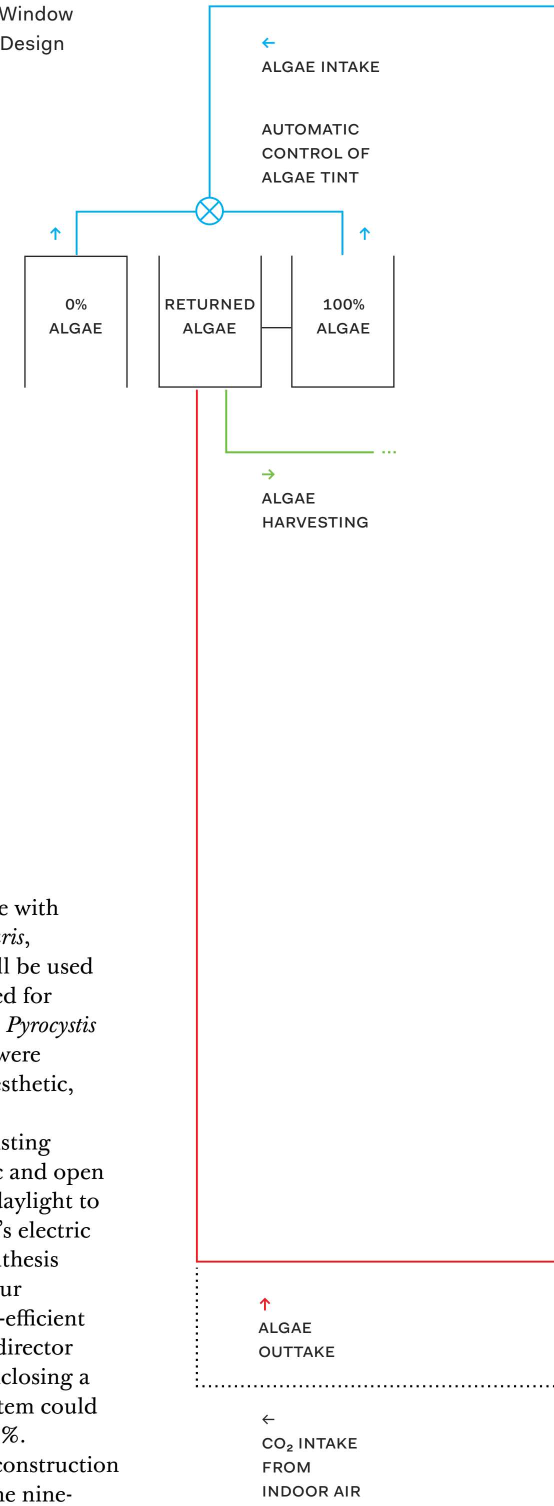
PROJECT TEXT BY MURRYE BERNARD, AIA
EDITED BY WANDA LAU

Few things can keep design-minded researchers—and research-minded designers—from iterating on potential solutions to societal and environmental concerns. From 62 entries, ARCHITECT's 15th annual R+D Awards jurors June Grant, Mónica Ponce de León, AIA, and Bradford Prestbo, FAIA, selected six winners that have made meaningful strides in tackling these challenges.

MIKE BASHER

> *For more images and full project credits, visit bit.ly/ARRD2021.*

Biochromic Window
Conceptual Design



MIKE BASHER

Toward Carbon Neutrality

High-Performance Biochromic Window

Integrated Design Research Lab, University of North Carolina Charlotte; Ecoclosure

In the era of climate action, a façade that reduces energy consumption and actively sequesters carbon can hardly come sooner. A microalgae window system by the Integrated Design Research Lab at the University of North Carolina Charlotte checks both boxes while cultivating a renewable energy source and supporting occupant wellness through improved indoor air quality and reduced glare and solar heat gain. The patent-pending unitized façade system serves a dual purpose by integrating photobioreactors with vision-glazed panels. The adaptable X-shaped microalgae growing modules interlock to form a latticelike structure, which is then housed within metal framing complete with a transom and mullions. The modules are factory assembled for quality control and suitable for whole-building retrofits or small-scale interventions, such as adding the system to existing windows like blinds.

The closed-loop system does not require fresh water or fertilizer. Ambient air—which contains carbon dioxide—enters through openings at the base and, warmed by the sun, rises through the latticework. The microalgae grow faster with more sunlight, providing the most shading in the summer. The oxygen they produce is pumped into the HVAC system. Fresh microalgae are pumped into the top of the system, while the carbon-loaded algae sink and exit through a pipe at the base. The harvested algae are transferred to a dewatering facility and then converted into biofuel.

