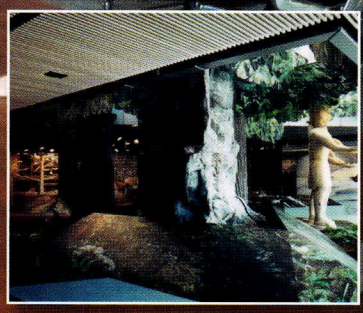
Oculus

Fall 2019

A Publication of
AIA New York
Volume 81, Issues 3 & 4
$10

THE FUTURE OF MATERIALS



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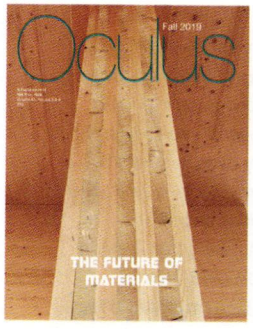
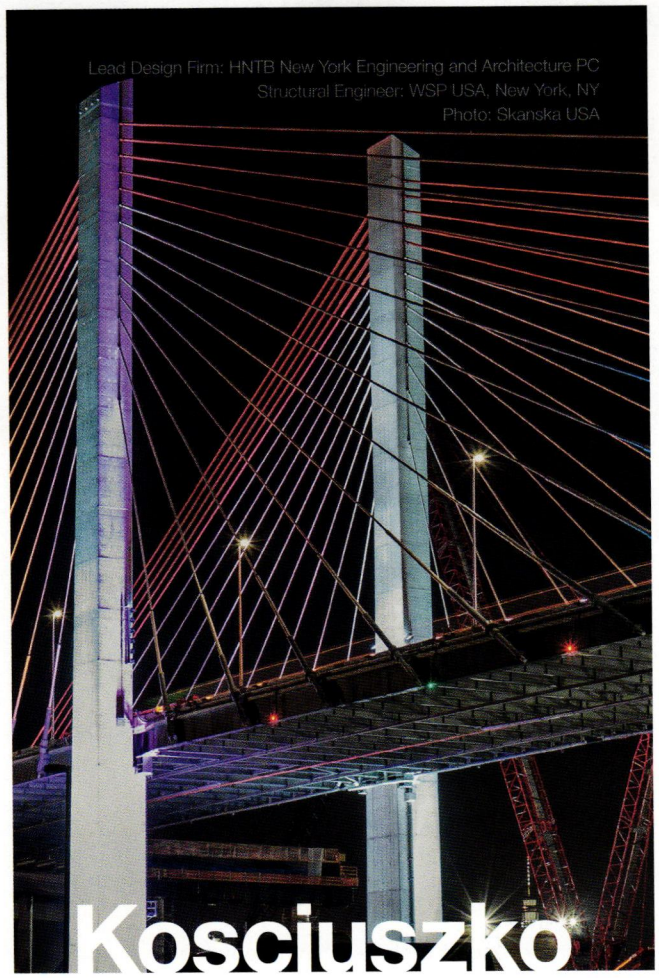
OCULUS FALL THE FUTURE OF MATERIALS



Cover: Detail of cross-laminated timber (CLT) produced by Katerra's new factory in the Spokane Valley in Washington, which aims to produce the largest volume of CLT in North America. Katerra's CLT is shown here in the offices of Catalyst, a five-story CLT building currently under construction in Spokane. The building is designed by Vancouver-based Michael Green Architecture (MGA), which was acquired by Katerra In 2018. MGA is leading the design of several other mass-timber construction projects, including an 11-story timber office building in Newark. Photo credit: Courtesy of Katerra/McKinstry

Above: Detail of Totomoxtle, a new veneer material made of corn husks, by Fernando Laposse, with Delfino Martinez, Lucia Herrera, and Noé Leon and featured in "Nature—Cooper Hewitt Triennial", on view through January 20, 2020. Photo credit: Courtesy of Fernando Laposse.

Corrections to the Summer 2019 issue: In the piece "Culture Pass," the name of urban planner and Princeton professor Chester Rapkin (1918–2001) was misspelled. Rapkin was a consultant for the Department of City Planning and later became a City Planning commissioner under mayors John Linsday and Abraham Beame. We regret the error. Clarifications to the piece "Affordable Housing, Not Included": Stanley Commons, designed by Dattner Architects, was mentioned in the context of the firm's Passive House work, but it is not a Passive House project. Dattner is working with Cypress Hills Local Development Corporation (CHLDC) on Chestnut Commons, but it is not working on CHLDC's Basement Conversion Pilot Program.



Kosciuszko à Gogo

The design of urban infrastructure affects city life as much as the design of its buildings. That's why replacing the **Kosciuszko Bridge**—a notorious pinch point in traffic between Brooklyn and Queens—was a high priority for Governor Cuomo. With heavy lifting from **HNTB**, **WSP USA**, and **Skanska**, a striking cable-stayed span has risen where the outdated bridge once stood, ensuring New Yorkers may still have trouble saying its name, but they never have trouble getting home. Read more about it in **Metals in Construction** online.

Oculus

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Fall 2019 Vol. 81, Numbers 3 & 4

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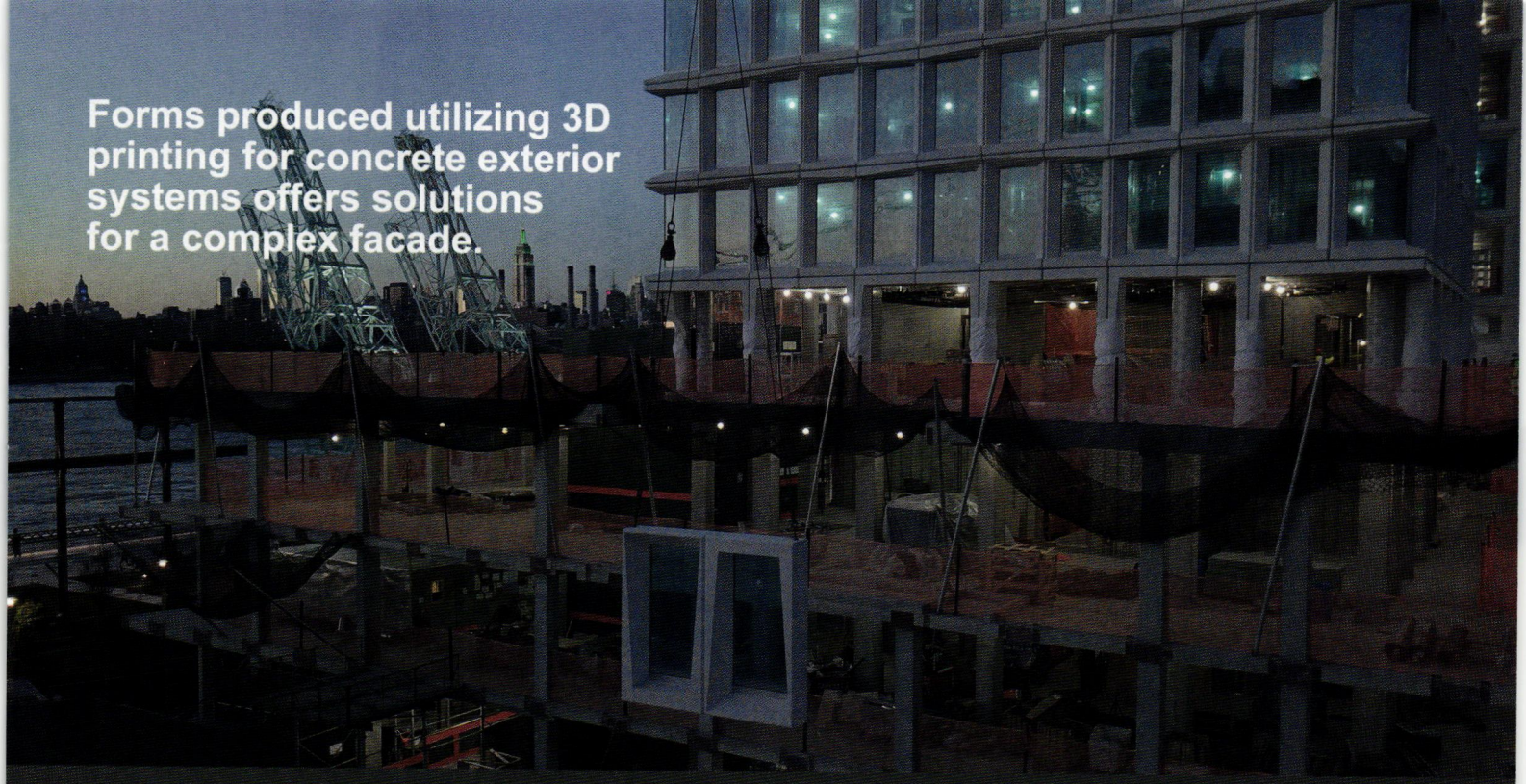
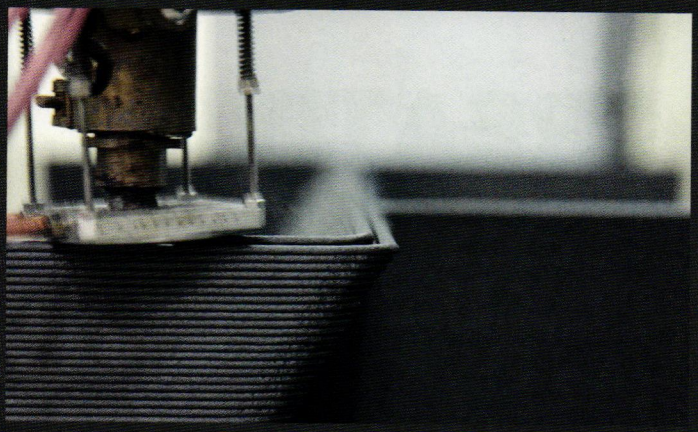


Forms produced utilizing 3D printing for concrete exterior systems offers solutions for a complex facade.



As part of a research project to verify the transformative possibilities of 3D printing for concrete applications, Gate Precast Company is using 3D printed forms in the production of a 42-story tower in Brooklyn, NY, clad exclusively with polished and acid-etched architectural precast concrete.

Through a design-assist relationship, Gate Precast, Two Trees, and architecture firm COOK FOX refined some of the window profiles on the tower to make it cost effective and practical to make use of the 3D printed forms. The multi-faceted window panels include aluminum framing and glass pre-assembled and caulked at the plant prior to shipping to the jobsite, streamlining the installation of the façade.

Casting on the 3D printed forms also provided the added benefit of incredibly sharp details and improved finishes.

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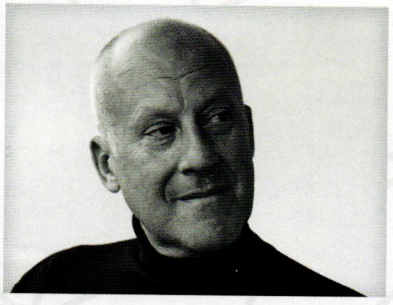

KEYNOTE SPEAKER: Norman Foster
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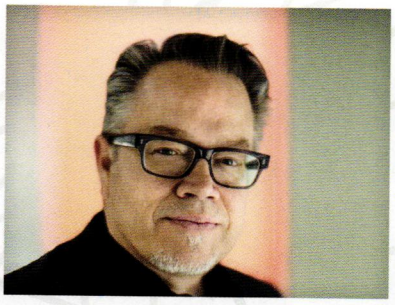

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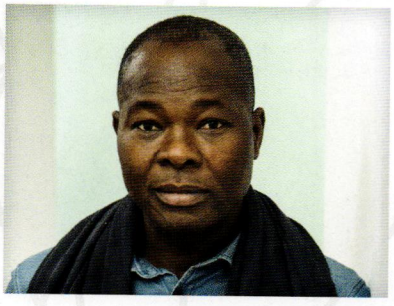

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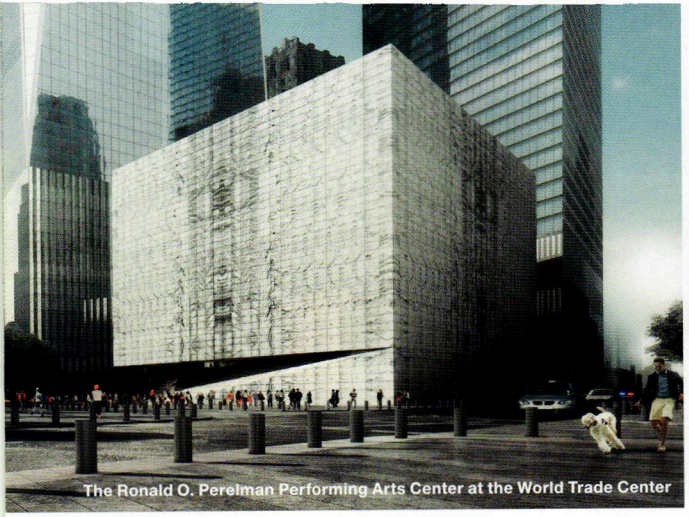

The Ronald O. Perelman Performing Arts Center at the World Trade Center


The Studio Museum in Harlem

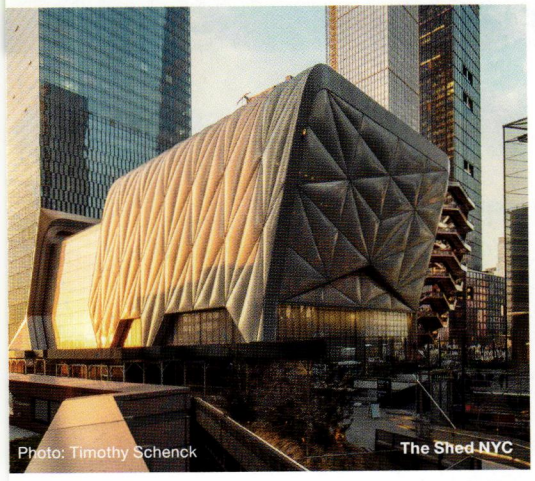
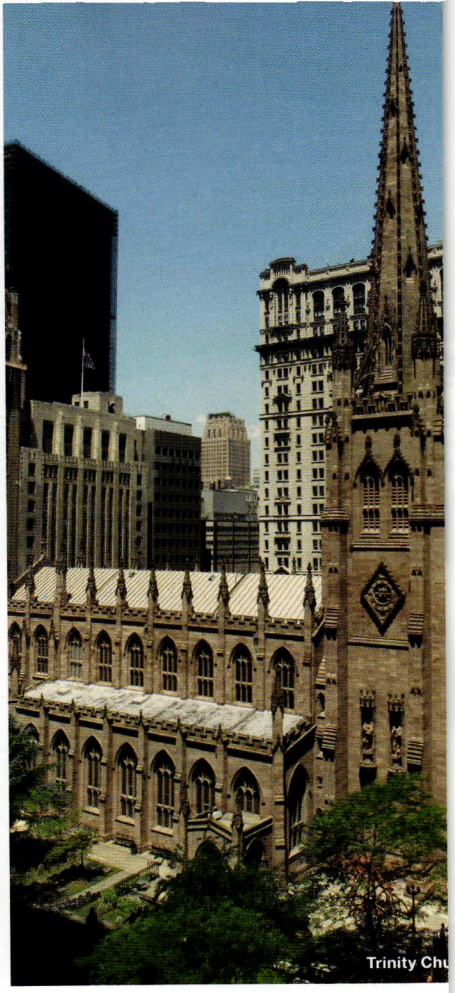


Photo: Timothy Schenck

The Shed NYC


The Frick Collection


Trinity Chu

The Ronald O. Perelman Performing Arts Center at the World Trade Center
Design Architect: REX
Executive Architect: Davis Brody Bond

The Studio Museum in Harlem
Architects: Adjaye Associates
in collaboration with Cooper Robertson

Trinity Church
Architect: Murphy Burnham & Buttrick Architects

The Shed NYC
Diller Scofidio + Renfro, Lead Architect
Rockwell Group, Collaborating Architect

The Frick Collection
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Executive Architect: Beyer Blinder Belle

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LETTER FROM THE PRESIDENT

LASTING IMPACTS

Photo credit: Ana Slade

As part of the 2019 presidential theme of Building Community, we have been focusing on the way our work impacts the broader community. As architects, we are constantly making decisions for others. In our most fundamental role, we translate the aspirations and needs of our clients into physical constructions. But the impact of our work ripples far beyond the clients who inform the goals of the projects. It is our role as architects to ensure that the built environment we are creating is for everyone, not just those establishing the project program. Though our projects are for the current occupants and broader community, our work is also for the future occupants and broader community. The decisions we make in shaping our structures are lasting—they often outlive the client and the design team—so it is clear why the responsibility to design thoughtfully is so critical.

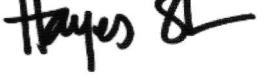
At the risk of stereotyping, I acknowledge that architects are often visual people, which can lead to a prioritization of the visual characteristics of our work over its other aspects. But we need to think about our projects more holistically than this. We need to think about the embedded aspects of the project, the tacit requirements imposed by our design decisions. We need to think not only of what we are building but how we are building.

One of the most glaring issues confronting our industry is that there are products and labor policies based on regular practices of forced labor (effectively, slavery). Over the past year, the AIA New York Chapter has been part of a working group looking for a way to address the issue of forced labor in the construction industry. The issue is a multifaceted one with thorns all around. There is the atrocity of forced labor in the production of construction materials as well as forced labor on construction sites. Currently, in other industries, there is much focus and attention on good stewardship, responsible sourcing, and lawful manufacturing practices. The construction industry, however, is lagging, and our product—architecture—has the longest life cycle. It's true that the challenge is particularly difficult in construction due to the fractured sourcing process, but that cannot be our excuse. We need to work to address this.

One recent and especially public example is the controversy Michelle Obama caused when in her 2016 address to the Democratic National Committee she reminded us that the White House was built by slaves. That is just fact. It is only a controversy because we are not comfortable with that fact and would rather not think about it.

A multidisciplinary group of AIANY members and outside collaborators headed by Sharon Prince, the founder of Grace Farms, has been working to chip away at the issue of forced labor in our built environment. I'm proud to be part of this task force, whose ultimate goal is to develop a standard, akin to LEED, for responsible labor practices. Sharon is concise in her assessment and often says, "Once you know about the forced labor embedded in a project, you can't unknow it." There is a long road ahead to birth a new standard for responsible labor; we are only at the start and will be reporting our progress.

Sharon is ideally suited for spearheading this work. At Grace Farms, a non-profit with a mission dedicated to justice and equity, she made a long-term commitment to the broader community and social responsibility as well as to architecture. In recognition of her work and commitment, we are delighted to honor Sharon with the NYC Visionary Award at this year's Heritage Ball, with fellow honorees Steven Holl (President's Award) and Phyllis Lambert (Center for Architecture Award). One of the most influential architects of our time, Steven's international body of work is defined by attention to context and his remarkable ability to blend space and light. Phyllis's legacy as an advocate for architecture is unparalleled. Not only has she raised the level of discourse within the profession through her own architecture, writing, and curation projects, but she is also a champion for the public's right to the best architecture, planning, and urban design. All three represent what's possible when we think beyond a single project to the potential ripple effects of our work on society at large. ■



Hayes Slade, AIA
2019 AIANY President

LETTER FROM THE EDITOR

THE NEW BUILDING BLOCKS

Photo credit: Nir Arieli

Over the last few decades, it's become clear that the expression "you are what you eat" applies just as much to buildings as it does to bodies. And, like a person, what a building consumes creates an impact far beyond any individual footprint.

In this issue, we take a closer look at the materials and material considerations that are changing the way we build today, from experimental compounds that offer a window into the future of construction, to ancient building materials, such as stone, that can now be accessed and evaluated in new ways. We've asked practitioners and researchers what construction materials have them most excited, and how they're applying their own research findings to projects of all scales. And we dive into changing standards for stamping a building with a clean bill of health, based on the implications of embodied energy on our climate.

A keen awareness of humanity's impact on the environment is reflected in conversations happening across many fields of design. An array of such projects is highlighted in the latest edition of the Cooper Hewitt Design Triennial, "Nature," on view through January 20. In February, MoMA will dedicate a show, "Material Ecologies," to the work of Neri Oxman, an architect and designer whose research creates a new vision for the convergence of nature with art and engineering (see Fred Bernstein's interview with MoMA curator Paola Antonelli on page 24 of this issue). Several new books celebrate the relationship between architecture and materials, including two stunners from Phaidon's fall list: *Stone*, by William Hall, and *Ezra Stoller: A Photographic History of Modern American Architecture*, by Pierluigi Serraino.

From here I yield the floor (and the remainder of this page) to some of the architects, designers, and researchers who generously offered their own insights for this issue, and thank our team of contributing writers who temporarily immersed themselves in new material worlds. We hope you find the work and possible futures presented in this issue as thrilling as we do. ■

Molly Heintz

Molly Heintz
Editor-in-Chief
editor@aiany.org

From current favorites to future wishes, a sampling of the materials on the minds of architects, designers, and researchers:

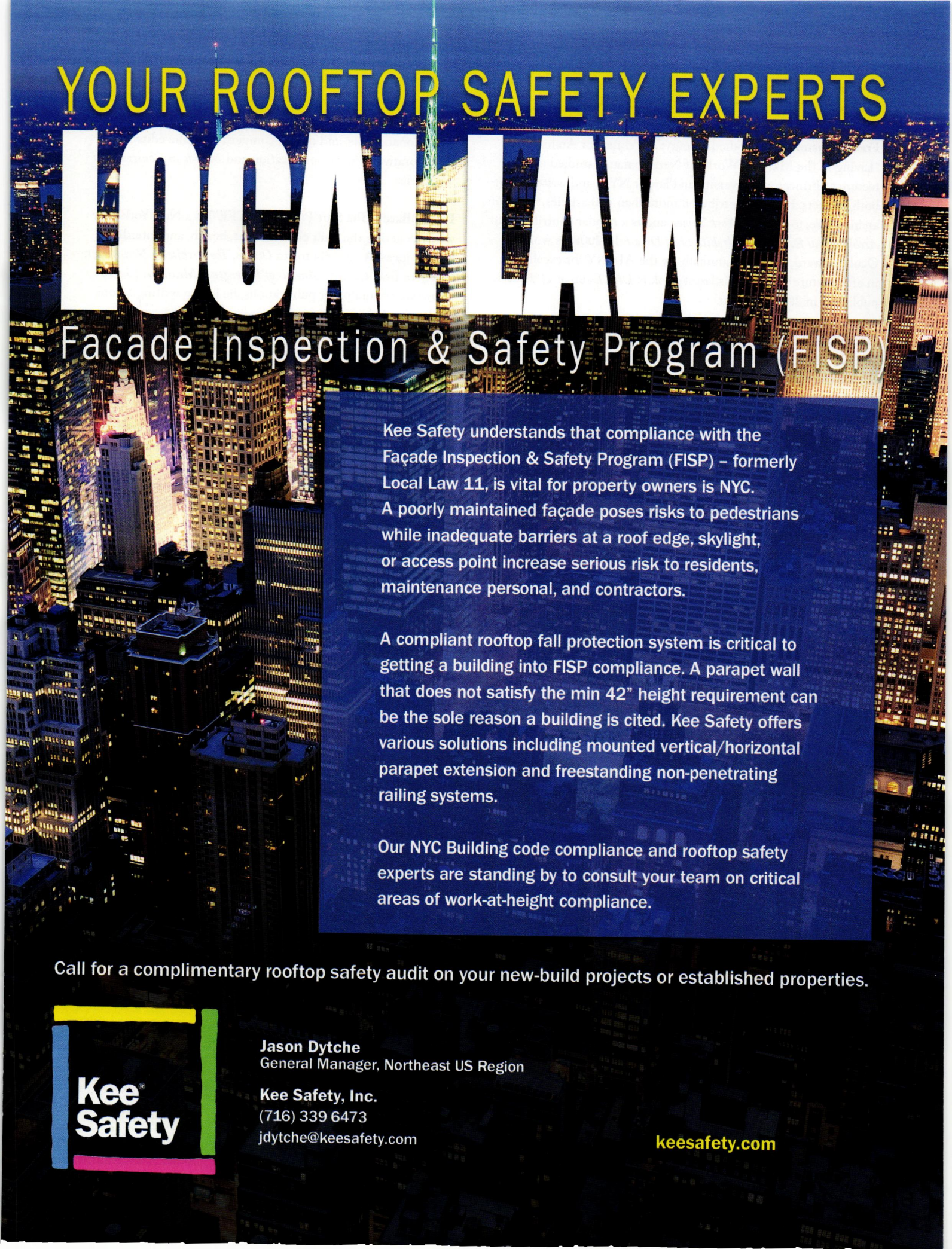
"Sheet pile can be the answer for site retaining walls in tight spaces. Naturally weathering to warm brown, its aesthetic blends well with plants, wood, and other warm metals."
—Signe Nielsen, FASLA, Principal, Mathews Nielsen Landscape Architects

"Lately I've been thinking a lot about light as a material. I've been experimenting with some of the physical aspects of photography, such as light-sensitive papers and emulsions, looking for ways to marry those analog, traditional techniques with new tools of digital fabrications."
—Noa Raviv, designer and technologist

"A material I hope will exist in the future is one that helps our indoor environment become probiotic—that is, to support those invisible microbes that are conducive to a healthy, environmental microbiome. On this, see research by the BioBE center in Oregon, and also some experiments by the architect David Benjamin to create bio-receptive surfaces."
—William Myers, curator and author of *Biodesign: Nature + Science + Creativity*

"We are currently in awe of an acoustical product by Baux, which we're hoping to use on the ceiling of some public spaces in an apartment building. Their Acoustic Pulp is made of sustainably harvested Swedish fir and pine trees, recycled water, non-GMO wheat bran, potato starch, plant-derived wax, citrus fruit peels, and no chemicals. It sounds like something you could eat."
—Lauren Schlesinger, AIA, and Adam Glickman, AIA, Principals, Glickman Schlesinger Architects

"A lot of our projects require particular consideration of acoustic performance. In spaces where there is an emphasis on pure forms and the play of natural and artificial light, finding monolithic materials that also lend acoustic attenuation are very hard to come by, outside of acoustic plaster products that are expensive and hard to maintain. We'd love to see innovation in a wider range of acoustic materials that can be applied to a substrate or that have an inherently abstract expression."
—Miriam Peterson and Nathan Rich, Principals, PRO-Peterson Rich Office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Fred Bernstein ("Embodied Energy: A Primer for Architects," "Living in the Material World of Neri Oxman") studied architecture at Princeton University and law at NYU, and writes about both subjects. He has contributed more than 400 articles, many on architecture, to the *New York Times*, and is a regular contributor to *Architectural Record* and *Architectural Digest*. In 2008 he won the Oculus Award, bestowed annually by the AIANY for excellence in architecture writing. His latest book is *Dirk Denison 10 Houses*, published in 2018 by Actar.

Natalie Dubois ("Beyond/At the Center," "Material Innovation On-Site") is a designer and writer. After completing her Master of Architecture at the University of Toronto, she worked in design and architecture for six years before attending the School of Visual Arts Design Research, Writing and Criticism program. She is interested in writing about all aspects of design and its impact on our lives.

Katherine Fung ("Will This Material Change the Way We Build?') is a freelance journalist who covers design, social justice, and international stories. Her work has been featured in print and on-air for Public Radio International, WNYC, and Reuters.

Jennifer Krichels ("Street Level," "The Future of Material Specification") contributes to several publications and works with architecture and design organizations on projects including books, educational events, and design competitions. She edits FX-Collaborative's *Podium* publication and *Metals in Construction* magazine.

Bill Millard ("The Soft Power of ETFE") is a New York City writer covering the built environment, health, and interdisciplinary ideas. A contributor to *Oculus, The Architect's Newspaper, Architect, Icon, Content, Annals of Emergency Medicine, Metals in Construction,* and other publications, he is also writing a book on density and sprawl.

Stanley Stark, FAIA, NCARB, LEED AP, ("In Print") has been associated with *Oculus* since 2003 as a writer and illustrator. He currently has a position with the City of New York.

Alex Ulam ("Mass Timber Going Mainstream") is a freelance journalist who writes frequently about architecture and urban planning. His work has appeared in *Landscape Architecture, The Architect's Newspaper, The Nation, Discover, Macleans, The National Post of Canada, Archaeology*, and *The New Republic*.

Julia van den Hout ("Inside Track") is founder of the editorial and curatorial office Original Copy and editor of *CLOG*, an annual publication that provides a platform for discussion of one topic at a time. ■

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ON VIEW

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Archtober
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Archtober, New York City's annual architecture and design festival, returns for the month of October. Organized by the Center for Architecture and now in its ninth year, the festival has more partners and sponsors than ever before, with over 80 institutions and companies participating. New this year is a partnership with the city's three public library systems (Brooklyn, New York, and Queens), which will host tours, panel discussions, and special readings. Also new are the festival's Weekend Getaway partners, who will offer opportunities to explore architecture just outside of the city, like Philip Johnson's Glass House in Connecticut.

Solar Carve (40 Tenth Ave.) was completed in August. It's the first New York commission of Chicago-based Studio Gang.

Photo credits: Tom Harris, courtesy Studio Gang (left); Christopher D. Brazee, courtesy Queens Modern (top right); Todd Mason, Halkin Mason Photography (bottom right)

Top: Church of the Transfiguration in Maspeth, Queens, designed by Jonas Mulokas and completed in 1962. Bottom: The Sunset Park Interim Library, designed by Leroy Street Studio for Brooklyn Public Library, opened in 2018.

The festival brings together a plethora of events, including daily building tours of both new and old structures, workplace tours, open houses, lectures, film screenings, a conference, competitions, and parties. This year's Archtober will also include a nighttime boat tour of the city's illuminated skyline and expanded family programming. Additionally, the Center for Architecture will be home to the Archtober Lounge, where printed calendar guides and program information will be available. Register at archtober.org. ***ND*** ■

AT THE CENTER

ON VIEW

Center for Architecture
536 LaGuardia Place

Fringe Cities: Legacies of Renewal in the Small American City
Through January 18, 2020

Rendering, circa 1970, of the proposed Genesee Esplanade of the Central Business District in Saginaw, Michigan.

Photo credit: Courtesy of the Castle Museum of Saginaw County History

"Fringe Cities" presents the ongoing investigation into the impacts of post-war urban renewal on fringe cities, defined as small cities on the edge of larger ones. The research is being conducted by Boston-based MASS Design Group, a non-profit architecture firm that believes that architecture is never neutral, but can heal or hurt. Urban renewal, the practice of city redevelopment and slum clearance, destructively introduced highways and other large-scale infrastructure projects into historic neighborhood fabrics, often exacerbating issues of poverty and segregation. Fringe cities experienced urban renewal like their fellow metropolises, but unlike them, have not rebounded from the damage caused by these practices. The exhibition, also curated and designed by MASS Design Group, examines the problem and potential solutions by looking at four cities: Easton, PA; Saginaw, MI; Spartanburg, SC; and Poughkeepsie, NY. In addition to the exhibition, the Center for Architecture will host several additional "Fringe Cities" events throughout the fall. ***ND*** ■

At ground level, 25 Kent's two volumes are separated to create a pedestrian street between spaces for retail. At the third floor and above, a connector joins the north and south volumes, linking space for office tenants.

Photo credit: Caroline LeFevre, courtesy of Gensler

STREET LEVEL

OPEN HOUSE NEW YORK SPOTLIGHT: 25 KENT

BY JENNIFER KRICHELS

In the earliest days of planning for 25 Kent Avenue—Brooklyn's first ground-up, speculative commercial building in 40 years—Gensler's vice chairman, Joseph Brancato, FAIA, NCARB, could feel the energy of the surrounding Williamsburg neighborhood as he stood at the site, cyclists whizzing past in the avenue's high-traffic bike lane. In the five years since design and construction began at the mixed-use building began design and construction, Kent Avenue and the site's eastern border, Wythe Avenue, have surpassed their already-trendy reputations, giving rise to three new hotels. Each has its own nod to the neighborhood—the William Vale with Vale Park, an elevated green space that is open to the public, and The Hoxton and The Williamsburg Hotel, both with sunken courtyards and stepped amphitheaters open to the street.

Perhaps no building will be more inviting to the community, however, than 25 Kent. Gensler as design development architect and HWKN as design architect opted to bisect the site with a public pedestrian avenue flanked by double-height retail space and open-air plazas, with landscape design by MPFP. "That's what's so exciting here: building a building that's going to support the community, but also one that's going to be great for tenants," says Brancato. "We didn't do one at the expense of the other."

At the heart of the concept was the division of the building's mass into two "trays," split by the pedestrian thoroughfare and shifted off-center, to create plazas to the east and west. This shift also had the advantage of placing the northwest corner of the building outside an adjacent floodplain. Above street level, the trays are joined by a center connector, which grows larger as floors ascend. The tapered shape allows more sunlight into the pedestrian avenue and also creates a flexible floorplate for smaller tenants who might share conference rooms or café space located in the connector. As it splays up, the connector gets wider and offers more space for full-floor tenants.

Though the north and south façades have punched window openings, the size of the glazing (8 feet wide by 10 feet tall) gives the feeling of a curtain-wall façade while blending with the neighborhood's industrial brick character. The building's brick façade is a custom mix named "25 Kent Blend"—"like a nice coffee," jokes Brancato. The east and west façades and the connector are clad in curtain wall, offering big waterfront and neighborhood views and high levels of natural light from

Top: The building's south volume is shifted west to create a 120- by 60-foot landscaped plaza, a move recreated on the northwest corner of the site. Bottom: The connector's curtain wall glass is slanted 33 degrees from vertical.

Photo credits: Caroline LeFevre, courtesy of Gensler

anywhere on the floorplate. Gensler has shifted away from thinking about office buildings purely in terms of square feet, says Brancato, and here made sure to maximize slab-to-slab heights to give tenants ceilings between 15 and 22 feet high. "If you want to think about a great experience," he says, "think about volume."

Recently, two floors of the building were occupied by a temporary exhibition by Beyond the Streets, which was featuring more than 150 graffiti artists from around the world, along with performances, lectures, and films. When permanently occupied, the building, whose tenants have not yet been announced, will devote one-and-a-half floors, or about 80,000 square feet, to maker space and light manufacturing, a mainstay of Brooklyn's economy. Developers hope the building will also draw a piece of Silicon Valley to the neighborhood, where tenants may find lower rents and a larger base of young talent than in Manhattan.

From a vast private balcony, an amenity for the future tenant of the building's eighth floor, a view of Williamsburg's waterfront reveals heavy machinery clearing a formerly industrial plot of land for the long-promised expansion of Bushwick Inlet Park. "When we started in 2014, it wasn't certain this was going to become a park," says Brancato. Community pressure pushed those plans forward and, with any luck, the same community will bring 25 Kent to life as well.

Open House New York 2019 Kicks Off At 25 Kent
Thursday, October 17, 2019
6:30-9:30 PM
25 Kent Avenue, Williamsburg

Want to see the building in person? Join the official kickoff to the 2019 Open House New York Weekend at 25 Kent with food, drinks, and entertainment. Ticket proceeds help support OHNY Weekend, when more than 275 sites around the city will open their doors for a celebration of architecture and urban design, October 18–20. Visit ohny.org for tickets and more information.

Gensler Team: Joseph Brancato, FAIA, NCARB, Leslie Jabs, CDT, RA, Joe Lauro, Peter Wang, LEED-AP, RA, Anne-Sophie Hall, CDT, LEED-AP, RA, Joe Lo, LEED-AP, RA, Bryan Couchenour, RA, Wei Kou, AIA, CDT, NCARB
Consultants: Structural Engineer: DeSimone, MEP/IT/security/LEED: Cosentini, Landscape: MPFP, Building Enclosure: EOC, Façade Access: Entek, VT: VDA, Lighting: BOLD, Wind: RWDI

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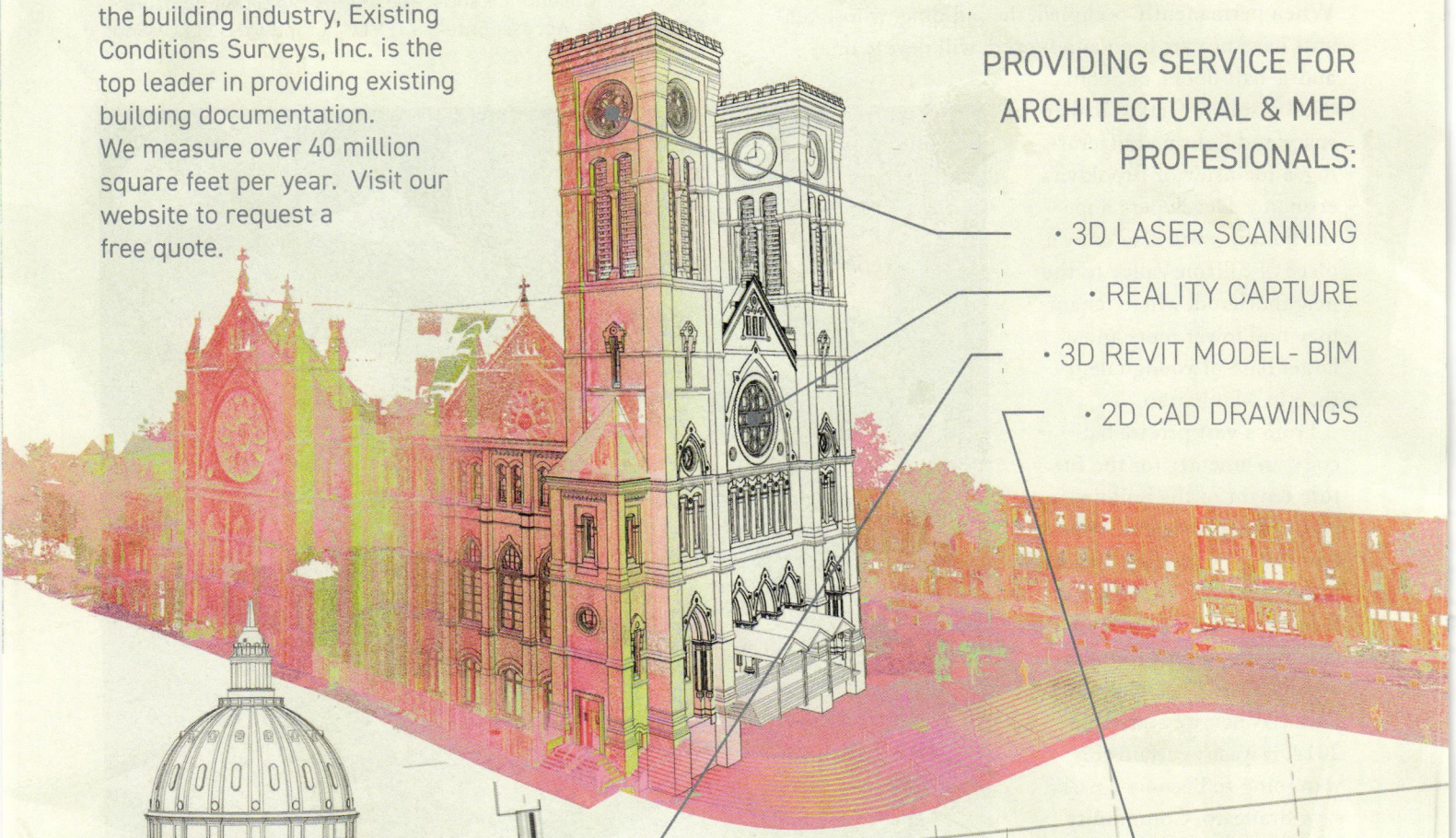

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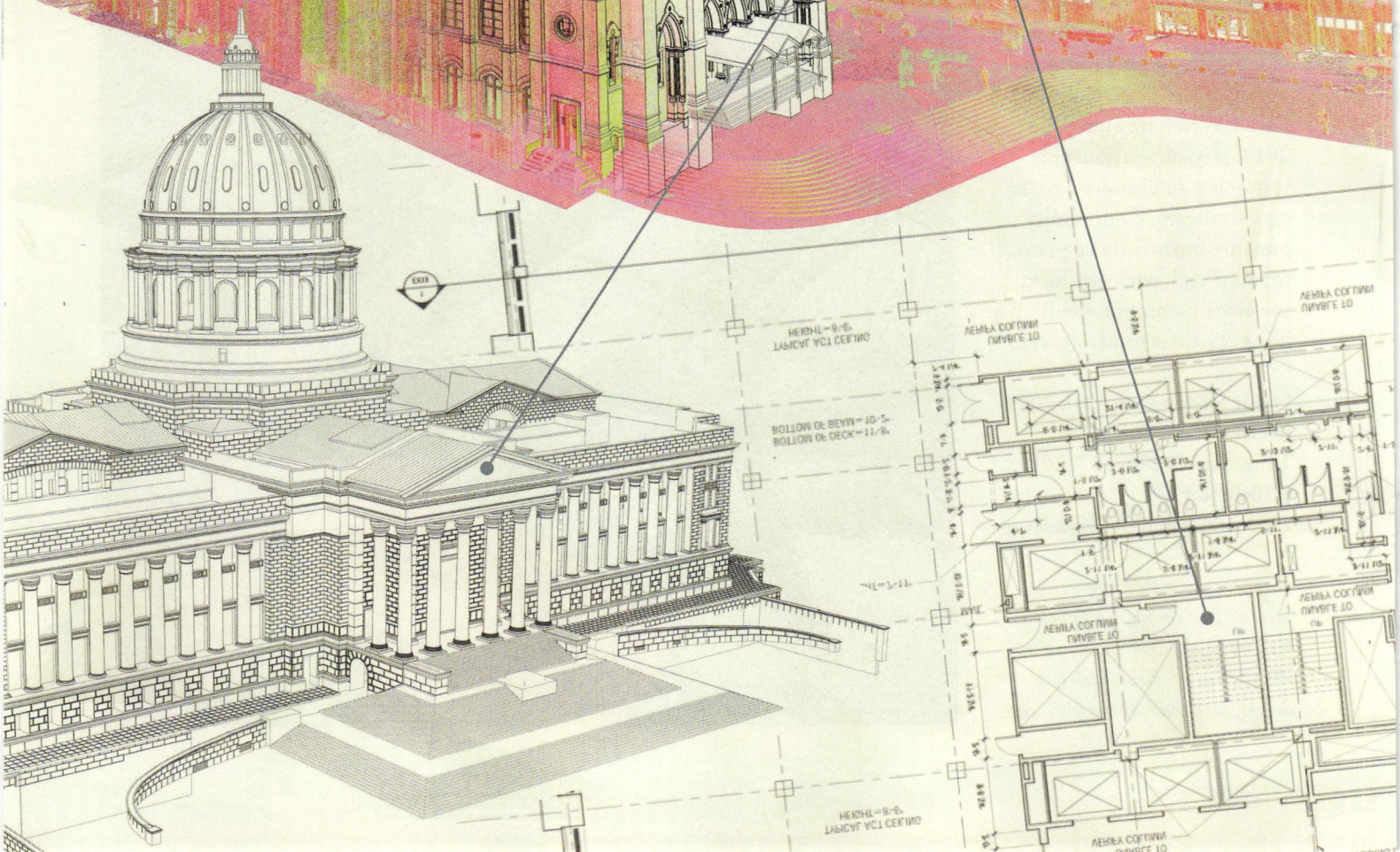