IDRL has tested six strains of microalgae with a range of useful bioproducts: *Chlorella vulgaris*, *Chlorococcum*, and *Scenedesmus obliquus* can all be used as biofuel; *Haematococcus pluvialis* can be used for bioactive compounds; *Spirulina* as food; and *Pyrocystis fusiformis* as a bioluminescent. These strains were also selected based on their hardiness and aesthetic, including color and bioluminescence.

IDRL's innovation stands apart from existing microalgae façade products with its aesthetic and open pattern that still allows clear views out and daylight to penetrate the interior, reducing the building's electric lighting load. "Due to its innate … photosynthesis performance responding to solar intensity, our microalgae window contributes to an energy-efficient and healthy built environment," says IDRL director Kyoung Hee Kim, AIA. She estimates that enclosing a building completely with the microalgae system could reduce its energy consumption by 20% to 30%.

Architecture, engineering, biology, and construction management students have contributed to the nine-year-old project, building full-scale mock-ups and testing structural integrity and watertightness.

IDRL is now in the process of developing an artificial intelligence–powered system to control microalgae tint and color, depending on user needs for visual and thermal responses, which will further distinguish this technology from its precedents.

"Algae projects are tough to fall in love with because it's not always pretty stuff. This system takes an aesthetic and functional approach to create an interesting and attractive solution."
—Juror June Grant

Robotic Construction **The Glass Vault**

Skidmore, Owings & Merrill; CREATE Laboratory, Princeton University; Form Finding Lab, Princeton University

Construction Sequence

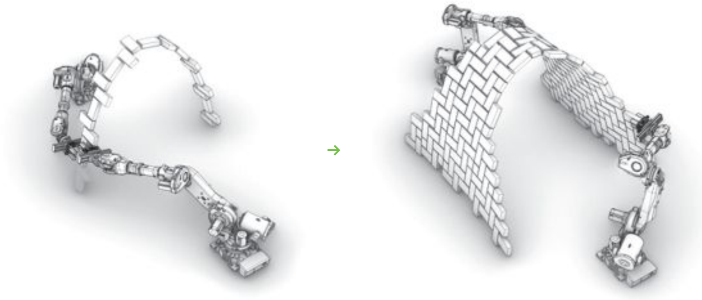
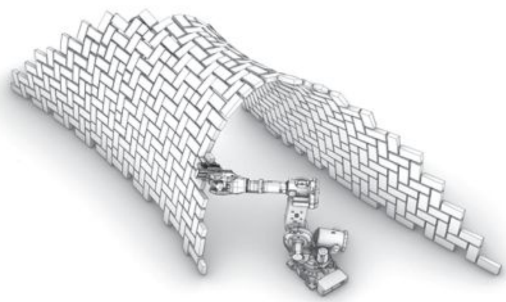


DIAGRAM: ISLA XI HAN/CREATE LABORATORY, PRINCETON UNIVERSITY



"The success of the installation shows the impact that robotic solutions can have on the construction industry—they're not just stacking vertical walls, but also creating complex shapes."
—Juror June Grant

MACIEJ GRZESKOWIAK/SOM

Humans and robots have worked side by side in the automotive industry since the 1960s. With modern robotics, architects and engineers are now testing advanced models of enhanced construction and fabrication.

The Glass Vault project, a collaborative effort by Skidmore, Owings & Merrill, Princeton University's CREATE Laboratory and Form Finding Lab, and TU Delft Glass & Transparency Research Group, is a notable example. Two human-scale, fixed-in-place robotic arms, provided by Global Robots and assisted by humans, can assemble a self-supporting, doubly curved, and visually stunning masonry shell 7 feet tall, 12 feet wide, and 21 feet long.

Also known as a timbrel vault, the thin and highly efficient structural system comprises a series of masonry arches that carry loads in compression. Building such a vault is labor intensive, but leveraging robotics may change this. "Our research focuses on how robots and humans can collaborate to achieve structures that each cannot build alone," says CREATE Laboratory director and assistant professor of architecture Stefana Parascho.