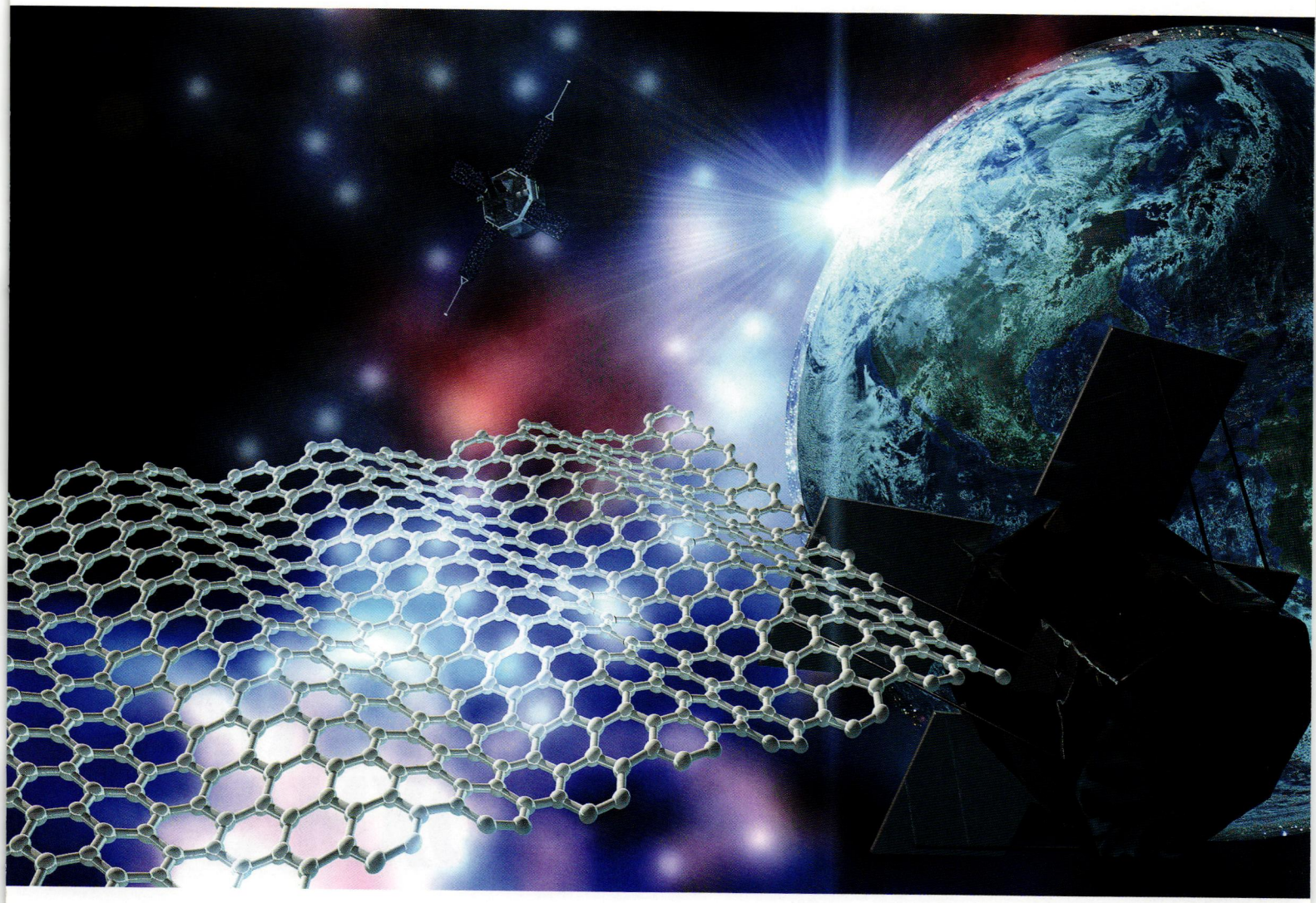


Image credit: Graphene Flagship

THE FUTURE OF MATERIALS

New materials in development like two-dimensional graphene are allowing architects and engineers to imagine groundbreaking applications on Earth and beyond.

A new generation of specially engineered products and tools is changing the way architects design and build.

In the pages that follow, we look at a selection of rapidly evolving building materials as well as the way architects themselves are playing an active role in materials research and development. Experiments in the lab, studio, and even on-site are yielding results that are inspirational and socially responsible, as the profession thinks about accountability not just to the client but the public and the planet. ***Molly Heintz*** ■

LIVING IN THE MATERIAL WORLD OF NERI OXMAN

An upcoming show at MoMA reveals a vision for how biology and the built environment intersect.

FRED A. BERNSTEIN SPEAKS WITH CURATOR PAOLA ANTONELLI

"The point is not just to display beautiful objects," says Paola Antonelli, the senior curator of architecture and design at The Museum of Modern Art (MoMA). She is describing "Material Ecology," MoMA's exhibition on the work of designer Neri Oxman, opening in February 2020. But Antonelli could be describing her entire career, in which she has filled galleries at MoMA and other institutions with striking objects that also illustrate important principles. For more than a decade, Antonelli has been following the work of Oxman, the founder (in 2013) of Massachusetts Institute of Technology's Mediated Matter Group, which focuses on the relationship between digital and biological fabrication in design and architecture.

Is this a retrospective?

It's too early for a retrospective! Neri is very young. Shall we call it a mid-career monographic show? Moreover, Curatorial Assistant Anna Burckhardt and I chose pieces that demonstrate new processes and new materials that are projected toward the future, not reflecting on the past.

Some of which might be used by architects?

Absolutely. Neri's group is working to develop tools that architects and engineers will be able to deploy.

Oxman, who originally trained to be a doctor, is known for her close study of natural systems. Back in

Opposite: Neri Oxman and The Mediated Matter Group's *Totems*, 2018. Architectural proposal for an environmentally responsive melanin-infused structure. Created for Design Indaba. Rendering by Eric de Broche des Combes, Luxigon. The glass structure is designed to contain multiple strains of melanin, naturally obtained on-site and biologically synthesized at the lab. It provides UV protection during the day, while enabling stargazing upon sunset. A first-of-its-kind biologically augmented façade, the structure is designed to protect endangered species on-site and to celebrate the diversity of life on our planet. Above: Neri Oxman and The Mediated Matter Group's *Totems*, 2018. Melanins are a group of pigments ranging in color from yellow to brown. The term "melanin" often refers to eumelanin, a particular type that is brown-black in color. However, other types, such as pheomelanin (yellow-red in color), also exist. This "library" represents the diversity of melanin, and includes constituent components of the reaction as well as melanin-containing natural materials, such as feathers and cuttlefish ink.

2008, when we started showing her work at MoMA, she was trying to understand and mimic nature. She would look at, say, the bark of a tree and try to distill algorithms from its growth patterns and surface behaviors, which she hoped to replicate in, say, building façades. From there her work evolved into harnessing nature directly.

Can you give an example?

Silk Pavilion II, the centerpiece of the upcoming show, is an architectural demo created by silkworms. After studying silkworms to understand how they behave in different conditions, Neri and her team created a framework for the silkworms to become the contractors on a building she designed. It's a very Italian relationship!

How so?

In Italy, it's considered rude for an architect to draw every last detail; the architect is expected to rely on the craftsperson and their expertise. That's the relationship Neri has with the silkworms: She's the architect and they're the expert contractors.

"Neri and her team created a framework for the silkworms to become the contractors on a building she designed." —Paola Antonelli

So there will be silkworms working at MoMA?

There's a silkworm blight in the United States right now. So the silkworms are working in Italy as we speak, and you'll see the process recorded on video. The finished pavilion will be at MoMA.

Are there any other living creatures in the show?

Neri is working with bees and ants, but it's too early for any real demonstrations.

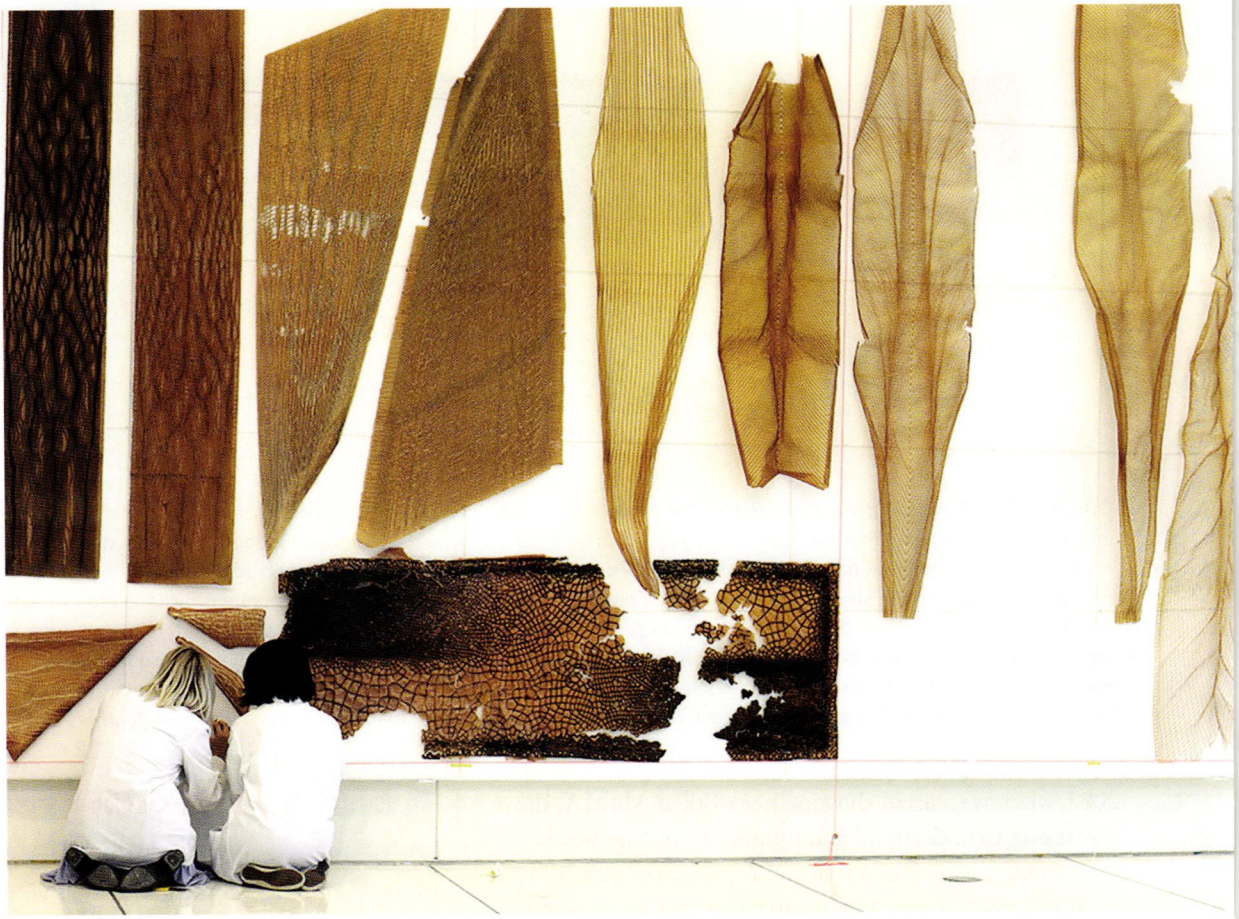
What other processes will the show display?

There will be demonstrations of the uses of the pigment melanin at an architectural scale, experiments that could in the future create biologically augmented façades that adjust to the movements and intensity of the sun and other stimuli. And there will be demonstrations of a process for 3D printing glass. We will show about a dozen of her projects, each accompanied by detailed explanations of the process.

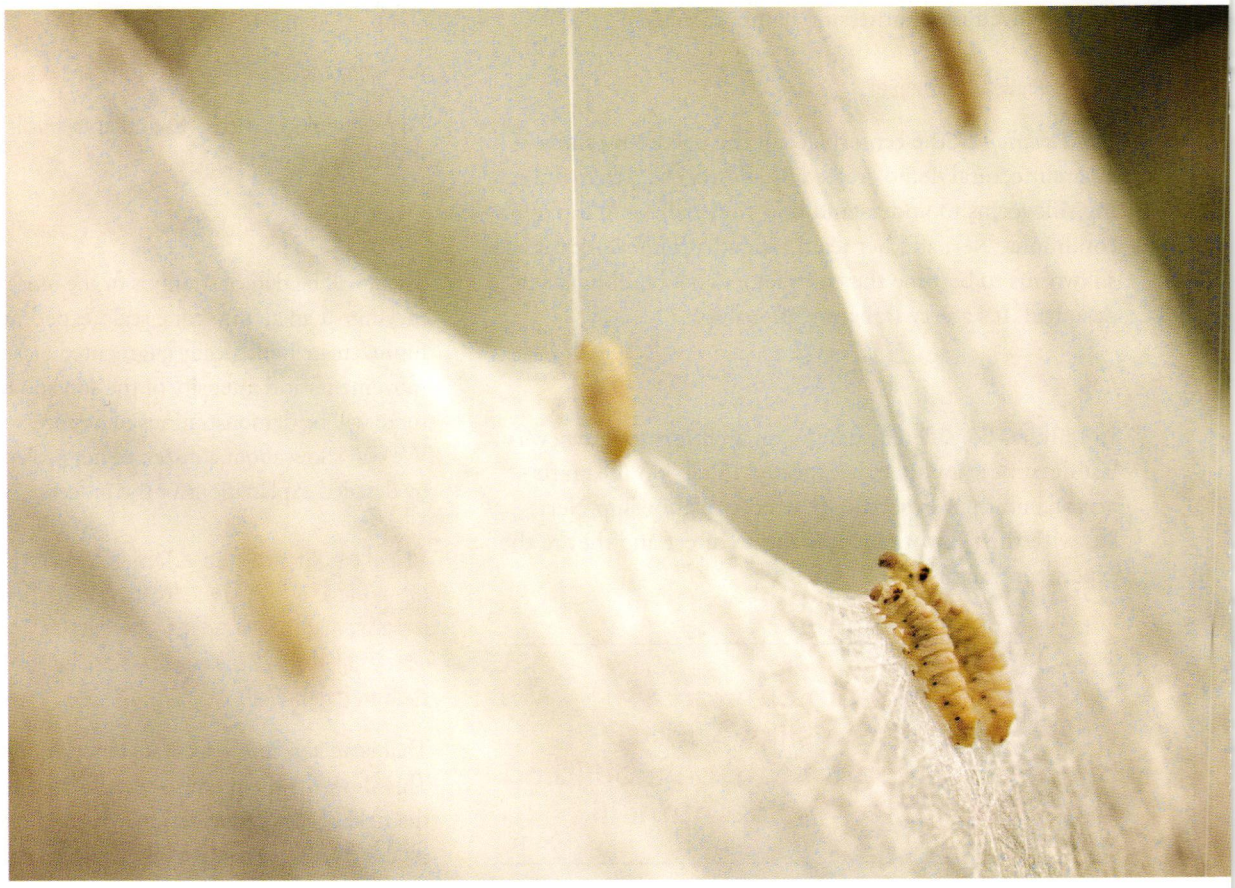
Your show "Broken Nature: Design Takes on Human Survival" (which ran at the XXII Triennale di Milano through September) had a startling premise: that the human race may be coming to an end, but we can use design to make the end more palatable, more elegant. Does this show fit that premise?

That is an absolutely accurate description of one of the premises. This show fits the premise because Neri is one of the leaders of the field of restorative design, which is about using design to establish a better relationship with nature.

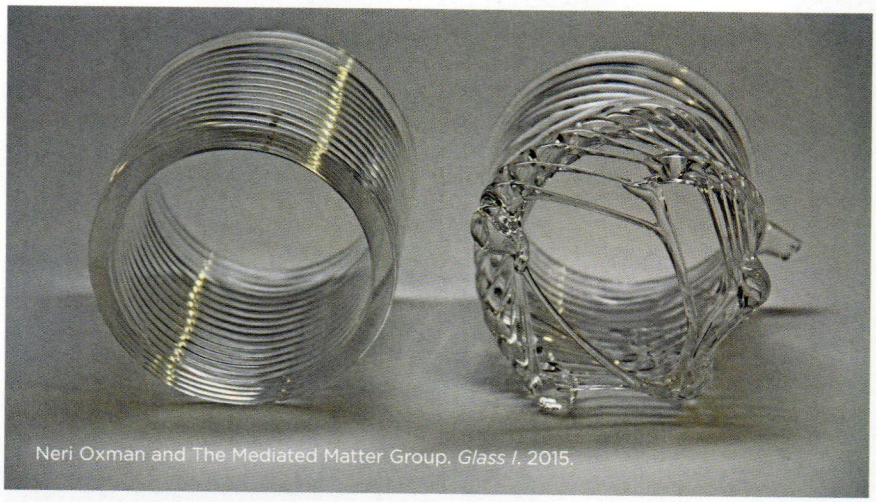
Photo credits: Neri Oxman and The Mediated Matter Group



Neri Oxman and The Mediated Matter Group. *Aguahoja I*.2018. The *Aguahoja* Artifacts Display: A catalog of material experiments spanning four years of research shows the range of aesthetics and behaviors we have been able to elicit in medium-to-large-scale prints via performative geometric toolpaths, generative design, bio-composite distributions, and variable fabrication parameters.



Neri Oxman and The Mediated Matter Group. *Silk Pavilion*. 2013. A *Bombyx mori*s ilkworm deposits silk fiber on a digitally fabricated scaffolding structure.



Neri Oxman and The Mediated Matter Group. *Glass I*. 2015.

Will the show address climate change?

In recent years I have been trying to address the climate crisis—which is also a political crisis—in every show I do. In this case, Neri's approach to the current predicament is to work with nature, learning from natural behaviors and including them in the design and building processes. It's a step in one of the right directions.

Is Neri doing architecture?

She is, and, as she likes to say, her client is nature. Neri is part of a group of architects and designers, including David Benjamin [whose work at Columbia University and at his firm, The Living, explores architectural applications of biological systems] and Skylar Tibbits [founder of the Self-Assembly Lab at MIT, which focuses on programmable material technologies], who don't feel the need to define themselves by finished buildings. Rather, they consider it their mission to develop new approaches and put them out into the world. It has happened in the past with people like Bucky Fuller, for instance.

"Think Centre Pompidou without the separate parts, but rather a single and continuous transparent building skin that can integrate multiple functions." —Neri Oxman

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Neri's work is often very beautiful. Is the urge to make the output look good a distraction from the goal of teaching people about science?

Some scientists are afraid that if their work is too formally elegant, they won't be taken seriously. That's always a risk, and Neri is a scientist. But in nature, beauty can be a statement—a way, say, for birds of paradise to attract the attention of potential mates. The beauty of Neri's work is also a way to attract attention. My job as curator is to take advantage of this attraction to expose the public to the underlying ideas.

What do you hope architects will take away from the show?

I hope architects will appreciate that the new tools are in their arsenal. And I hope they will leave with an enormous amount of inspiration. ■

Neri Oxman on the infinite possibility found in nature.

FB: Why should architects look to the natural world for inspiration?

NO: In the designed world—due to the limits of manmade materials and the technologies used to create them—it is not yet possible to match the resolution and sophistication of the natural world. Bricks are dumber than cells, and synthetic fibers are yet to fire electrical signals into the textiles they inhabit. But what if we can change that by creating new technologies that can vary the physical properties of matter at a resolution and sophistication that approach that of the natural world? If bricks were smart, buildings would likely weigh less, generate less carbon, and accommodate multiple functions in real time.

How will your work improve architecture?

The goal is to enable architects to overcome the existing mismatch between homogenous, single-property materials and environmental forces (like variable load and variable heat) by offering methods and technologies for digitally fabricating variable optics glass, variable density concrete, variable strength metals, and so on. Equally exciting is the ability to print glass with inner spatial pockets and channels that can contain other materials, augmenting an architectural façade with, for example, photosynthetic media or biofuel. Think Centre Pompidou without separate parts, but rather a single and continuous transparent building skin that can integrate multiple functions—not unlike the human skin, which serves as both a barrier and a filter. The prospect of this design approach—considering the building not as a machine but as an organism, a structure that's made of a single material system that can act, at once, as structure and skin—this thrills me.

Photo credits: Courtesy The Mediated Matter Group

INSIDE TRACK

Three faces of in-house R&D show how architecture can harness the environment.

BY JULIA VAN DEN HOUT

In 1942, at the height of World War II, the United States Navy reported an urgent need for new emergency splints to aid in the transport of wounded soldiers. The metal splints previously used were proving to be more harmful than helpful, as reverberations in the material only heightened impact on the injured during travel. Designers Charles and Ray Eames responded with a molded plywood leg splint, a lightweight construction of thin layers of veneer. Now collected and displayed by museums as elegant sculptural pieces, the wood splint was not only implemented for other military applications during the war, but was also a crucial first step towards what ultimately became the Eames's hallmark furniture designs.

Today it is not a war effort that occupies our design minds, but current ecological conditions. The urgency of climate change has spurred new research and development, and at the forefront of this effort are offices that have established dedicated in-house R&D teams.

Such offices approach research in a variety of ways—from project-oriented efforts to large-scale data-driven analyses. As a result, the outcome of in-house R&D can take many different forms: some may have a physical manifestation, others are informational only; some have commercial potential as products, others offer valuable data.

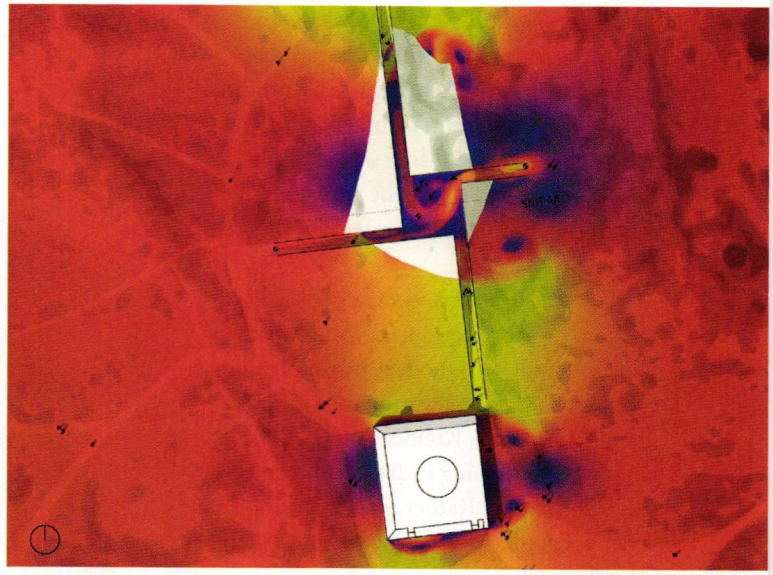
At BIG, a firm that has in several ways reshaped our perception of the traditional "architect," R&D often takes on an entrepreneurial role. In 2015, the office launched an internal division called BIG Ideas. With dedicated groups in both the Copenhagen and New York offices, BIG Ideas is in large part positioned as an in-house product design firm. "We're focusing

Facing page: The Gople Lamp, a collaboration between BIG Ideas and Artemide, was primarily designed as a grow lamp to stimulate photosynthesis indoors. Above: Another collaboration between the firms, Alphabet of Light, is a lighting system that allows designers to create unique lettering from a set of modular elements.

on elements outside the building itself—things that are outside the typical scope of an architect's work," explains Erik Berg Kreider, senior industrial designer at BIG Ideas. "It's about increasing the sphere of influence on our built environment."

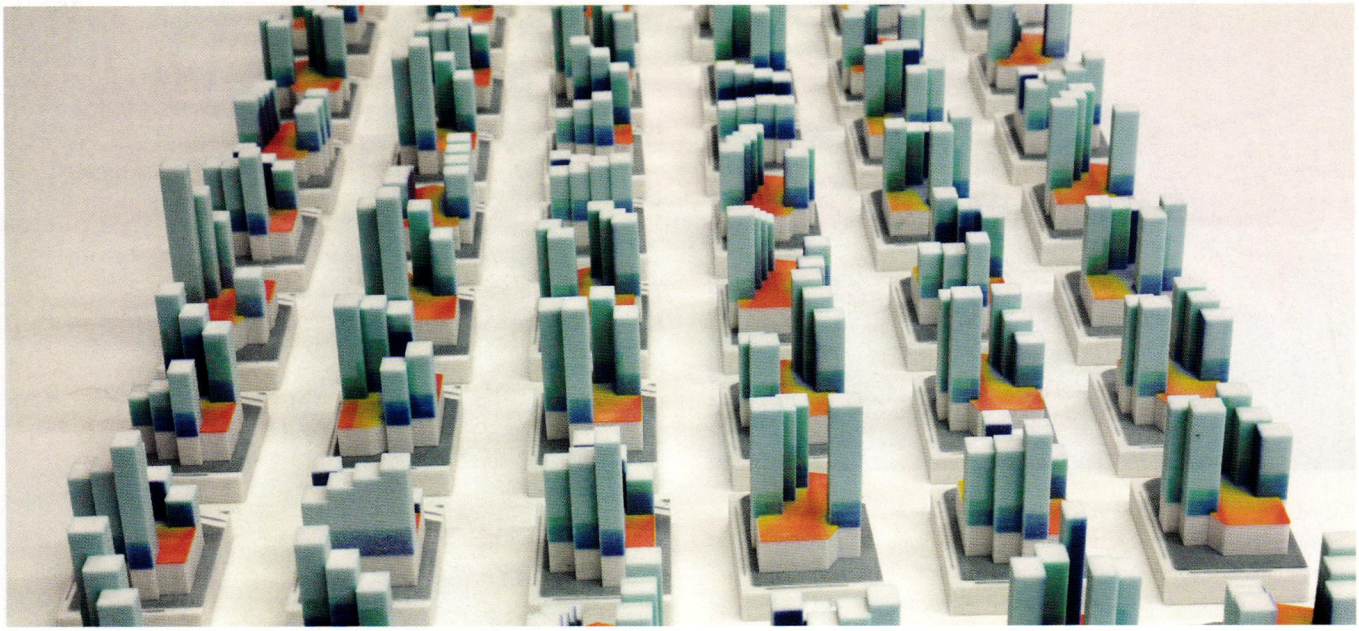
While this endeavor within BIG is driven by the firm's signature fresh mix of curiosity, opportunity, and ambition, the concept is not exactly new. In essence, after all, this is a continuation of the notion of the *Gesamtkunstwerk*. When the design team has an idea for a fixture, piece of furniture, or system that does not yet exist, the BIG Ideas team tackles it as a new project. "We work to create something that is tailor-made for what we need, and something we think would improve a living or working condition," says Kreider. Often such projects result in new product designs, such as the Alphabet of Light, a modular lighting system that was produced in collaboration with Artemide, an Italian lighting manufacturer. Through magnetic connections, any letter can be shaped from illuminated tubing. Another lighting product that came out of the BIG Ideas team, in 2016, is its Gople Lamp, a pill-shaped Venetian glass fixture that is described by Artemide as "intertwining modern technologies with artisanal traditions."

"We work to create something that is tailor-made for what we need, and something we think would improve a living or working condition."
—Erik Kreider



Top: A plastic-bristled tile developed by the BIG Ideas team forms a synthetic ski slope at the firm's Amager Bakke/Copenhill project, which officially opens this October. Bottom: A wind-simulation model for the Tirpitz Museum in Blåvand on the west coast of Denmark, completed in 2017.

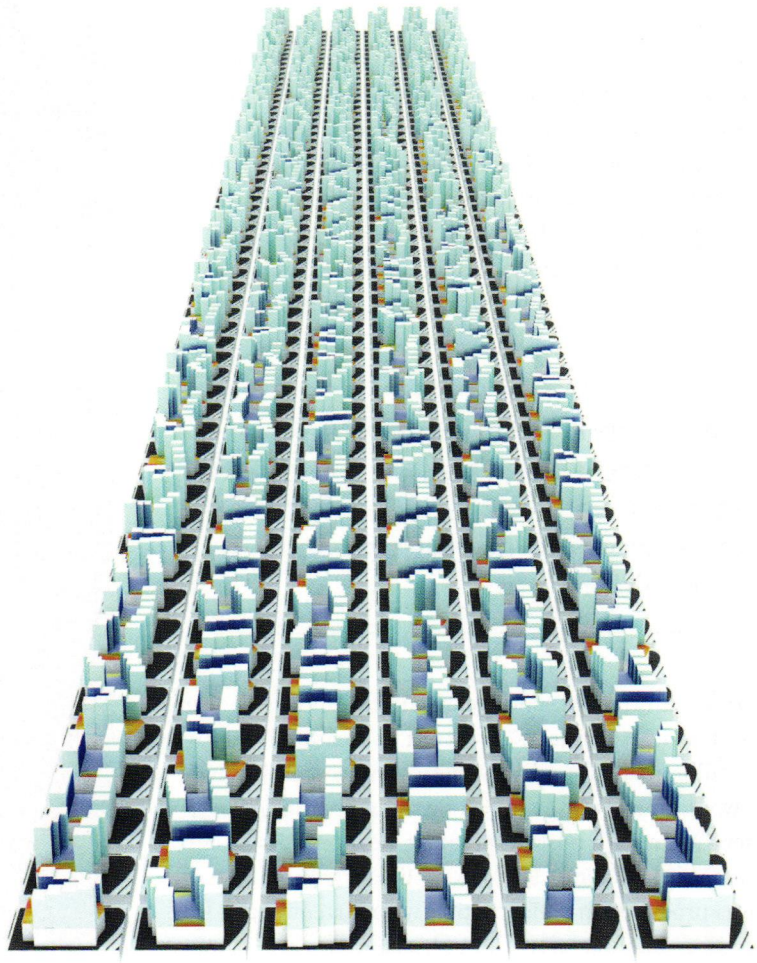
Photo credits: Courtesy of BIG (facing page and this page, top and bottom); BIG/Rasmus Hjortshøj (top right)



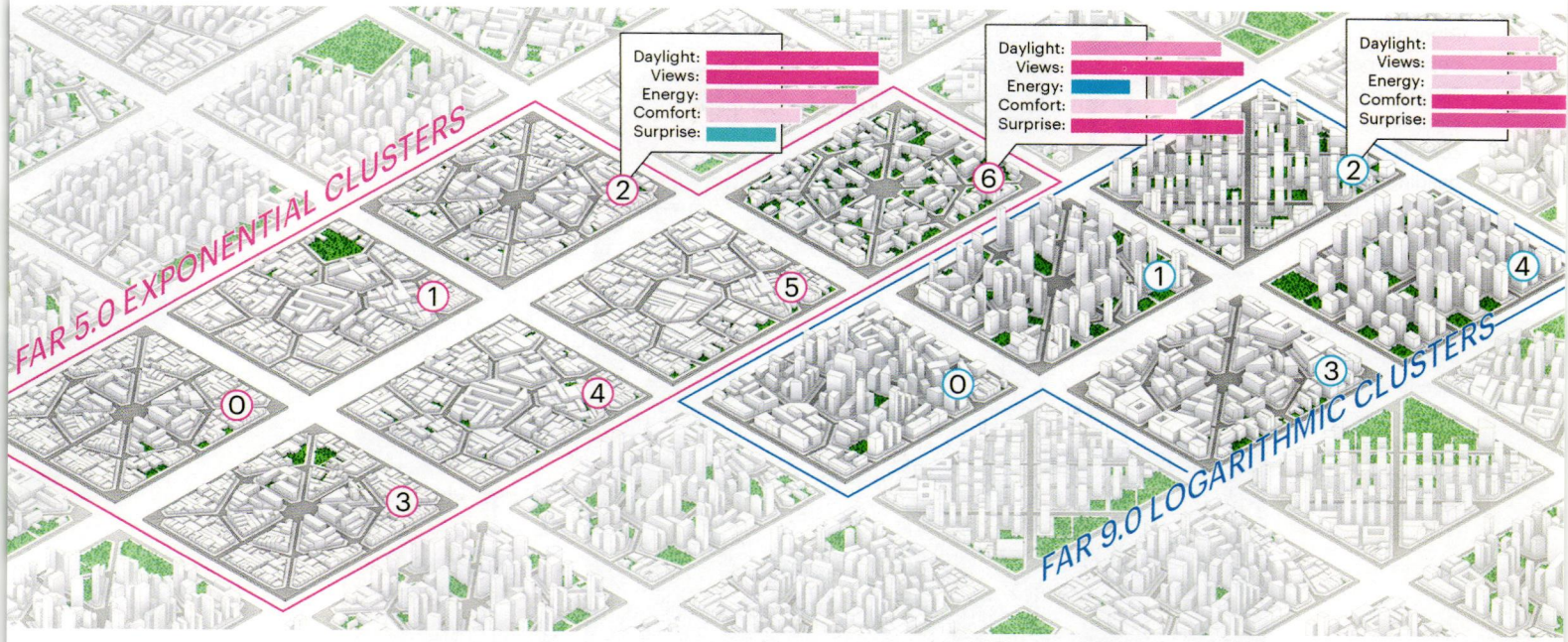
These custom products may have commercial potential, attractive to anyone in search of a beautiful design piece for their home, but they are often driven by a larger aim. The Gople Lamp, for example, is first and foremost designed as a grow lamp, stimulating photosynthesis indoors. Moreover, the BIG Ideas team also works on research that does not necessarily result in the same commercially appealing items. For its Amager Bakke/Copenhill project, a waste-to-energy plant in Copenhagen, the team developed a new plastic tile. The product was an integral element of the artificial ski slope on the building's roof, with thin plastic bristles on the interlocking rectangles simulating the feeling of skiing on snow.

BIG Ideas even takes on large-scale research projects, developing, among others, thermal simulation models, urban planning analyses, and resiliency proposals for cities like New York. As Kreider notes, "A lot of what we're designing is directly informed by this information. Rather than imposing a style, design decisions are based on tangible information."

In 2016, KPF established KPF Urban Interface, or KPFui, to address similar data-driven urban research projects. Led by Luc Wilson, the in-house think tank of multidisciplinary researchers investigates new



Examples of the computational design workflow developed by KPF Urban Interface (KPFui) where thousands of massing scenarios are generated and evaluated based on key project metrics such as views, daylight, and walkability. Above: Models from 815 Water Street in Tampa. Facing page: From KPFui's report "How To Generate A Thousand Master Plans," SimAUD 2019.



ways of working with design data, and develops generative approaches that transform how architects design on a range of urban scales, from individual buildings to full cities.

At KPF, a multi-office international firm with 650 employees, the Urban Interface team takes on a crucial role. As Nicholas Desbiens, head of Digital Practice, explains it, research is "fuel for a creative process." The core of the practice revolves around the architectural project and internal design studios. Surrounding these, KPFui's applied research offers an outward-looking approach, searching for new technologies and how they may affect the work within the design teams. The firm's Digital Practice team then evaluates these new ways of working and creates strategies for implementing them within the firm.

Not only do KPF's research-driven investigations allow the firm to create in different ways, but they allow an expansion of knowledge going into a project. "Project schedules can be so tight that it helps to be able to come to the table with a certain skill set and technical sophistication," says Desbiens. "Research is a way of keeping this skill set sharp."

In a large global practice like KPF, a hurdle is how best to disseminate the research and gained knowledge on a company-wide level. Here KPFui works closely with Desbiens's Digital Practice team. As he explains, "Custom tools created for a specific project are evaluated, and if they show potential to be applied to other projects more generally, they will be developed into more robust solutions by comparing with similar approaches and vetting outcomes across different projects."

The firm's dedication to research has paid off, as some of the most advanced tech companies, like Google and IBM, have come to KPFui for its data-rich methodology. Earlier this year, the firm's research resulted in an installation with Google's Sidewalk Labs in Toronto, where visitors were able to interact with data in a physical way, which served as a tool to gather public feedback to help inform future design decisions.

While the R&D teams at firms like BIG and KPF work within the larger framework of the design practice, research is the primary driving force at Terreform One. Set up as a non-profit "research consultancy," Terreform One has an ultrafine focus: "We're a think tank for ideas about the city, especially ideas that relate to what we call socio-ecological design." This is not to be mistaken with "sustainable" and "eco-friendly" design, which founder Mitchell Joachim notes are too frequently employed as empty terms.

> **"Custom tools created for a specific project are evaluated, and if they show potential to be applied to other projects, they will be developed into more robust solutions."**
> **—Nicholas Desbiens**

Joachim is the first to admit that his adverse response to these more traditional labels may be a limitation. "Socio-ecological design is a mouthful," he says, "and it stinks from a branding perspective." More imperative here, however, is the need to solve problems. "We have the statistics," he adds. "We have the ability to author designs that do make sense and have a relationship to the Earth's metabolism." First and foremost, Terreform One's goal is therefore to "design against extinction," a tagline that should catch anyone's attention. With rapid climate change, species are disappearing at an unimaginable rate.

Image credits: KPF

Right and opposite page: Terreform One's eight-story commercial building in Nolita will have a façade the designers describe as "a permeable vertical meadow," a double-skin façade with an open garden that will serve as a sanctuary for the Monarch butterfly.

As Joachim explains, this is a problem that affects many different disciplines and areas of thought. While this means it is a daunting challenge to address, it is also our most urgent crisis to solve.

Terreform One's strategy is simple: "Everything we do involves the living organism. So when it comes to materials or how we approach architecture, we perform research that directly involves a living organism. We are in the service of making sure this particular organism is thriving in the architected environment that we provide for them."

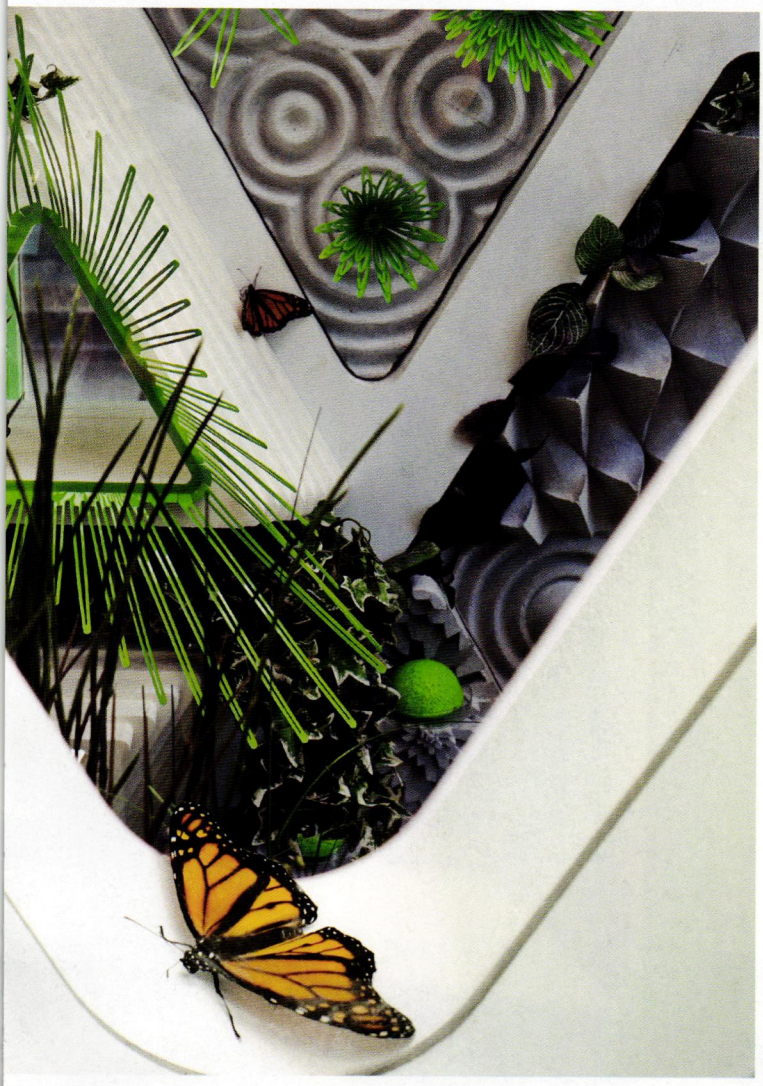
Joachim has carved out his niche after working for what most would consider "traditional" architecture firms. He spent time in the offices of Frank Gehry and I.M. Pei, but began his research trajectory in a research fellowship with Moshe Safdie. "We would ask questions like, 'What is a tall building?'" says Joachim. "It's so simple, and you look through this massive wall of knowledge, and you try to find out what is that missing brick and how can you solve it?"