The robots begin by constructing a single arch at the vault midspan. One robot uses an angled gripper to act as centering while the other robot positions and adheres the next brick. The robots alternate tasks until the first arch is complete and self-supporting. The robots then work separately to build out the vault in opposite directions. Meanwhile, humans serve as mason tenders, adding bonding material—rigid epoxy—to each brick. "Stabilizing an almost fully constructed arch would be difficult for a human to do, but robots are built for exactly these tasks: providing support and precision," Parascho says. "Applying mortar or glue is a simple task for a human but would require vision or other sensors if performed by a robot. This is why we divide the work."

The overall form of the Glass Vault is intentionally asymmetric to prevent the robot's "elbows" from clashing while building the arch. The Princeton researchers tested several prototypes to identify one successful form achievable through meticulous choreography.

The transparent glass bricks, supplied by Poesia Glass Studio, are 10 times stronger in compression than their clay counterparts. All 338 units are the same size, yet their positioning creates joints that range from approximately 0.25 inch to 0.5 inch. For the larger joints, the human steps in to add a small acrylic filler. By allowing robots to do what they are good at—precise, repetitive tasks—and humans to handle the judgment calls, this construction process is the modern version of craftsmanship.

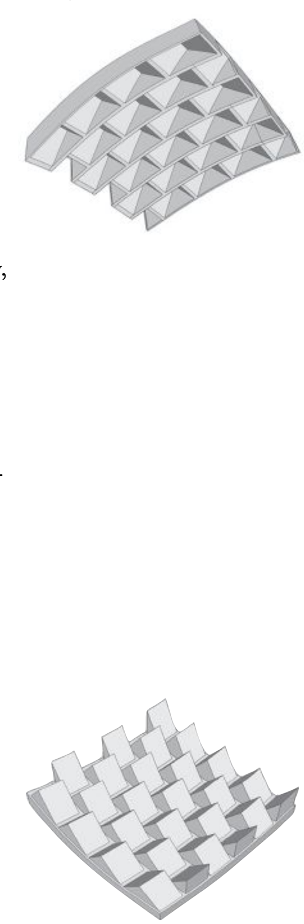
The final prototype was assembled before an audience during the March 2020 exhibition "Anatomy of Structure: The Future of Art + Architecture" at the University of Westminster's Ambika P3 gallery, in London. The team of robots and humans completed the Glass Vault in two weeks, working only during exhibition hours.

The panel surface and interior porosity provide cavities that absorb soundwaves via loss to friction.

ADALAC Acoustically Diffuse & Absorbent Lightweight Aerated Concrete

Daniel Butko, University of Oklahoma

Prototype Geometries



DIAGRAMS: ZACHARY MAGGIA; EMILY BUTKO

Anyone working in a minimalist, industrial office will likely attest that spaces filled with hard surfaces can quickly become echo chambers. Currently, concrete—planar, dense, and highly reflective of sound waves—is not the material of choice for acoustical mitigation. However, along with its inherent structural and thermal properties, concrete can be quite porous, not to mention amenable to experimentation with form. To test its noise-control capabilities, researchers at the University of Oklahoma (OU) are developing sawtooth panels made of acoustically diffuse and absorbent lightweight aerated concrete.

Designed for use on walls and ceilings, ADALAC panels can reflect, diffuse, and absorb sound frequencies related to everyday speech. Designers and manufacturers often address acoustical needs with materials that provide either absorption or diffusion, but not both, says Daniel Butko, AIA, associate professor of architecture at OU's Christopher C. Gibbs College of Architecture. To enhance the porosity of the 20-inch-square, 6-inch-thick panels, Butko and his collaborators, which include Zachary Maggia, AIA, added a powdered aluminum admixture that reacts with the cement during hydration to create hydrogen gas bubbles. The sawtooth structure of the panels, with a subtle convex or concave geometry, was optimized through computational design with the aim of creating an economical, modular solution.

The team measured the panels' sound absorption, reverberation times, and noise reduction capabilities in the laboratory. Covering 20% to 37% of a room's wall or ceiling with ADALAC panels yields a 40% to 55% reduction in reverberation times in speech frequencies—at least double the performance of existing aerated precast wall panels on the market.

"Future research will explore utilizing recycled aluminum powder to reduce dependence upon new aluminum, replacing approximately 40% of the cement with fly ash, and developing a method of capturing or exchanging the excess heat created during hydration," Butko says. He is currently pursuing additional grants and partnerships to further explore the panels' viability in commercial markets.