"We have the ability to author designs that do make sense and have a relationship to the Earth's metabolism." —Mitchell Joachim

Terreform One's practice is predicated on the same kind of research methodology: A research project will begin with the hard questions, the team will educate itself as much as possible, and then the team will bring in experts of all kinds to further develop the approach.

While research is Terreform One's primary occupation, its expertise has resulted in design commissions. For a new project in New York, an eight-story commercial building on Cleveland Place, the client requested an ecological approach. While initially hesitant about taking on a commercial design project, Joachim and his team saw it as an opportunity to create a safe habitat for the Monarch butterfly, which is native to New York, but increasingly disappearing.

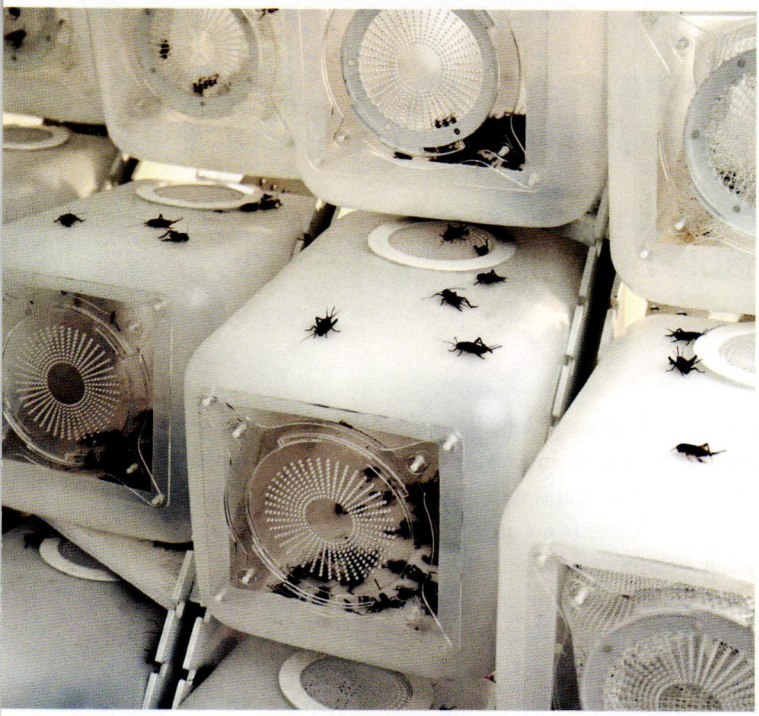
Photo credits: Terreform One



"We thought that would be a great semiotic to project at a building in New York City," says Joachim. With a semi-enclosed but porous double-skin, the building will offer spaces for caterpillar nurseries, milkweed growth, and production; storage areas for chrysalides; and places for adult butterflies to mate. The building will also include pollinated gardens on the roof, an education center, and courtyards to further serve as sanctuaries for the butterflies. For this project, "the monarch was our client," explains Joachim.

Certainly, not every firm has the resources to invest in a dedicated R&D team, but the value of research and development, especially when brought in-house, is clear. It offers an increased level of control over every detail of a project, allowing custom design solutions that can be more consciously developed. And it expands the skill set and voice of the architect, both for building projects and as a key player in the future of the city. As Desbiens suggests, the advantages of research within practice may even offer value on a disciplinary level: "There is a lot of room for investigation into how architects do their work—looking at our own creative process and how we generate ideas, seeing how projects change over time, and learning from past projects." ■

Below: Terreform One's projects each have the goal of serving living organisms. The group's Cricket Shelter (right) is based on the premise that harvesting insects for food typically takes 300 times less water for the same amount of protein generated by livestock farming. Designed to deliver both food and human shelter, the modular, edible-insect farm (left) can serve distressed populations as well as advanced economic regions that wish to foster alternative food sources.



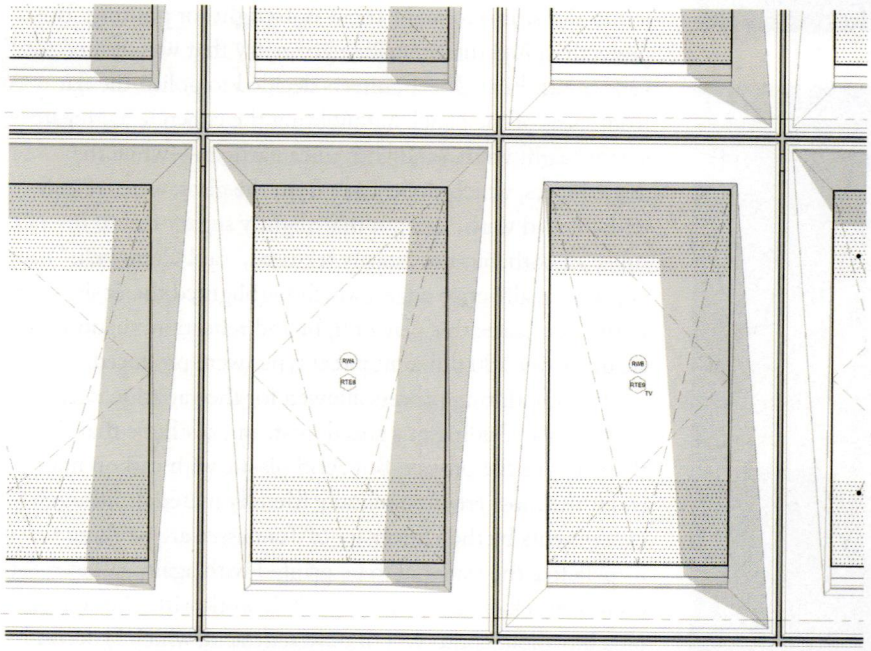
MATERIAL INNOVATION ON-SITE

During construction, architects are using both futuristic and low-tech methods to create better, more sustainable buildings.

BY NATALIE DUBOIS

What does material innovation look like in architecture today? As architects push for greener, healthier designs, material selection becomes ever more important. Dr. Andrew Dent, executive vice president of research for Material ConneXion, a New York-based consultancy for designers with an in-house materials library, considers a material innovative "if it moves the trajectory of a material's journey forward in some way." While he has great hope for bio-based materials in the future, he notes the challenge is that very few natural materials, whether spider silk or algae, last as long as we want them to. "So, for us, innovation is taking existing materials and finding better and more sustainable ways of using them," Dent said. "There is no such thing as sustainable materials. It all depends on how you use them."

Two projects nearing completion, both firsts of their kind, demonstrate this incremental approach to innovative, sustainable materials in different ways. One South First, a new mixed-use building by COOKFOX under construc-



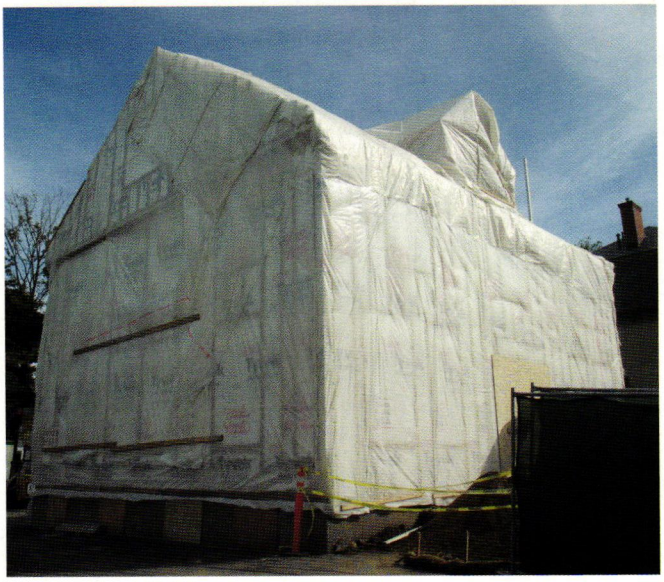
Facing page: The precast concrete panels of One South First's façade. This page, from top: A drone shot of panel mockups at Gate Precast's plant; installation of the panels in October 2018; an elevation drawing of the building's east-west residential façade.

tion along the Williamsburg, Brooklyn, waterfront, embraced futuristic technologies to create its precast concrete façade with large-format 3D printed molds. Harvard HouseZero, a single-family residential retrofit in Cambridge, Massachusetts, went back to basics by sourcing the most natural materials that the architect, Snøhetta, could source locally.

The precast concrete façades of One South First—a 42-story building composed of two interconnected towers, whose shape was determined by SHoP Architects in a 2013 master plan for the Domino Sugar Refinery site—were inspired by the material that used to be produced there: sugar. In crystals or cube form, sugar is geometric, reflective, and textural but sharp. Precast's material properties suited the concept, explained COOKFOX architects Pam Campbell and Arno Adkins, who were partner-in-charge and co-manager of the project, respectively. Furthermore, they wanted the building skin to "do something performative as opposed to just aesthetic," said Campbell. "The shaping of the façade, which was more simply possible because of the use of precast, was all about solar strategies." The windows, whose metal frames are cleverly concealed by the precast, were factory-installed into the panels. The concrete partially shades the windows, contributing some energy savings

"There is no such thing as sustainable materials. It all depends on how you use them."
—Andrew Dent

Photo credit: Courtesy of Gate Precast (left and top right); courtesy of Autodesk (middle right); courtesy of COOKFOX Architects (bottom right)



Harvard's HouseZero project began with a single-family house which was retrofitted to become a prototype for energy-efficiency.

by taking into account each façade's solar orientation, but necessitating an extra-deep (20-inch) panel with a lot of variation. COOKFOX brought on Gate Precast, an architectural and structural precast company headquartered in Jacksonville, Florida, early in the project.

Gate Precast's senior vice president of engineering, Steve Brock, had already been working with Oak Ridge National Laboratory on 3D printed molds for precast concrete when they became involved on the Domino Sugar project. Traditionally, custom precast molds are made out of wood and assembled by skilled carpenters. With One South First's very tight schedule, Dean Gwin, president of Gate, noted that the company "simply didn't have the mold-building craftsman available for that many molds." So it became the first building to employ this new technology for precast concrete molds. "It was a research project, because it had never been done on the scale we were trying to do it," said Brock. He explained there was a lot of trial and error: which plastic to print with (they used an ABS plastic with carbon fiber reinforcement); how much material to use in the print (not overprinting or underprinting); and whether the concrete in the molds would vibrate properly (to get air bubbles out). "They just came out requiring less work after the concrete was cast in our yard than the wood ones would," Brock said. This is partially due to the nature of the 3D printed mold itself.

Fresh out of the 3D printer, a mold has a corduroy texture from the layers of material built up by the printing process. Then it gets sanded down by a CNC machine. The result is a much smoother and sharper panel than one can achieve with wood molds, which require coatings and caulking over joints and seams to make them watertight for pouring. This perfectly suited the crystalline geometry that was desired for One South First. The architects decided to polish the flat front faces of the panel, highlighting the concrete aggregate—a very bright white sand with mica particles—while the angled faces, which slope away from the glass, were treated with an acid wash. "It's got that slightly sugary feel to it—not super smooth, but not heavily textured," said Campbell. "You get these really crisp edges, which highlighted the design idea in the first place: this play of light and reflection, shadow and shade." Over 100 different panel types were produced.

The 3D printing process allowed for the variation needed for the solar shading at a speed, cost, and aesthetic that fit the needs of the project. But ABS plastic with carbon fiber is not the most environmentally friendly material, although experiments by the University of Tennessee are working to re-pelletize the material to be printed with again. What most excites Brock of Gate Precast is their work with Oak Ridge on a bio-mold composed of polylactic acid, which is derived

Photo credits: Snøhetta

More Than Just a Pretty Façade

The 3D printed mold opens the door to new creative freedoms for architects and potentially more opportunities for ornamentation. That's exactly what architect John Meyer, founder and managing partner of EDG Architecture and Engineering, is exploring with his new company, Modern Ornamental, launching later this year.

The company was born of the desire to find a cost-effective way to replicate historic architectural façades. Meyer said his staff has been working on the research and development of their technology for five or six years, conducting hundreds of tests and experiments. Featuring very intricate and complex details, every mold and concrete mix is unique to each project. Modern Ornamental will offer the possibility of conserving older façades, preserving the architectural fabric as well as the environment by reducing demolition and new construction. It will also offer the ability to create new custom façades from scratch.

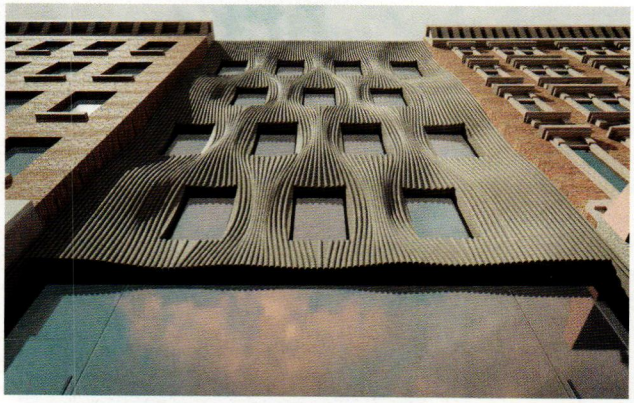


Photo credit: EDG Architecture

A rendering of a façade constructed with precast concrete from 3D printed molds illustrates the creative possibilities of EDG's technology.

The firm is working on an app-like interface that will allow clients to toggle project parameters, such as pattern, texture, shape, color, window frames, sills, and lintels. "I think this is the beginning of the next era of creative design," Meyer said, "where architects and designers are what they set out to be: sculptors, creators—people envisioning a unique building and façades. Now it will be possible."

from plant starch, and wood flour, a byproduct of the furniture industry in the area. Additionally, combining 3D printed molds with ultra-high-strength concrete or lightweight concrete, which both have sustainable benefits, when printing costs come down.

In Cambridge, Harvard's Center for Green Buildings and Cities (CGBC) and Snøhetta converted a single-family house near the university's campus into a living laboratory and prototype—which has never been done before—in the hope of demonstrating and learning how we can retrofit existing housing stock to be radically more efficient. The house requires almost zero energy to operate and has zero carbon emissions, including embodied carbon within materials.

If One South First's material approach was high-tech, Harvard HouseZero's approach was low-tech. Architect Aaron Dorf, the director of the project, explained that the firm achieved these ambitious goals in part through very careful material selection. "We really need to find ways to radically or incrementally reduce the emissions of building practice," he said. "The most direct way to do that is to seek out the most natural and nearest source of materials that also require the most minimal amount of processing." Accordingly, the house employed a variety of locally-sourced, natural materials, such as white cedar shingles, birch plywood, and recycled brick. Dorf cited both the Living Building Challenge and Harvard's Office for Sustainability for having helpful lists of materials and chemicals to cross-reference selections against.

The white cedar shingles, for example, illustrate the decision-making process behind the project's material choices. The house is in a historic district, so the exterior cladding needed to fit in aesthetically in order to get construction approval. White cedar is local to the region, and the architects left the shingles untreated since cedar has a natural oil in it, so it does not require a finish. This means less maintenance and therefore less chemical use, over time. To clean the shingles, all that is needed is water and vinegar.

> **"Insulation is one of the highest carbon materials that goes into the house. So reducing the carbon there, without affecting the performance, was really critical." —Aaron Dorf**

One product that was particularly challenging to source was insulation. Dorf noted that "insulation is one of the highest carbon materials that goes into the house. So reducing the carbon there, without affecting the performance, was really critical." They wanted a non-petroleum based insulation, but the types of products they were looking at aren't as prevalent in the U.S. market as they are in Europe or Canada. "There are things that get eliminated because they can't be sourced or sourced fast enough," he said.

To reduce carbon emissions, the architects employed locally-sourced materials as much as possible, including untreated white cedar shingles (left) and recycled denim fiber insulation (right).

The team eventually selected a wood fiberboard insulation for exterior walls above grade and a recycled denim fiber insulation for interior walls. (The importance of the house's material selections is such that Harvard does not want to release specific product information until the house has been tested for at least a year). The insulation selected required Snøhetta to entirely rethink the wall cavity construction, ensuring constant ventilation like a rainscreen, as well as the construction process itself. It was its own education, Dorf explained. "We had to basically make them tent the house over during the construction process," he said, "because you have these water-sensitive things that will be great once they're fully sheathed. But in the interim, you can't leave them exposed to the elements. We had to make sure you treat this building differently at every step of the way."

While the material approach to Harvard HouseZero was rooted in the natural, the project itself employed the latest technologies to the fullest. It has hundreds of temperature, humidity, air speed, air pressure, and occupancy sensors embedded throughout, which creates a real-time computational fluid dynamic model of the structure for the CGBC. "It's like when you see them make CGI movies: all the key vertices on a body are measured with a node to recreate how the body works with a computational model," explained Dorf. The house's systems are reprogrammable so the CGBC can experiment with different algorithms to operate it; Dorf thinks the software and algorithms being developed will be applicable to the building industry in the future.

To be innovative with architectural materials is tough, Dent from Material ConneXion admits, because there are maintenance and even safety concerns with using new products. "The problem with architecture is that you need the new innovation that's just been found, that's amazing, to last for the next 70 years—which is really hard to expect for any innovation," he said. But precisely because of the long life span of buildings, if architects can get it right there's "an opportunity to create a real change."

On the surface, neither One South First nor Harvard HouseZero appears radically different from other projects of their kind. But the details tell a different story: incremental improvements in how materials are made and selected reveal the potential for advancing architecture in critical ways. ■

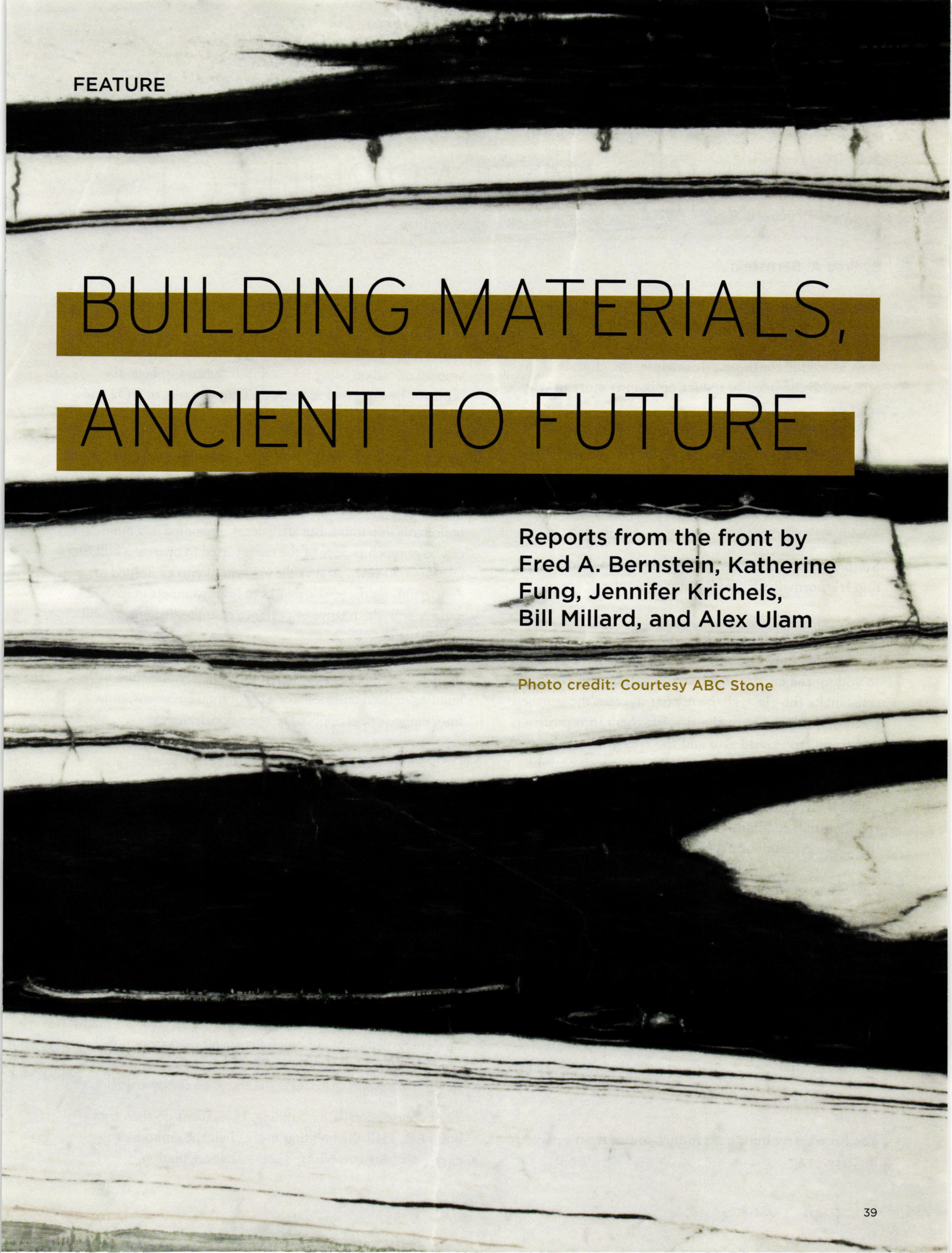
PROJECT TEAMS

One South First

Architect: COOKFOX Architects, DPC
Richard Cook, FAIA, Partner
Pam Campbell, Partner
Arno Adkins, Senior Associate
Adam Beaulieu, Associate
Avnee Jetley
Seth Brunner
Shira Grossman
Client: Two Trees
Architect of Record: dencityworks architecture
Master Plan: SHoP
Structural: Rosenwasser Grossman, Consulting Engineers
MEP: Dagher Engineering
Civil: Philip Habib and Associates
Geotechnical: GeoDesign Inc.
Exterior Wall Consultant: Vidaris/Laufs Engineering Design
Energy Modeling: YRG/WSP
Acoustic: Longman Lindsay
Landscape: Field Operations

Harvard HouseZero

Lead Architect, Landscape Architect & Interior Designer: Snøhetta
Tine Hegli
Aaron Dorf
Dennis Rijkhoff
Matt McMahon
Anne-Rachel Schiffmann
Karli Molter
Max Obata
Pål Eide Hasselberg
Claire Fellman
Client: Harvard Center for Green Buildings and Cities
Energy/Climate Engineer: Skanska Teknikk (Norway)
Structural Engineering: Silman Associates
MEP/FP Engineering, Lighting: BR+A
Civil Engineering: Bristol Engineering
BAS/Controls/Natural Ventilation System: WindowMaster
Acoustics: Brekke & Strand Akustikk
Code & Accessibility: Jensen Hughes



BUILDING MATERIALS, ANCIENT TO FUTURE

Reports from the front by Fred A. Bernstein, Katherine Fung, Jennifer Krichels, Bill Millard, and Alex Ulam

Photo credit: Courtesy ABC Stone

EMBODIED ENERGY: A PRIMER FOR ARCHITECTS

By Fred A. Bernstein

Two-and-a-half-trillion square feet. That's the equivalent of 50 New York cities, and it's the amount of new construction the world can expect to see in the next 40 years, if current trends continue. Meanwhile, the climate is in crisis, with the need to reduce emissions more urgent each day.

Buildings are responsible for nearly 40% of total greenhouse gas emissions, which makes the challenge to architects clear: find ways to use less energy—or else.

And that includes embodied energy.

What is embodied energy?

Simply put, it's the energy expended to make a building. It's normally expressed in megajoules.

How is embodied energy computed?

Take the windows in a new office building. You'd need to add up the energy expended to extract the raw materials, make the glass, shape it, coat it, crate the finished windows, ship them to the site, lift them into position, and so on. You could also add the energy needed to maintain the glass and, eventually, to remove and recycle it. A calculation that includes those final steps is called a life-cycle assessment (LCA). Doing that for all the materials in a building comprises a whole building life-cycle assessment (WBLCA).

How is embodied carbon different from embodied energy?

Energy is "cleaner" in some places than in others. For example, power in the Pacific Northwest is generally produced hydroelectrically, while power in China tends to be produced by burning coal. So, while it takes the same amount of energy to make rebar in either location, rebar from China can have up to six times the embodied carbon as rebar from, say, the Nucor steel mill in Seattle.

Six times as much?

Yes. So where a building product comes from really matters.

And that means embodied carbon is a better measure than embodied energy?

Yes. It reflects what really matters, environmentally: the amount of carbon being released into the atmosphere. It's normally be expressed as tons of CO_2e—that is, of CO_2 and its equivalents.

Shouldn't architects focus on making buildings more efficient to light and cool?

Reducing the amount of energy it takes to operate a finished building is important. But the energy embodied in a building can be as much as 50% of the energy used to operate a building in its first 50 years. And as the amount of energy needed to operate buildings decreases, thanks to improvements in materials and systems, the relative importance of embodied energy will only increase.

To put it even more starkly, according to the UN Environment – Global Status Report 2018, nearly one-third of building-related emissions, or 11% of total emissions, come from embodied, as opposed to operational, energy.

I've heard it's also important to look at the "time value of carbon." What does that mean?

When thinking about the impact greenhouse gases have on the environment, what matters is not just how much carbon a process releases, but when that carbon is released. (Carbon released today will be in the air longer, and thus will do more damage to the environment, than carbon emitted 20 years from now.) Once a building has been constructed, the embodied carbon has already been emitted, whereas carbon from operations will be released over time.

As stated by Anthony Pak, an LCA consultant based in Vancouver, Canada, "If we don't reduce emissions now and end up triggering some tipping points as a result, it may not matter how energy-efficient our buildings are 60 years from now."

What's the best way to decrease the embodied energy in a building?

Try to reuse an existing building. If you can't do that, try to build less. Half the building means half the embodied energy—nothing complicated about that calculation.

What if I can't build less?

Then choose materials with the lowest embodied carbon among the available options.

There are so many options. Where do I begin?

Start where you can do the most good. "Structural systems almost always comprise the largest source of embodied carbon in the building—up to 80%, depending on the building type," says Paula Melton, editorial director of BuildingGreen. If the structure is concrete, try using a low-cement variety. (By some estimates, production of Portland cement is responsible for 5% of total global CO2 emissions.) If the structure is steel, try to use as little as possible. (Diagonally braced frames, for example, tend to use far less steel than moment frames.) And use recycled steel—better yet, steel recycled using clean energy—whenever possible.

Is wood always a good choice, in terms of embodied energy, since trees store carbon?

Scientists are all over the place on this. That's why Kate Simonen, an embodied carbon expert at the University of Washington, advises architects to choose the material that's best for a given project, then use it judiciously. "If you take the average concrete building and compare it to the average wood building, you might see that many different studies show wood tends to have a lower carbon footprint," she notes. "That doesn't say you couldn't have optimized the concrete system to be at a similar level."

Is there an easy way to compare different options?

Two online tools dominate the U.S. market —Athena Impact Estimator and Tally. Another program worth checking out is One Click LCA. And a free-to-use, open-source embodied carbon calculator, EC3, will be released at the Greenbuild conference in Atlanta in November.

Doesn't LEED already handle this?

Hardly. Under LEED v4.1, you can get up to five points for performing a WBLCA. But you can also get points for doing things that will increase the embodied carbon in a building.

How can that be?

The two energy goals—cutting embodied energy and cutting operational energy—can be at odds. To choose the simplest example: The better insulated your building is, the less energy it will take to heat and cool. But it takes energy to make insulation, transport it, and install it. So, in that case, decreasing the operational energy—which can get you LEED points—requires increasing the embodied energy.

Is there a certification system that is better on the question of embodied carbon?

The Living Building Challenge is a certification system that "sets the bar where it needs to be," says Eric Corey Freed, an architect, author, and advocate based in Portland, Oregon.

What is the government doing about embodied energy?

Good question. In June, U.S. Senator Amy Klobuchar introduced a bill to "require transparency in reporting the greenhouse gas impacts of products procured by certain federal agencies." That's a start. California already has a law, being phased in over the next two years, that will help the state procure building materials that meet certain global warming potential targets. Other states are looking at similar "buy clean" legislation.

What about city governments?

There are scattered efforts. Vancouver, as part of its Climate Emergency Response, has called for a 40% reduction in the embodied carbon of new buildings and infrastructure from a 2018 baseline.

And in New York?

The private sector is taking the lead. For example, Amanda Kaminsky, founder of Building Product Ecosystems, a consulting firm, is working with developers and two city agencies to replace up to 40% of the Portland cement in new concrete with regionally-recycled glass. According to Kaminsky, the change lowers the concrete's embodied carbon because manufacturing cement produces much more CO2 than is produced cleaning and grinding the necessary quantity of glass.

What is the AIA doing?

National AIA has several initiatives, including "developing a framework to track embodied carbon" in response to a 2018 letter from 50 architecture and engineering firms, according to spokesman Matt Tinder. AIA New York, through its Committee on the Environment, will sponsor a panel discussion on the ways material choices, layout, and structural efficiency can reduce embodied carbon (January 16 at the Center for Architecture).

How do we persuade clients to care about embodied energy?

Talk dollars and cents. The best way to reduce embodied energy is to use less stuff. And less stuff costs less money. You can also tell your commercial or institutional clients that, right now, focusing on embodied carbon is a way to differentiate themselves from their competitors, by demonstrating leadership on this important issue.

With thanks to Donald Davies of Magnusson Klemencic Associates, Stacey Smedley of Skanska, Martin Torres of Walter P Moore, Frances Yang of Arup, and the experts quoted above.

WILL THIS MATERIAL CHANGE THE WAY WE BUILD?

Graphene is strong, lightweight, water-resistant—and so much more. If it lives up to its promise, it may transform architecture.

By Katherine Fung

Last year, researchers at the University of Exeter in South West England announced they had successfully incorporated flakes of graphene into concrete. The result was twice as strong as traditional concrete, with half the mass. It's just one of the many ways that scientists believe graphene will revolutionize architecture and construction.

Since its discovery in 2004, graphene has been touted as a "miracle" material. The substance, which is derived from graphite mined from the Earth, is stronger than steel and highly water-resistant, yet so lightweight it's the only 2D material in the world. It also conducts heat and electricity efficiently. All that means graphene could enhance every element of buildings, including flood-proof foundations, highly fire-resistant walls, anti-corrosive paint, and solar roofs.

But, for all the buzz, the graphene-based house of the future doesn't exist quite yet. That's in part because researchers are still testing and developing graphene-enhanced building materials.

"There's a huge gap between a research lab where someone says, 'Aha, I've got a square centimeter of graphene-enhanced concrete that can stand up to something like a nuclear blast,' and how in the world you mass produce that so it's useful to somebody," said Les Johnson, co-author of the 2018 book *Graphene: The Superstrong, Superthin, and Superversatile Material That Will Revolutionize the World.*

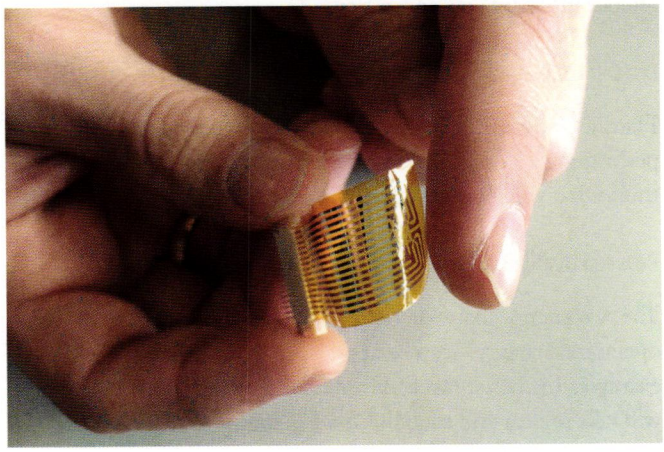
One day, adding the substance to fiberglass rebar and concrete for façades could decrease the amount of materials needed to construct a building—and ultimately, the project's carbon footprint. Once those products become available on the market, though, it could still take some time before architects, builders, and local municipalities embrace them.

Terrance Barkan is the executive director of the Graphene Council, a network of universities and companies developing uses for graphene. "Until there have been tests done to meet all of the strength requirements, and graphene gets added to building code specifications," he said, "no one's going to build with it."

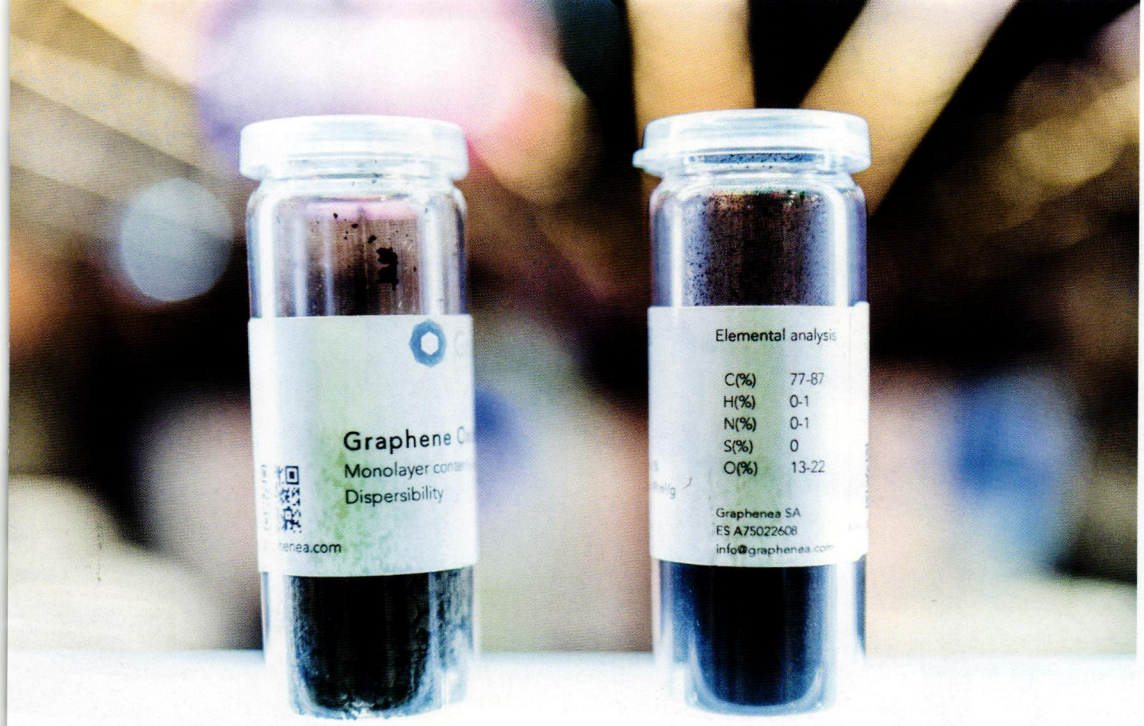
Another challenge is that scientists haven't figured out how to mass produce continuous sheets of graphene yet; all the graphene that's produced now is in the form of tiny flakes. But Johnson and his co-author, Joseph Meany, said that some of the most exciting innovations will require the material to be in sheet form. Meany imagines that when that happens, superthin layers of graphene could potentially be used to reinforce retaining walls, create entire walls that conduct electricity and insulate homes, and harness solar energy. But that technology is still a long way off.

The good news is that researchers around the world are racing to get there. Last year, scientists at Massachusetts Institute of Technology made major strides toward developing a technique for producing consistently high-quality graphene sheets. Several hundred people are working on graphene-enhanced composite materials, like fiberglass rebar, at Oakridge National Lab in Knoxville, Tennessee. The United States, China, and other countries have federal initiatives funding research

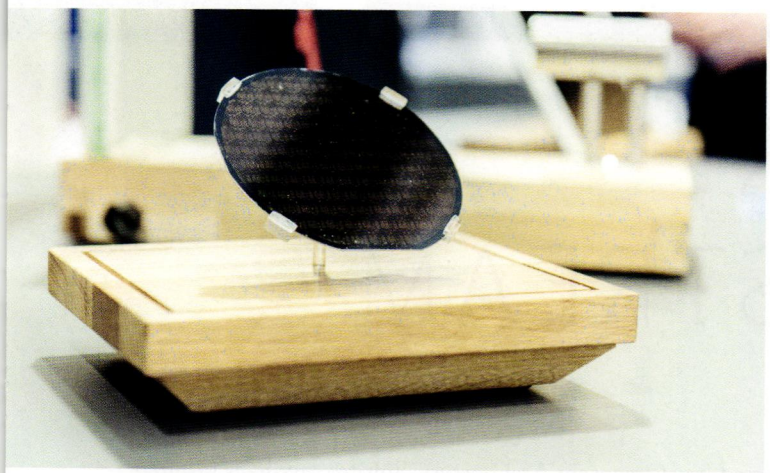
Superthin layers of graphene could potentially be used to reinforce retaining walls, create entire walls that conduct electricity and insulate homes, and harness solar energy.



Graphene modulators have the potential to be one of the key building blocks for 5G technology.



Clockwise from left: Graphenea, a partner of the Graphene Flagship, produces scalable and high-quality graphene for electronics; the Istituto Italiano di Tecnologia together with the University of Rome Tor Vergata and TEI Crete use graphene's excellent electrical properties to evolve a solution to generate clean energy for a sustainable future; the KTH Royal Institute of Technology in Stockholm uses graphene photodetectors to identify the "molecular fingerprint" of diseases.



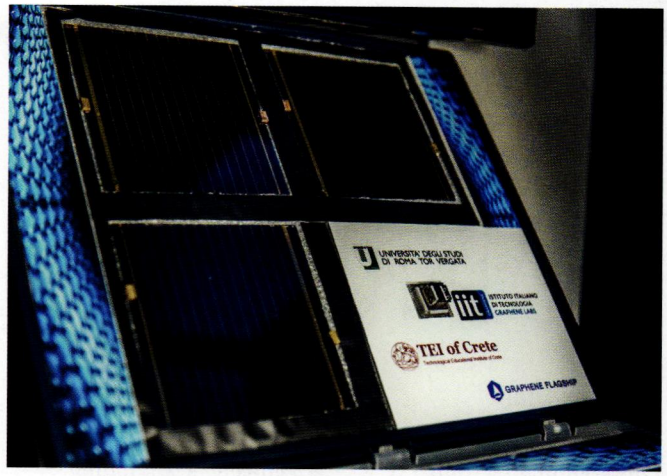


Photo credits: Graphene Flagship

at companies and universities, because whoever develops technologies for producing graphene and practical uses for the material first will have a huge economic advantage. The E.U., for example, is funding a one-billion-euro initiative known as Graphene Flagship, a consortium of academics and industrial researchers aiming to bring applied uses of graphene into European society within the decade. While some private investors have been disappointed with the pace of development, many are still hoping to ride the wave of graphene-based products when they finally become available to the public.

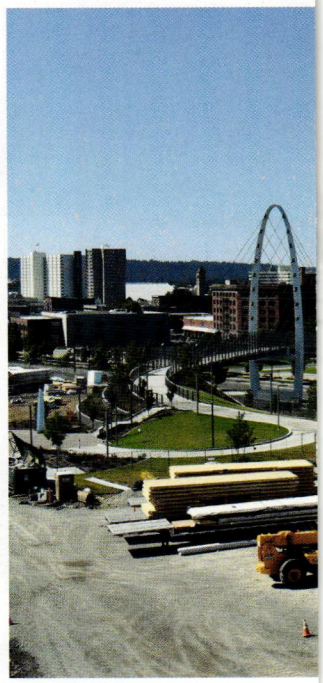
Scientists have also made major progress in producing graphene flakes that can be incorporated into other materials. As a result, graphene-enhanced consumer products, like golf balls, sneakers, and eyeglass frames, have exploded onto the market in the past year. Barkan said that glass products and paving stones containing graphene—which promise extra strength and less color fading, respectively—are already available to the construction industry, even though manufacturers may not disclose it because they want to protect their formulas.

Another innovation that's on the market now is graphene-enhanced paint. Earlier this year, the UK-based company Applied Graphene Materials announced an initial run of spray paint under the brand Hycote. The addition of graphene allows the coating—which is two to three times tougher than regular paint—to prevent rust.

The Ford Motor Company is already using graphene in its F-150 and Mustang cars. The company discovered that adding graphene to polyurethane created an engine cover that dissipated heat 30% more quickly than in previous models, while also reducing noise.

As more investment flows in, Barkan also warns about ensuring the quality of the products companies are promising. Graphene is a nanomaterial, undetectable to the human eye. The equipment to test the material costs over a million dollars.

"Unless you test what you have, you have no idea what's in it," Barkan said. "Consumers are at the mercy of the companies."



MASS TIMBER GOING MAINSTREAM

By Alex Ulam

Cross-laminated timber (CLT), a relatively new building product in the U.S., is touted as a more environmentally friendly and lower-cost alternative to concrete and steel, but currently it is not permitted under New York City building codes and those of many other municipalities. That is about to change, thanks to provisions in the 2015 International Building Code that the city is on track to adopt next year.

The incorporation of CLT into the city's building codes is welcomed by proponents such as New York City developer Jeff Spiritos who, with SHoP Architects, had planned to build the city's first CLT high-rise building on West 18th Street in Manhattan several years ago. That project received national attention because it was the recipient of the U.S. Tall Wood Building Prize, established under the 2015 Timber Innovation Act passed by Congress. But Spiritos said he had to shelve the development in large part because of the cumbersome process of obtaining the necessary special permits from the NYC Department of Buildings.

Currently, Spiritos has several multifamily CLT projects underway: two in New Haven, Connecticut, and one in New Rochelle, New York, which are being designed by the firm Gray Organschi Architecture. Spiritos says he is inspired to build with CLT out of a concern for the environment but also because of cost savings, especially in a city like New York, where labor costs are high. "Wood is a renewable resource and it is environmentally imperative when you consider that buildings contribute 40% to 50% of greenhouse gases," he says. "On average, mass timber projects in New York City will be 10% to 20% less expensive overall than block and plank, concrete, or steel."