DANIEL BUTKO

"The researchers took a thorough approach in exploring the relationship between material and geometry in order to think about utilizing concrete differently in the industry."
—Juror Mónica Ponce de León

Cove.Tool An App to Optimize Building Design for Sustainability

Cove.Tool

Architects have longed for software that can estimate project energy use across different building systems, address inevitable client questions on investment, and generate visual and understandable results. In 2017, Patrick Chopson, AIA, and Sandeep Ahuja began the process of automating the meticulous and often repetitive tasks involved in building energy modeling while running their Atlanta-based sustainable design consultancy, Pattern R+D. Daniel Chopson, Patrick's brother, soon added his software development experience to the effort and within a year, they had a beta version of Cove.Tool—and a promising startup to boot.

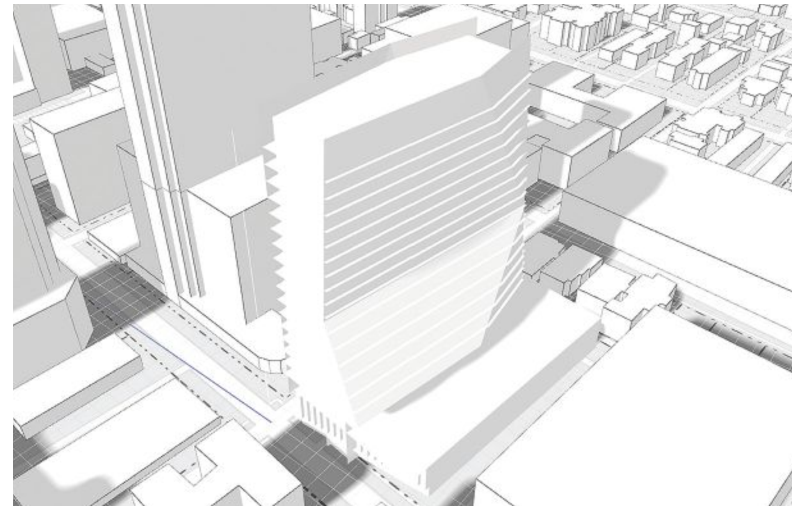
The cloud-based app optimizes for project cost while considering multiple parameters. The software runs thousands of simulations to find the lowest-cost solution to meet the desired performance target, which can be as simple as code compliance or as ambitious as net-zero or net-positive energy design. Not only can Cove.Tool assess performance through the different design phases, but it also can identify opportunities for greater savings in cost, energy, carbon, and water consumption.

The program offers a holistic solution, freeing architects from the task of finding different software for each design parameter, such as daylighting or HVAC. While several existing programs can facilitate project delivery, Ahuja says, "these highly fragmented standalone specialized 'hero' applications do not communicate through a functional data structure." Remodeling a building in each application can take upwards of 100 to 200 employee-hours, she estimates. Cove.Tool uses a room-identifying algorithm to convert models created from common platforms, including Autodesk Revit, Sketchup, Rhinoceros, Grasshopper, and Archicad, for its analyses.

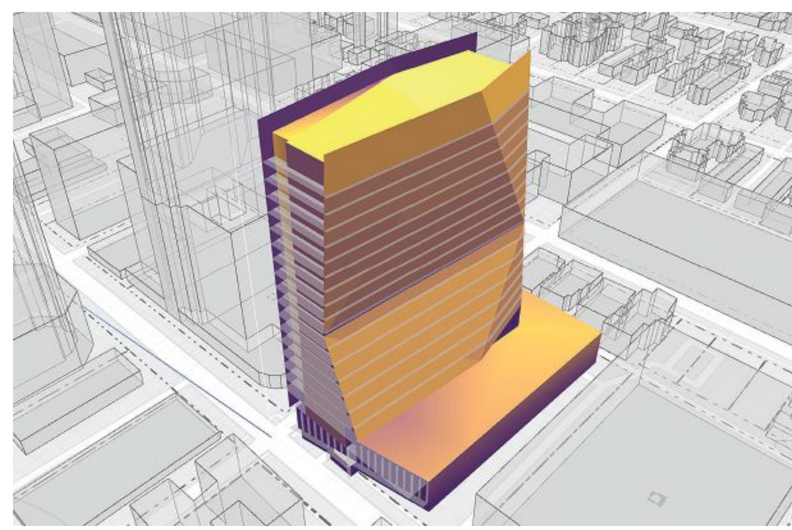
With more than 12,000 users to date, Cove.Tool aims to become an automated sustainability consultant that firms and projects of all sizes and budgets can afford to hire, so to speak. Indeed, one of the startup's objectives is to democratize access to building performance analysis tools and information.