The code changes will be much less costly and make it easier for architects to get approvals for mass timber buildings, says Andrew Ruff, senior associate at Gray Organschi Architecture. He notes that currently, "You have to show all your numbers, which is possible, but requires a design team that is willing to go through all these steps."

Back in the 1800s, most of the buildings in U.S. were built from wood, but urban fires and new building technologies spurred changes. Now, innovations in timber technology that address fireproofing issues combined with an appreciation of the environmental benefits of building with wood is reawakening an interest in the material. There are several new recently

Left: Cross-laminated timber (CLT) from a new factory launched by Katerra in the Spokane Valley in Washington. The facility aims to produce the largest volume of CLT in North America. Right: The Catalyst Building, a five-story CLT office building currently under construction in Spokane, is being built from Katerra-manufactured CLT. Bottom: In Brooklyn, 320 Wythe Avenue (pictured) and 360 Wythe Avenue in Williamsburg, designed by Flank Architecture, use nail-laminated timber and are the first mass timber structures built in NYC in over 100 years.

completed mid-rise buildings in Brooklyn that incorporate nail-laminated timber, a wood technology from the 19th century, which is currently permitted under NYC Building codes. Those buildings, designed by Flank Architecture, are reportedly the first new brick-and-beam structures built in the city in the past hundred years.

However, CLT, a mass timber product, offers significant advantages over nail-laminated timber. It is considered strong enough for taller structures and can also be used throughout an entire building. CLT consists of sheets of jointed wood members stacked crosswise and glued together on their wide faces, which provides dual-span strength, as opposed to nail-laminated timber, which provides only single-span strength. Concerns about seismic and fireproofing issues were a major disincentive to using CLT in large-scale urban buildings, but testing by the International Code Council has paved the way for its adoption into building codes.

CLT has been on the market for about 25 years, and it has made inroads in Europe, most notably Austria, which has the world's largest mass timber industry. In England there are about 600 buildings made from the material, including critically acclaimed structures such as the nine-story Murray Grove in London, designed by Waugh Thistleton Architects. That structure took only 49 weeks to build, whereas an equivalent concrete structure would have typically taken 72 weeks.

"On average, mass timber projects in New York City will be 10% to 20% less expensive overall than block and plank, concrete, or steel." —Jeff Spiritos

In addition to being significantly lighter in weight than concrete, CLT involves less construction waste and, because it can be craned into place, takes up less space on city streets during construction projects. "The real game changer with CLT has been that you can use it as a floor," says Kenneth Brand, vice president of codes and compliance at the American Wood Council. "There is no need to shore it underneath and hold it together for several days; it is ready as soon as it is in place."

The 2015 International Building Code allows CLT buildings of six stories or 85 feet high. According to Brand, however, the big implications for dense urban environments such as New York City will be in the new 2021 International Building Code, which he says will allow 18-story buildings.

The acceptance of CLT by municipal building departments should hasten acceptance of other mass timber products coming to market, most notably mass plywood, a new material composed of plywood veneers. In August, Mass Plywood, manufactured by Freres Lumber in Oregon, received approval for use as a structural material from the APA – The Engineered Wood Association. Mass plywood, according to Freres's website, has greater minimum design values in cross sections than does CLT, and it also allows for more custom tailoring to meet the needs of the end user.

For Spiritos, the incorporation of new wood technologies into building codes cannot come fast enough. "In the past 50 years, construction costs have increased 10 times," he says. "We have been building the same way for a long time; we need to fundamentally change the way we build to reduce environmental and construction costs."

Photo credits: McKinstry (left ro right); Flank Architecture + Development (left)

THE SOFT POWER OF ETFE

Tensile strength, light weight, thermal efficiency, variable transparency, and UV stability make ethylene tetrafluoroethylene a miracle material—at least in the right contexts.

By Bill Millard

The Shed, the new Hudson Yards performance space by Diller Scofidio + Renfro (DSR) and Rockwell Group, has rapidly established a high profile in Manhattan's arts world. Two features of its McCourt Space are particularly eye-catching: its kinetic steel framework and quiltlike cladding. The inflated cushions of translucent white ethylene tetrafluoroethylene (ETFE), light and flexible enough to allow for the operable frame and other efficiencies with materials and energy, proclaim that this institution plays by brand-new rules.

The light, transparent, chemically inert polymer, a relative of polytetrafluoroethylene (PTFE or Teflon), was developed by DuPont in the 1950s. Used as an insulator in pneumatic-cushion designs in the U.S., it has become a cladding material elsewhere, particularly in Europe, since the 1980s. It is especially well suited to facilities with long horizontal or angled spans where glass would be troublesomely heavy: the National Aquatics Center (Water Cube) by Arup and various partners for the 2008 Beijing Olympics; Herzog & de Meuron's Allianz Arena in Munich, Germany, and Beijing National Stadium (Bird's Nest); Nicholas Grimshaw's Eden Project in Cornwall, England; and Foster and Partners's Khan Shatyr Entertainment Center in Kazakhstan.

More recently, American architects are adopting ETFE as a solution to structural, thermal, and other challenges, with minimal maintenance (it's slick enough to clean itself during rainfall) and an aesthetic bonus in the form of daylight. It's sustainable, too: since it is ultraviolet-stable, it avoids slow discoloration and has held up well in European buildings for 20 or more years. HKS Architects's angular roof on the U.S. Bank Stadium in Minneapolis, home of the Vikings and the 2018 Super Bowl, introduced ETFE to mainstream U.S. audiences in 2016. HKS's forthcoming stadium for the Los Angeles Rams, with ETFE forming an open canopy, finesses the distinction between enclosed and open-air structures.

Fritting or repetitive-pattern digital printing allows fine-tuning of translucencies, from 95% transparent to off-white, smoky-black, or other colors at 75% to 85%; ETFE is never completely opaque. US Bank Stadium uses 65% fritting on a three-layer pillow inflated to about 6 psf, says John Hutchings, FAIA, principal and sports director at HKS. "The first game I went to," he reports, "people were wearing sunglasses. I thought, *We've done it!* We were able to achieve an indoor stadium that felt like you were outdoors in the elements."

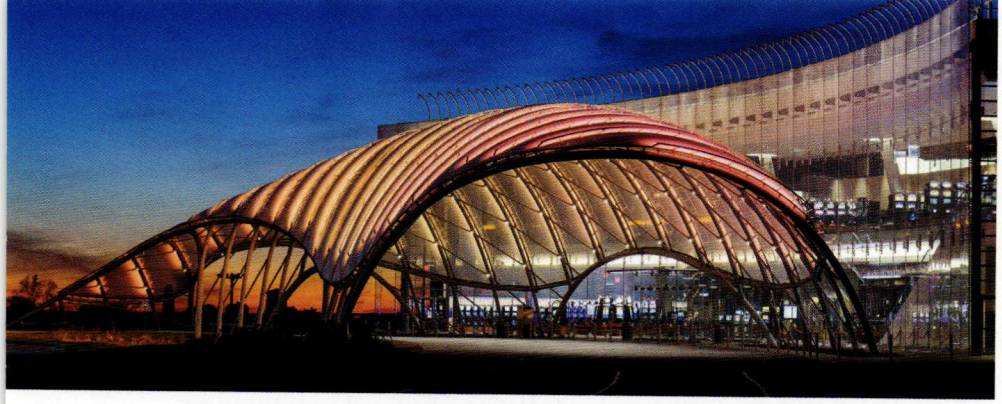
ETFE, like any new technology, generates both enthusiasm and skepticism. Early adopters recognize the reasons for its popularity while cautioning about its vulnerabilities. Properly deployed, it is a game changer, offering most of the advantages of glass, plus novel benefits, at about 1/100th the weight. Incautiously applied, it could become material science's version of the Edsel. Its future depends on how well architects and engineers consider its properties and integrate it into systems.

DSR Associate Principal Charles Berman, AIA, views the Shed as the New York market's "icebreaker" for the material, yet it is not the area's first. That honor belongs to the Empire City Casino and Raceway in Yonkers, NY, designed by Studio V's Jay Valgora, AIA, AICP, with Nic Goldsmith of FTL Architecture and Engineering as specialty structure consultant, and completed in 2013. The *porte cochère* welcomes patrons of the harness-racing complex beneath a sweeping canopy of ETFE on a light steel framework.

Properly deployed, ETFE is a game changer, offering most of the advantages of glass, plus novel benefits, at about 1/100th of the weight.

Owner Tim Rooney asked for "something that would be iconic and reposition his property," says Valgora. Inspired by the gridshells of Frei Otto (Goldsmith's one-time employer) and Robert Maillart's predilection for light, efficient designs, the two designers envisioned a form that would "leap up out of the hillside, so it grows out of the geometry of the site," says Valgora. He and Goldsmith derived the frame from a torus segment, modeling its curves as a digital equivalent of the chains Antonio Gaudí hung to derive catenary curves for the Sagrada Familia in Barcelona.

Valgora cites Roland Barthes's credo balancing vision and execution ("Architecture is always dream and function, expression of a utopia and instrument of a convenience") and finds ETFE as practical as it is graceful. Covering the grid with ETFE foil rather than glass allowed for lightness and economy: the column-free frame's steel members are only eight inches in diameter (12 inches for the larger edge elements), and the design accommodates wind uplift as well as gravity loads. And, in case of fire, ETFE evaporates almost instantly rather than burning, obviating a sprinkler system.



Top: A steel-framed *porte cochère* at Empire City Casino and Raceway in Yonkers, designed by Studio V, was the New York area's first ETFE-clad structure. Right: The ETFE-clad Shed at Hudson Yards, designed by Diller Scofidio + Renfro and Rockwell Group.

"If a car caught fire underneath the canopy," notes Valgora, "there would be nothing to harm anyone." Negotiations with code officials, however, called for imagination, he notes: "One challenge to designers using foil is that sometimes you have to educate building departments that may not be used to this material."

ETFE, Valgora says, is "more efficient, lighter, more beautiful, more interesting, more sustainable, and more energy-efficient, and has a lower carbon footprint than many of the other alternatives." He encourages wider use, yet he and others describe its caveats soberly. Inflated-cushion applications insulate reasonably well, Valgora notes, though ETFE's R value does not compare with that of solid walls. Noting variation with cushion dimensions, says Robert Katchur, DSR's project director on the Shed, "when you average it across the façade using overall thermal transfer-value calculations, you end up with the equivalent to a current third-generation insulated-glass-unit curtain wall."

Inflation systems must include compressors, dehumidifiers, and filters. Katchur notes that the Water Cube was maintenance-challenged, and "the Beijing air was so polluted that it was basically blowing dirt into the pillows." Adds Berman, "And due to the static cling of the material, once it goes in, it never comes out." The Shed's ETFE manufacturer Vector Foiltec uses air-delivery systems that function only when filters are in place.

In some sports, transparency is a mixed blessing. To keep outfielders from losing fly balls in the sun under the ETFE roof at the Texas Rangers's new Globe Life Field, HKS and Foiltec are exploring a brown-tinted variant with a louvered effect that gives players some shade while giving fans light. Hutchings notes that grass quality under ETFE is largely unexplored: he knows of only one ETFE stadium that has successfully grown natural grass; others use artificial turf. And since ETFE cushions can be punctured, they must be positioned away from the public and protected from wildlife. "There have been reports of birds pecking the material," Hutchings says, "so they actually have bird-arresting wires."

Berman and Katchur cite the Shed as a precedent for more New York architects to use ETFE. The balance between its thermal property and lightweight nature, Katchur suggests, makes it productively disruptive; the Shed is a case of weight savings freeing up creativity in multiple systems. Its controllable translucency is part of the Shed's aesthetic. On other projects, combined systems allow dramatic exterior effects, like the Allianz Arena's multicolored LED fixtures held on outriggers affixed to the steel framing and creating a variable interior glow. Hutchings also envisions ETFE finding uses in "big atria in office buildings because it's so much lighter weight than a glass or polycarbonate skylight system."

"I don't think the ETFE has a one-to-one replacement for glass," says Berman, "because the unique geometry required to make the cushions function is different than the planar nature of glass." It occupies its own category, suitable wherever mass is not beneficial, and inappropriate where important design criteria include blast resilience, perimeter security, or acoustic insulation (it is particularly permeable by low frequencies), but definitely worth considering where other systems control those factors. "The Shed has an acoustic blackout shade system," Katchur says, that "keeps the neighbors asleep while the party rocks on inside." As in concert halls that use box-in-box concrete structures to control sound, "the façade is not really participating in the acoustic exposure of the building. The façade is there for thermal and moisture, and you allow the mass to be the mass."

Inflatables are not totally novel: some may recall Ant Farm's promotion of soft vinyl structures in the 1960s. The difference, say Berman and Katchur, involves both technical features—UV stability, ultrasonic welding—and a more cautious approach to both testing and applications. With "some of those early plastics in façades," says Berman, "the architects and engineers were pretty far out over the skis relative to the material itself." The burning of Montreal's geodesic Biosphere in 1976 was a turning point that may have soured cautious clients on lightweight structures. Yet "ETFE has the advantage of coming out of another industry and then being repurposed; it's a bit more robust," Berman notes. "It's still quite experimental in its own way, quite different than a lot of other materials, and a little less out on a limb." Like many ideas from more daring decades, this one isn't just an experiment worth revisiting; it's an experiment worth getting right.

Photo credits: Paul Warchol (top); Iwan Baan (bottom)

THE FUTURE OF MATERIAL SPECIFICATION

Today's innovations have the potential to revolutionize architecture and design—but will practitioners embrace these new technologies?

By Jennifer Krichels

Stone might be the world's oldest building material, and it remains one of the most labor-intensive to work with. Despite technological advances in other areas of the design and construction industry, sourcing stone has historically required a lot of literal heavy lifting: architects and designers who wanted to see specific materials would visit vast stone yards or warehouses, waiting as each slab was hoisted into view. The potential for damage to a piece of stone was significant, and it was difficult for designers to understand how unique characteristics would look once several slabs were fabricated and installed together. "We would have one face-out of the selection from a block, out of 10 to 50 slabs," says Jonathan Tibett, who co-founded stone supplier ABC Stone 25 years ago. "We'd been struggling for years on how to best present that."

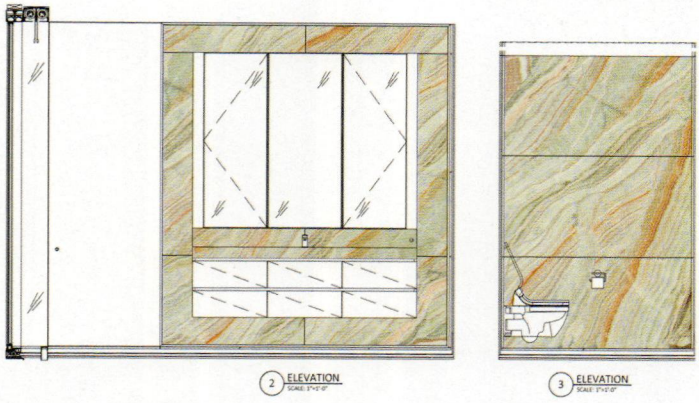
Nearly three years ago, however, Tibett stumbled on a digital technology that could transform the way ABC did business, and eight months ago the company launched its Digital Stone Catalogue featuring Advanced Stone Imaging Software Technology (ASIST). Now, more than 15,000 slabs of stone in ABC's inventory have been digitally photographed and uploaded to the catalogue, which is available on 65-inch HD screens at the company's Manhattan showroom. The imaging software color-corrects and scales each slab to the closest 1/16th inch, allowing individual characteristics and flaws to be visible. Once a designer narrows her selection—searching by color and category is possible—she can receive photo files and apply them to project renderings. "As rendering software in the architectural design community has become priceless, this assists the designer in showing the client exactly what the selection looks like," says Tibett. "This creates accuracy in the process." As for the future of technology for the business, he points to the possibilities afforded by virtual reality software. "I think that's going to be a big aspect of what's coming for us. We could potentially take people on a journey to our quarry partners."

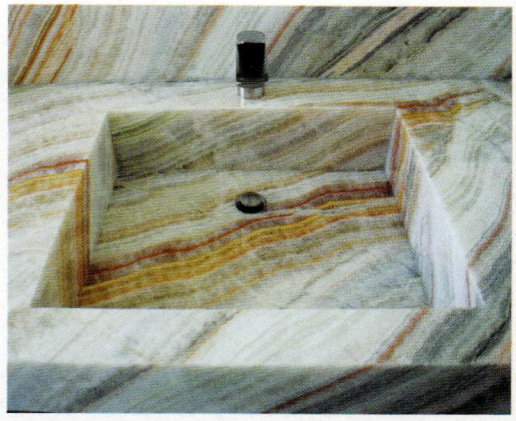
A short trip north of ABC's showroom in Manhattan, Schüco, an international window, door, and façade supplier founded in 1951, is already exploring new frontiers in virtual reality (VR). The company's Virtual Construction Lab (VCL), launched in 2016, creates customized sales proposals that provides 3D models of project components, performance analyses of façade characteristics (blast resistance, water drainage, etc.), animations of installation scenarios, and more. The VCL includes a team dedicated solely to VR and augmented reality; in one demonstration of new technology last fall, participants could don a VR headset and handheld controllers and navigate a glass-enclosed office building, changing façade details as they went. On cue, a virtual helicopter would fly by, allowing the user to experience the noise-mitigating properties of various systems.

Upon arrival at ABC Stone's warehouse, slabs are photographed with the company's Advanced Stone Imaging Software Technology (ASIST) and uploaded to a Digital Stone Catalogue.

"The biggest challenge in our industry is resistance to change and lack of long-term interest in innovation."
—TJ Deganyar

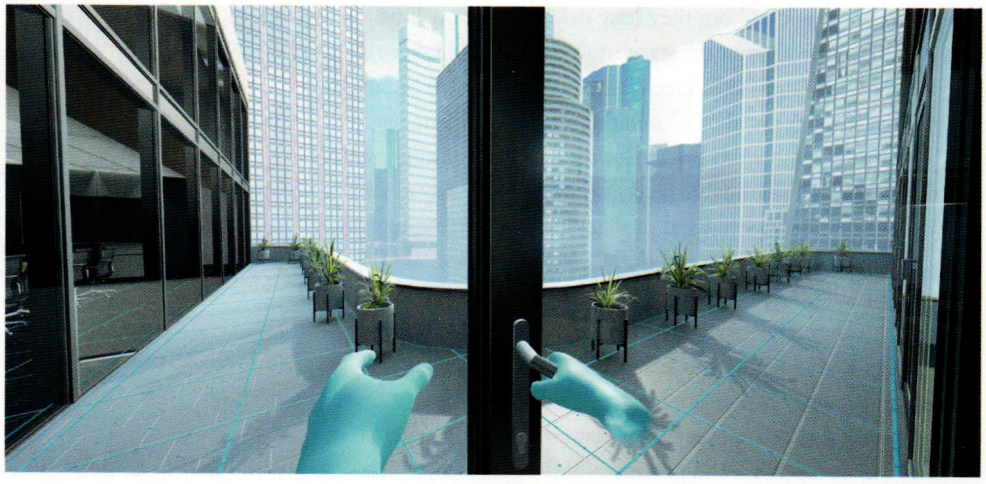
Though technology that supports more efficient material specification for architects is rapidly evolving, practitioners still tend to gravitate to their most trusted methods and suppliers rather than to innovations in the field. In an interview on Schüco's website, VCL Director TJ Deganyar admits, "The biggest challenge in our industry is resistance to change and lack of long-term interest in innovation." A 2016 report titled "The Architect Specification Journey: Understanding the Role of Building





Bathroom elevations featuring images of Onice Bella Rosa slabs from ABC Stone's Digital Stone Catalogue, and a photo of the final installed material.

A user's view within Schüco's VR environment, part of the company's Virtual Construction Lab (VCL), simulates both visual and acoustic scenarios for building enclosures.



ABC Stone's Digital Stone Catalogue uses imaging software that color-corrects and scales each stone slab to 1/16th inch, allowing a very high level of detail when viewed on screen.

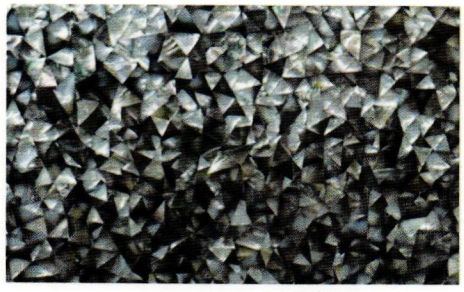
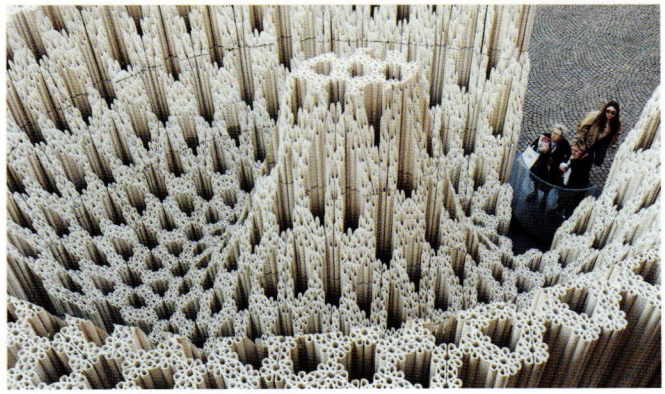


Image credits: Clockwise: ABC Stone; Courtesy Schüco; ABC Stone

Product Manufacturers Today & Tomorrow," conducted by B2B International in conjunction with the AIA, supports the same sentiment: of 330 architects surveyed, more than seven in 10 choose suppliers with whom they have existing relationships.