Guided by user feedback, the Cove.Tool team rolls out new features on a weekly basis. Coming soon, Ahuja says, is a 3D drawing tool with which users can "draw, modify, and collaborate on their early-stage designs directly inside the Cove.Tool platform to get beautiful, automatically closed geometry."

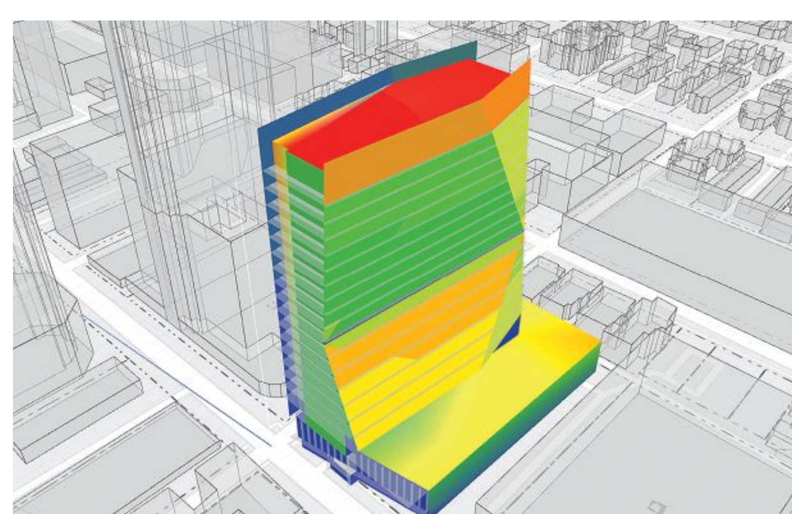
Shadow Study



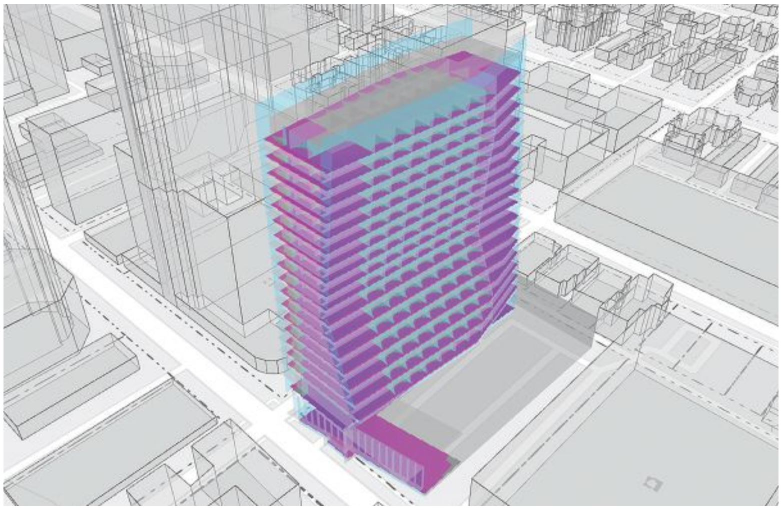
Radiation Analysis



Sun Hours Analysis

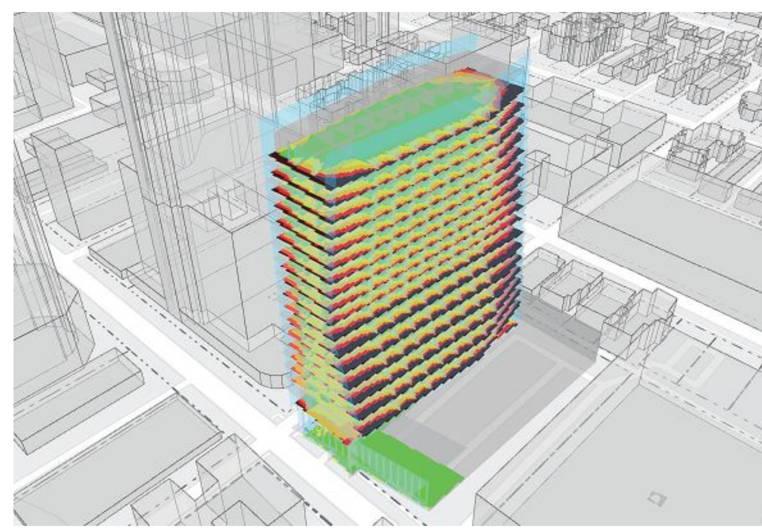


90° Sight Lines Study



Total Quality Views Study

Annual Sunlight Exposure Analysis



"Cove.Tool's quick response time and iterative feedback loop are advancing the incorporation of sustainable design practices in architecture. The startup is part of a growing grassroots movement to democratize technology in the industry."
—Juror Bradford Prestbo

COVID-19 Occupancy Assessment

Spatial Daylight Autonomy Analysis

COURTESY COVE.TOOL

"Front Flats demonstrates what can be accomplished at scale today when disparate technologies, which have been available, are integrated at a high level."
—Juror Bradford Prestbo

HANNAH YOON

LEFT: COURTESY ONION FLATS; RIGHT: DEMETRIOS VAROUMAS

Front Flats

Onion Flats

Philadelphia's Kensington neighborhood has been called the largest open-air narcotics market for heroin on the East Coast. But as the area steadily gentrifies, it seeks a different *cause célèbre*: net-zero living.

In 2017, local architecture/development firm Onion Flats purchased the lot across from its office, located along the elevated rail tracks between Fishtown, a neighborhood that had fully gentrified into a hip arts and dining destination, and Kensington, which was beginning to follow suit. Noticing that the area lacked affordable apartments, Onion Flats designed and built Front Flats, a four-story, multifamily residential prototype for economical, net-zero, resilient design. With 28 units—450-square-foot one-bedroom units and 320-square-foot studios—and rents below market rate, the development targets recent college graduates, service industry workers, and empty nesters fleeing the suburbs.

In a sense, Front Flats is mimetic. Photovoltaic panels wrap its roof and façades, advertising the energy savings happening within. "We treated the solar panels as a material in many ways," says Onion Flats president and CEO Timothy McDonald. Suspended 24 inches beyond the building exterior, the translucent bifacial panels fulfill three functions: They let natural light pass through inside, provide occupants privacy, and generate power—enough for Front Flats to be at times net positive.

Behind the PV arrays, prefabricated, super-insulated wall panels clad the building exterior—their specification reduced construction time by half. An innovative plumbing strategy placed water recirculation lines inside hot water supply lines, cutting heat loss by half, and decentralized the building's hot water source with multiple air-source heat-pump water heaters—which are all electric, naturally. Each apartment comes with its own compact Minotair HVAC and dehumidification unit, which uses no outside condensers and circulates indoor air through antimicrobial and HEPA air filters. McDonald says this decentralized approach is simpler, more economical, and easier to maintain than conventional methods.

Perhaps the team's biggest challenge was to design living units that would rent for less than their competitors, even though construction costs would be comparable. Front Flats' high performance has proven a draw to younger generations—particularly when they learn utilities are included in the rent.

Still, filling out the units out proved challenging because the development opened just two months before the onset of the COVID-19 pandemic in the U.S. But following a summer social media campaign touting the energy recovery ventilators' 24/7 air-scrubbing capabilities, the remaining units were gone within a month.

“The project team used architectural ingenuity to solve a real health care crisis during the pandemic.”
—Juror Mónica Ponce de León

LEFT: ALDO RODRIGUEZ;
ABOVE: FABIAN GARCILITA

Hospital COVID La Margarita

Kainsa; Movil Technologies

RIGHT: ALDO RODRIGUEZ

Like many cities worldwide, Puebla, Mexico, saw its emergency rooms overwhelmed during the first wave of the COVID-19 pandemic. Just a few years earlier, the city had lost its largest hospital to an earthquake—and had not yet replaced it. With many lives at stake, Puebla needed to act fast.