In an attempt to disrupt the status quo, online architecture database Architizer launched a product marketplace called Source in January 2016 after raising $7 million in series A financing. The platform was meant to streamline the time-consuming process of researching building products, allowing architects to join for free and submit material and product information requests to several relevant suppliers at once. As a series A investor, SHoP was an early adopter of the service, but "a lot of the suppliers were already suppliers we used," says Katherine Anderson, SHoP's material specialist. "At least for our scale it felt like almost going an extra step to use Source." She also points out that certain project details are covered by nondisclosure agreements until later in the specification process, and the platform, which shut down last year, needed more information to customize her search than she could legally supply.

Anderson says the firm has found that the best approach to material specification is to collaborate with manufacturers to come up with unique shapes or finishes, and understand how a material will age over decades. At FuoriMilan 2017, the firm collaborated with architectural terra-cotta manufacturer NBK Keramik to create Wave/Cave, a structure of 1,670 unglazed terra-cotta blocks that had been CNC-milled into 797 unique shapes. The experimental project grew out of SHoP's work with NBK to fabricate the façade of 111 West 57th Street, a 1,428-foot-tall residential building clad in wavelike terra-cotta profiles that reference the material used on many of New York's oldest skyscrapers. To Anderson, close collaborations between architects and manufacturers are the best way to advance sustainable principles. "We were always interested in sustainability and working locally," she says, "and we're trying to learn what's the next step: How do the material choices we make really affect the climate? What's the bigger picture?" And, she points out, that bigger picture begins with using today's technologies to understand even the oldest building materials in new ways. ■



Above, with detail: Wave/Cave, a structure of 1,670 unglazed terra-cotta blocks CNC-milled into 797 unique shapes, was created by SHoP with NBK as an installation for FuoriMilan in 2017.

Photo credits: From top: Spirit of Space; Tom Harris

A SUSTAINABLE FUTURE MEANS SHARING RESEARCH

BY GREG BENCIVENGO, RA, AND SHEFALI H. SANGHVI, AIA, LEED AP BD + C

The future of building materials requires advocacy for a one-stop, open-to-the-public, environmentally conscious building materials database. We as architects must make healthier, more sustainable material selections and specifications commonplace in the architecture, engineering, and construction industry, with continuity from the design process through the end of construction.

We often have an adverse reaction to building materials when opening a package of product samples or walking onto an active construction site—we are assaulted with potentially harmful odors. But we do not have this same reaction to a finished building. The materials have not been significantly altered, but our perception of them changes when experienced as part of a larger assembly or completed project.

Efforts to reduce environmental impacts within the architectural profession must address the needs of those who rely on designers and owners to speak for them. A large, broad, and often vulnerable population are the users of civic projects, including affordable housing, schools, libraries, healthcare facilities, and transit stations. In selecting materials, architects should factor in not only the potential impacts on the end user—for example, reducing or eliminating interior finish products that release harmful gases after installation—but also the impacts on the manufacturer and installer. As with much of the architectural industry, civic spaces and their end users are subject to market-driven impulses that usually consider cost and ease of material procurement. The future occupants, however, are largely left out of the discussion. Buildings can never be truly "environmentally conscious" if we don't account for the effects of the components that go into their design.

Integrating sustainable, forward-looking materials (such as masonry with ground-glass pozzolan, carbon-neutral concrete, or even mushroom-based textiles) into projects, whether of a civic nature or not, requires thorough research and vetting, but also sharing information. Thoughtful material specifications can easily be undone during construction, whether through value engineering, changes in market availability, or a contractor's unfamiliarity with a new or different product. Civic projects are often restricted by tight operational and construction budgets and require durable, long-lasting materials. Therefore, the benefits of such materials cannot be pushed without substantial proof of concept, and any cost considerations must be dealt with sensitively and openly.

The industry needs a publicly accessible unifying body and voice that consolidates information on materials.

Standards such as LEED, Green Globes, and Passive House offer pathways toward achieving and validating sustainably-minded design decisions, but guidelines for selecting materials can be murky and contradictory across platforms. Additionally, in the civic realm, some institutional clients and developers have deeply researched and tested material standards that do not always align with an architectural sustainable agenda. Often, selections are made based on durability and long-term maintenance, but may not factor in potential issues such as off-gassing over time or disposal at end of life.

Several beneficial existing platforms already exist, such as Health Product Declaration Collaborative and Parsons Healthy Material Lab, but can be limited by competing interests or specific agendas. The industry needs a publicly accessible unifying body and voice that consolidates this information.

The value of healthier or more sustainable materials is often intangible, and such selections can be overridden by the need to build and operate a building at an affordable cost. Part of the architect's duty is to educate the client about the benefits of forward-looking materials so they become part of standard practice; material selections must be architect-driven and client-supported. The research effort required to make this happen is not always an affordable reality for architects, who must either build it into project fees or have a separate stand-alone research and development department.

Bringing our research out into the open by advocating for a third-party platform to aggregate and filter through this work could help clarify and standardize material selections, benefitting us all in the future. If we are truly going to tackle architecture's impact on the environment and address it as the crisis it is, we need to benefit from the research and work of our peers.

Greg Bencivengo, RA, is an architect at Dattner Architects. He views design as a combination of the rational and intuitive, and is intrigued by the potential of architecture to reflect and influence cultural and societal behavior.

Shefali Sanghvi, AIA, LEED AP BD + C, is a project manager and Studio Resource Leader at Dattner Architects and has over 14 years of affordable housing experience. She is dedicated to building energy-efficient buildings that are both socially and financially sustainable. ■

OP-ED

LOOK TO NATURE TO HELP CREATE A HEALTHY WORKPLACE

BY AMY JARVIS, AIA

For most people, stress is inevitable, particularly workplace-generated stress. In America, 83% of professionals report being stressed at work and every day, and up to one million employees miss work because of stress, according to a 2013 study by Everest College. The Health Advocate Inc., a consumer-oriented healthcare information service, found that this translates to a jaw-dropping $300 billion loss in productivity each year. Even though there are endless career paths, each with their own set of challenges, the causes of workplace stress are consistent across most sectors. Recent surveys from Harvard Business Review and Gallup, among others, show the three main causes: impossible deadlines, heavy workloads, and lack of professional development.

Overall, employees are working harder for what they understand to be less reward, causing tension and anxiety between staff members and leading to decreased productivity and increased illness. A recent study by economic researchers at the University of Warwick in Conventry, England, discovered that happiness does in fact translate to increased productivity: happy workers were 12% more productive, while unhappy workers were 10% less productive. Although we understand workplace stress will never go away entirely, we can do our best as employers and designers to prevent undue stress from monopolizing our energy and focus. Smart employers are looking towards change management techniques that can improve morale and increase productivity, such as allowing flexible hours, permitting mental health days, and addressing employee fatigue. Once these fundamental changes are underway, the next step is to make physical changes to the actual workplace to help create a more positive and relaxing environment.

While office design itself is not always an inherent stress generator, it can either stall or propel the culture change set forth. Today there are endless materials and products that can be used to organize the workspace or make it more attractive. But how can designers create office spaces that not only look good, but also alleviate stress and promote productivity?

Materials that connect workers to nature is one proven strategy. Studies have shown that daylight, artwork, and views to the outdoors or access to nature itself help decrease stress and increase productivity, resulting in a more positive work environment. The best office design allows natural light to penetrate as far into the building as possible and takes advantage of natural materials. Think about how you felt in a doctor's office designed in the early 1990s; now envision yourself lounging on a beach or relaxing by a fireplace in a log cabin. Natural products and light help make individuals feel relaxed, connected, and grounded, while artificial products like vinyl tile or white ceiling tiles cause anxiety and discomfort.

Materials that connect workers to nature is one proven strategy to alleviate stress and promote productivity.

Sustainable, natural materials are best for designing almost any room, whether it be an office space, bedroom, or even a classroom. These can include wood, cradle-to-cradle metals, stone, non-synthetic carpets and fabrics, and glass. Humans are very perceptive to authenticity, and when a space is finished with a natural product, they respond in a positive way, such as having a more optimistic attitude or just feeling good in the space. Compare this experience to wearing a shirt made from 100% cotton vs. wearing a 60% cotton/40% polyester shirt: although both shirts may appear the same, they feel and look very different when worn.

Few individuals are able to work in a noisy office, so products that help reduce noise pollution can also help decrease work-related stress. Soft materials that absorb sound—like felt panels, upholstered seating, and natural rugs—are great for controlling noise while adding more visual interest to the space. Overall, when selecting these products, it is best to avoid synthetic products, particularly those that off-gas VOCs and other toxic chemicals. Our bodies are very in tune with the notion of being disconnected from nature, and exposure to VOCs causes a number of physical reactions, such as allergies and damage to the central nervous system.

Finally, clutter can kill almost anyone's mood. We encourage our clients to take a moment to think critically about their personal workstation to determine what can be organized in more efficiently. To start, any old papers, folders, and office supplies that are used only once or twice a week can be relocated to a drawer or cabinet or stored digitally. Decluttering decreases distractions and makes it easier to complete tasks in a timely fashion. Once you have cleared your desk, add a small plant—it will give some color to your now empty desktop while offering a small escape into nature.

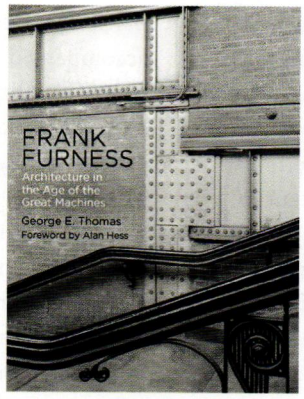
Amy Jarvis, AIA, is an associate at Spacesmith. Born and raised in Houston, Amy found her way to New York after graduate school to begin her career in architecture. She brings a background in fabrication and working with world-renowned artists to a wide range of projects at Spacesmith. ■

IN PRINT

REVIEWS

Frank Furness: Architecture in the Age of the Great Machines, by George E. Thomas. University of Pennsylvania Press, Philadelphia, 2018. 281 pp.

Architectural historian George Thomas places the influential work of Frank Furness in a central position at the birth of modern architecture in America, a time during the post-Civil War era when America's economy became a global force. The organizing idea of Thomas's book is that Furness's importance and growth as an architect is linked to the entrepreneurial, industrial, and technological infrastructure of late 19th-century Philadelphia, an environment in which the architect thrived. Led by industrialists and engineers, major Philadelphia companies and institutions such as the Pennsylvania Railroad and the University of Pennsylvania, with their appetite for the new, became Furness's major clients. Furness's career promoted a new view of architecture. Its energy was drawn from the social and technological forces at work in the industrially oriented enterprises of Philadelphia. His career illustrates how deep the roots of modernism are.



Furness trained with Richard Morris Hunt in New York City in the late 1850s. After service in the Civil War, he established a practice in Philadelphia, his hometown, with George Hewitt. His major projects spanned from the early 1870s, when he won the competition for the Pennsylvania Academy of Fine Arts, to the late 1890s. Commissions came steadily for institutions, universities, railroads, libraries, academic buildings, hospitals, and housing. Asymmetry, functional planning and layouts, clearly visible steel construction and ironwork, machine imagery, current building technologies, and eclectic forms drawn from but not beholden to any stylistic convention all became hallmarks of his work. Some major projects included the University of Pennsylvania Library, Pennsylvania Academy of Fine Arts, University of Pennsylvania Library, Wilmington Railroad Station, and the Baltimore and Ohio Terminal. His designs brought the academy and the factory together.

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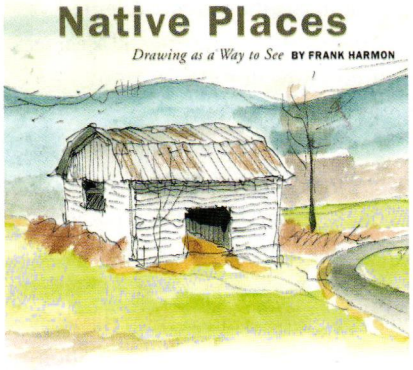
Furness was part of a lineage of modern architects that led from his young associate Louis Sullivan down through Frank Lloyd Wright and Louis Kahn. Furness died in 1910 and remained a Victorian to the end. But he brought the values of engineering culture, planning, and materials directly into design. He opened architecture to a future without historic influences, and strove to express the poetry of the present.

Native Places: Drawing as a Way to See, by Frank Harmon. ORO Editions, San Francisco, 2018. 168 pp.

Frank Harmon, AIA, a Raleigh-based architect who teaches at North Carolina State University, has been drawing relentlessly throughout his career, recording and commenting on what he sees, with an emphasis on the vernacular. In clear, quick depictions, he reveals the beauty and poetry in the particular. This volume offers drawings accompanied by short essays selected from his online project, Native Places.

In his book, grouped into chapters on various settings throughout the United States (particularly the South) and in Europe, Harmon has recorded both the natural and the man-made. His spare line work combines with wash, watercolor, and occasionally colored pencil, creating focus as he develops volume, detail, and atmosphere. He presents a simple sketch of a barn—many barns, in fact—and supplements it with insight into the knowledge that sited and created it. It is a powerful technique that subtly emphasizes the riches of looking and seeing the world before our eyes.

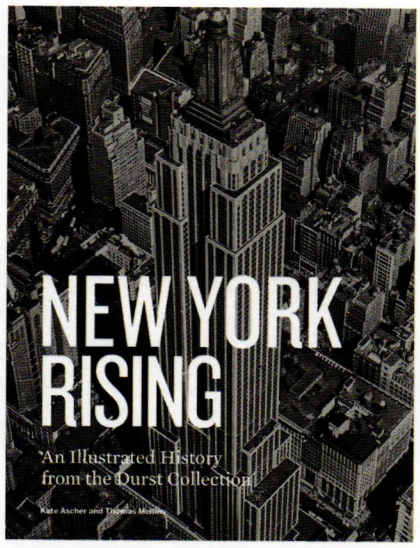


Indeed, his drawings and text find treasures in the ordinary. Beyond barns, there are rural and urban houses, window boxes with plants, New York's Jamaica Bay, views from planes, tools and objects lying around—all telling their own stories. A few are so spare they seem abstract and dramatic, such as a thunderstorm over Lower Manhattan. Others are cinematic, including views down roadsides, where he picks up the natural plants along with the man-made ones (e.g., signs and power poles). Sometimes he combines the disparate events of a day, like a wren with a worm and a CAT excavator, both doing their jobs. In many of his sketches, particularly of buildings, Harmon is extolling both craft and time. Drawing in London and in towns throughout the South, he captures buildings of all scales that present a weathered but noble face.

Harmon's beautiful and evocative drawings, which keep the eye oscillating between image and text, reinforce the value of looking and seeing. They serve as a reminder to all of us to keep observing and recording.

New York Rising: An Illustrated History from the Durst Collection, by Kate Ascher and Thomas Mellins (with contributions by Hilary Ballon, Ann Buttenwieser, Andrew Dolkart, David King, Reinhold Martin, Richard Plunz, Lynne B. Sagalyn, Hilary Sample, Russell Shorto, and Carol Willis). The Monacelli Press and the 2018 Trustees of Columbia University in the City of New York, 2018. 263 pp.

This is a history of New York City told from the perspective of its real estate development. It is drawn from



the collection of Seymour Durst, scion of the Durst family real estate organization, housed in Columbia University's Avery Library. Asher and Mellins, principal authors and editors, have organized this volume into 10 chapters reflecting the eras and themes of the city's development from the 1640s to 2001.

The first two chapters establish New York's early history and the major developments that influenced its expansion: the Erie Canal and the growth of the port; the 1811 plan, which imposed a grid on Manhattan and commoditized the land; the Croton Aqueduct System, which gave the city fresh water and spurred population increase; and Central Park. These strategic investments and initiatives propelled the city forward and opened up boundless opportunities.

The remaining chapters are thematic by building type, systems and infrastructure, or location or district (Midtown, Times Sq.). Each chapter is supplemented by a portfolio of selections from the Durst Collection. These 170+ exhibits were selected by the contributors, and each is accompanied by short narrative prepared by them. These sections are the jewels of this volume, and consist of maps, site plans, illustrations, analytical drawings and diagrams, floor plans, land use plans, historic postcards, photographs, and more. It is a wealth of material, all on point, riveting in interest and all with a tale to tell. One sequence of many: views of Times Square, starting in 1898, punctuated by an NYPD vice map in 1973, and continuing to a ground-level Time Square pedestrian space in 2001.

This is a history through a particular lens. As authors Asher and Mellins report, "the story of New York Rising is one of never-ending speculation and innovation…big ideas, big personalities, big risks that collectively shaped a city like no other." Read it!

Stanley Stark, FAIA, NCARB, LEED AP, is the book critic for Oculus. ■

LAST WORD

FALL PREVIEW

Photo credit: Sam Lahoz

BENJAMIN PROSKY, ASSOC. AIA, EXECUTIVE DIRECTOR
AIA NEW YORK CHAPTER CENTER FOR ARCHITECTURE

As New York City builds and rebuilds and fills in many of its lots with new development and adaptive reuse, we have been curious to find out how smaller regional cities may be simultaneously responding. How far-reaching is this new era of urban investment? Are smaller cities feeling some of the financial ripple effects from larger cities? Despite the fact that much of the industry and manufacturing that historically fueled these smaller American cities have disappeared, are new types of jobs and economies emerging?

During an informal chat with Michael Murphy, co-founder of MASS Design Group, a firm that has been known mostly for its social impact work in Africa, Haiti, and the U.S., we talked about the firm's more recent focus on the future of the smaller American city. MASS had recently opened up an office in Poughkeepsie, NY, where Michael grew up; here, through research and community-based projects, the staff members were trying to see how design could play an important role in shaping the city's future.

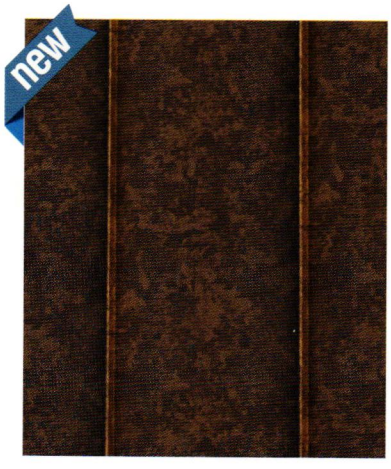
We were excited that MASS Design Group proposed a collaboration between the Center for Architecture, University of Richmond, and others on a research project over the past year that has resulted in a major exhibition at the Center this fall, exploring the firm's concept of "fringe cities." In "FRINGE CITIES: Legacies of Renewal in the Small American City," MASS Design Group defines fringe cities as small and independently situated, with urban landscapes marked by mid-century urban renewal. Anticipating future infrastructure investment, these cases provide insight and cautionary tales, demanding further inquiry to avoid repeating the mistakes of the past. A snapshot of an ongoing investigation into the last great federal investment in the small American city, this exhibition examines the role of design in packaging and selling strategies for renewal. Historical data, analysis, and contemporary interventions from over 100 small American cities will be on display. It is our hope that this exhibition will provide a platform for more small cities to tell their stories.

Also this fall, Archtober, New York City's architecture and design festival, returns for its ninth year. With more than 80 partner organizations across the five boroughs, this year's festival will be bigger than ever, showcasing the impact of the built environment through a myriad of talks, tours, studio visits, exhibitions, and more. Don't miss our popular Building of the Day series of architect-led walking tours; highlights for 2019 include FXCollaborative's Statue of Liberty Museum, Studio Gang's Solar Carve, and Steven Holl Architect's Hunters Point Library.

We are also excited to announce two new Archtober partnerships for 2019. To highlight their work as local community centers, NYC's three public library systems—Brooklyn Public Library, New York Public Library, and Queens Public Library—will join the festival, allowing us to reach even broader audiences. Library programs will include branch tours, panel discussions on new library construction and the future of libraries, and special architecture-focused story-time hours. Also new this year are the festival's Weekend Getaway partners. Take a short train trip or car ride to explore architecture beyond NYC while enjoying the fall foliage! This year's Weekend Getaway partners include the Glass House, Grace Farms Foundation, and Art Omi. To see a full line-up of events, visit Archtober.org. Be sure to follow us on Twitter and Instagram @archtober.

See you at the Center! ■

Craig Ranch Phase III, McKinney, TX | Installing contractor: StazOn Roofing | Architect: JHP Architecture
Material distributor: Roofing Supply Group | General contractor: Amicus Construction | Owner: Lincoln Property Co. | Photographer: Tom Coplen
Material: Steel coil | Colors: Weathered Steel, Zinc



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-J. Mark Wolf, AIA, Vice President, JHP Architecture

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