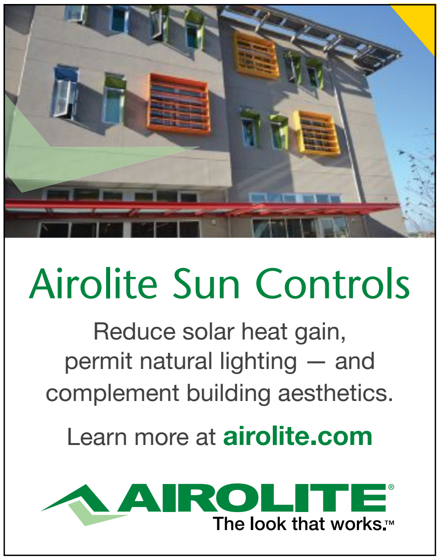
Health care projects can take years of planning and design before teams even embark on construction. The 17,000-square-foot, 40-bed Hospital COVID La Margarita was designed and built in 60 days through a public-private partnership between the Mexican Institute of Social Security (IMSS) and Movil Technologies, with construction by Kainsa. Despite the urgency, the team had the prudence to incorporate sustainable design strategies and technologies, resulting in the project's EDGE certification by the Green Business Certification Institute.

Precast concrete sandwich panels, with a high thermal mass and an R-15 insulation value, make up the hospital's interior and exterior walls. A steel-clad sandwich panel roof finished with reflective paint further lightens the hospital's heating and cooling loads. Other features include occupancy sensors paired with LED lighting and low-flow plumbing fixtures. Together, these efforts provide a projected savings of 66% in embodied energy, 28% in energy use, and 30% in water use, as compared with a baseline building.

The expected economic savings in building operations will help support staff training, recruitment, and the purchase of medicine and equipment. The project team also followed the World Health Organization's protocols and recommendations for space planning, which resulted in strict controls on the flow of patients, medical practitioners, and administrative staff based on isolation and transfer techniques.

The hospital serves as a prototype that can be replicated in different scales and locations, says Kainsa partner Eduardo Kuri. "It is a versatile system and perfect to reduce the lag in health infrastructure in the country." IMSS is planning to develop more EDGE-certified hospitals in Mexico.

Post-pandemic, the hospital will continue to serve the Puebla community, which remains vulnerable to earthquakes. The project team plans to add a surgery room, for which the existing architecture can readily be adapted.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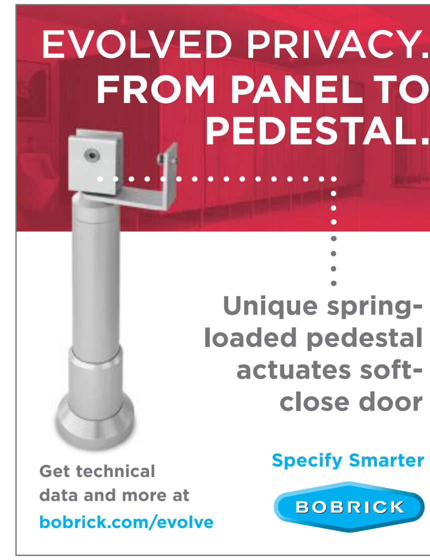
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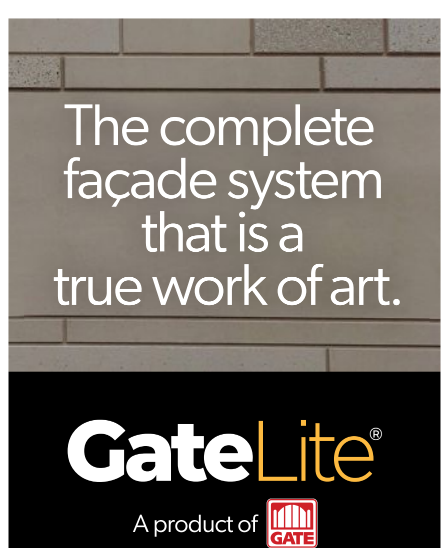
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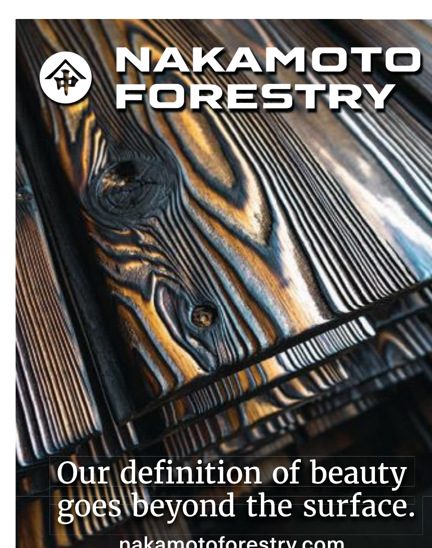
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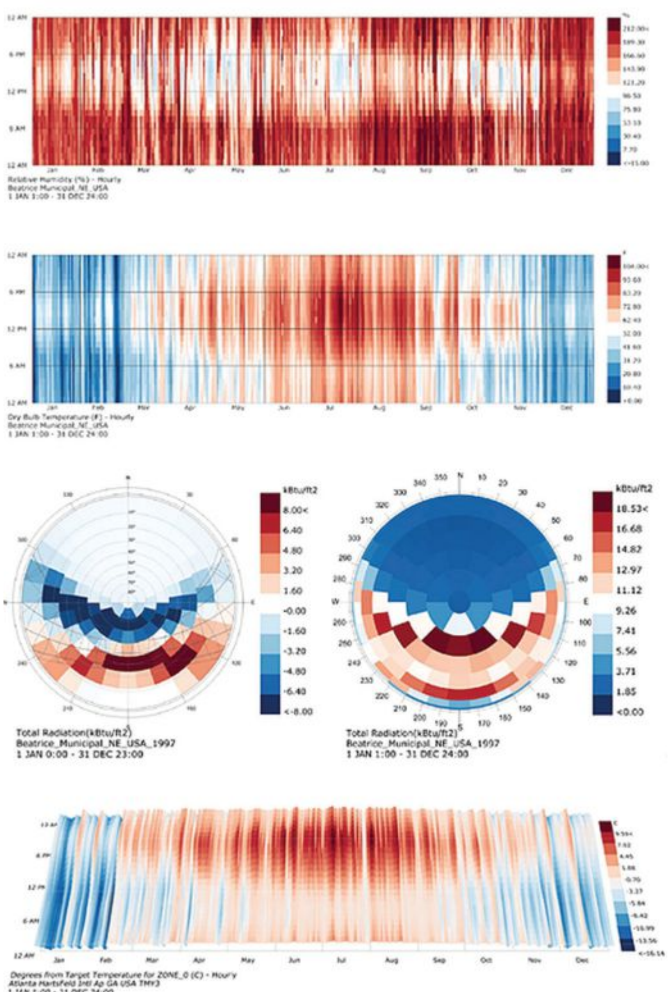
Editorial: Why R+D Matters

TEXT BY PAUL MAKOVSKY



Cove.Tool, one of this year's R+D Award winners, is a cloud-based app that optimizes building design for sustainability, and is part of a growing grassroots movement to democratize technology in the industy.

COURTESY COVE.TOOL

Research and development have always been one of the defining principles of the practice of architecture. The process provides powerful knowledge and insights, leading to smarter ways to design, create, and build.

Fifteen years ago, ARCHITECT held our first annual R+D awards as a way to showcase the often unsung work that designers and manufacturers put into refining their projects, products, and processes. Among the past winners, one from 2010 stands out: Adrian Smith + Gordon Gill Architecture's idea of decarbonizing a city—something that then was a novel idea but today is relevant to anyone in the building industry.

This year's six winners offer up innovative solutions to real-world problems—ones that make the built environment a healthier and more sustainable place to live, work, and play. Take Cove.Tool, as an example. This small, Atlanta-based startup, part of a movement to democratize technology in architecture, has created a cloud-based app—of the same name—with a quick response time and iterative feedback loop that not only estimates project energy use across different building systems but also presents its analyses in a beautiful and understandable way. The software adds a certain elegance to the process of designing better, more energy-efficient buildings.

Another winner, Robotic Construction: The Glass Vault—a collaborative effort by Skidmore, Owings & Merrill and Princeton University's CREATE Laboratory and Form Finding Lab, among others—is leveraging the specific abilities of robotics and humans to build structures that each group could not build by themselves.

The COVID-19 pandemic has hit hospitals hard worldwide, but that didn't deter a team in Puebla, Mexico, from designing and constructing a 40-bed hospital in just 60 days. If that wasn't impressive enough, the project also incorporated sustainable design strategies and technologies, which will provide savings in building operations that will help support staff training and purchase supplies. This is another example of the innovative and pragmatic solutions that design professionals can apply to real-world problems at scale.

At the time this issue headed into production, the Architecture Billings Index had reported days earlier that billings growth is near the highest levels in the history of the index. AIA chief economist Kermit Baker, HON. AIA, expects a sharp upturn in nonresidential building activity later this year and into 2022—great news for architects and the industry. But as the profession gets back to the business of building, we should remember that architects, designers, builders, and manufacturers like the R+D Award entrants—who take a chance on an idea and run with it—are showing us the way forward, through creative ways to improve the way we design.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