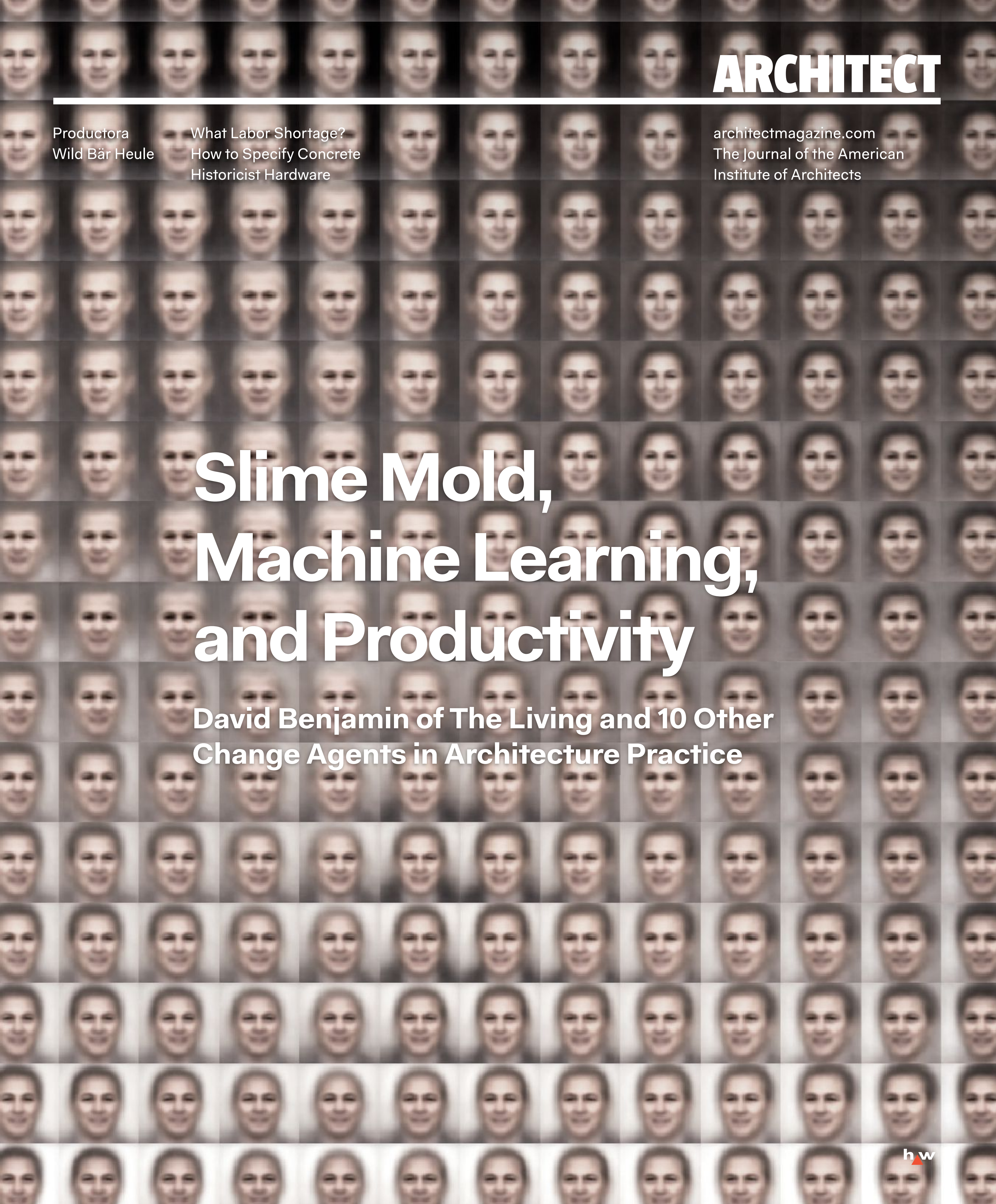

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What Labor Shortage?
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Slime Mold, Machine Learning, and Productivity

David Benjamin of The Living and 10 Other Change Agents in Architecture Practice

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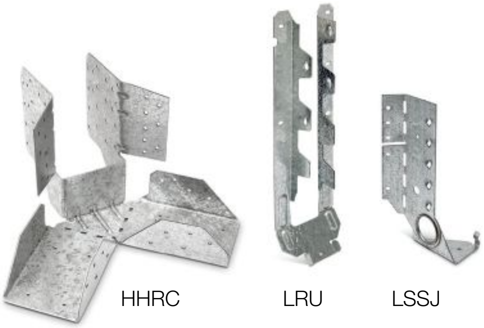
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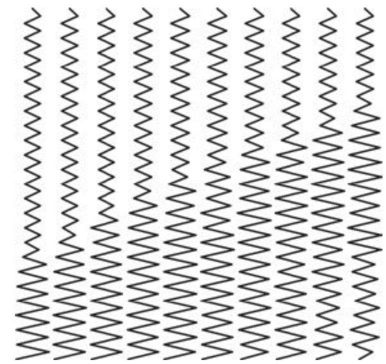
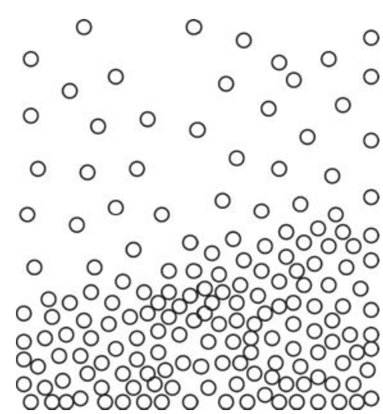
Volume 107, number 1. January 2018.
On the cover: Facial recognition set from the Twin Mirror exhibition by David Benjamin and The Living





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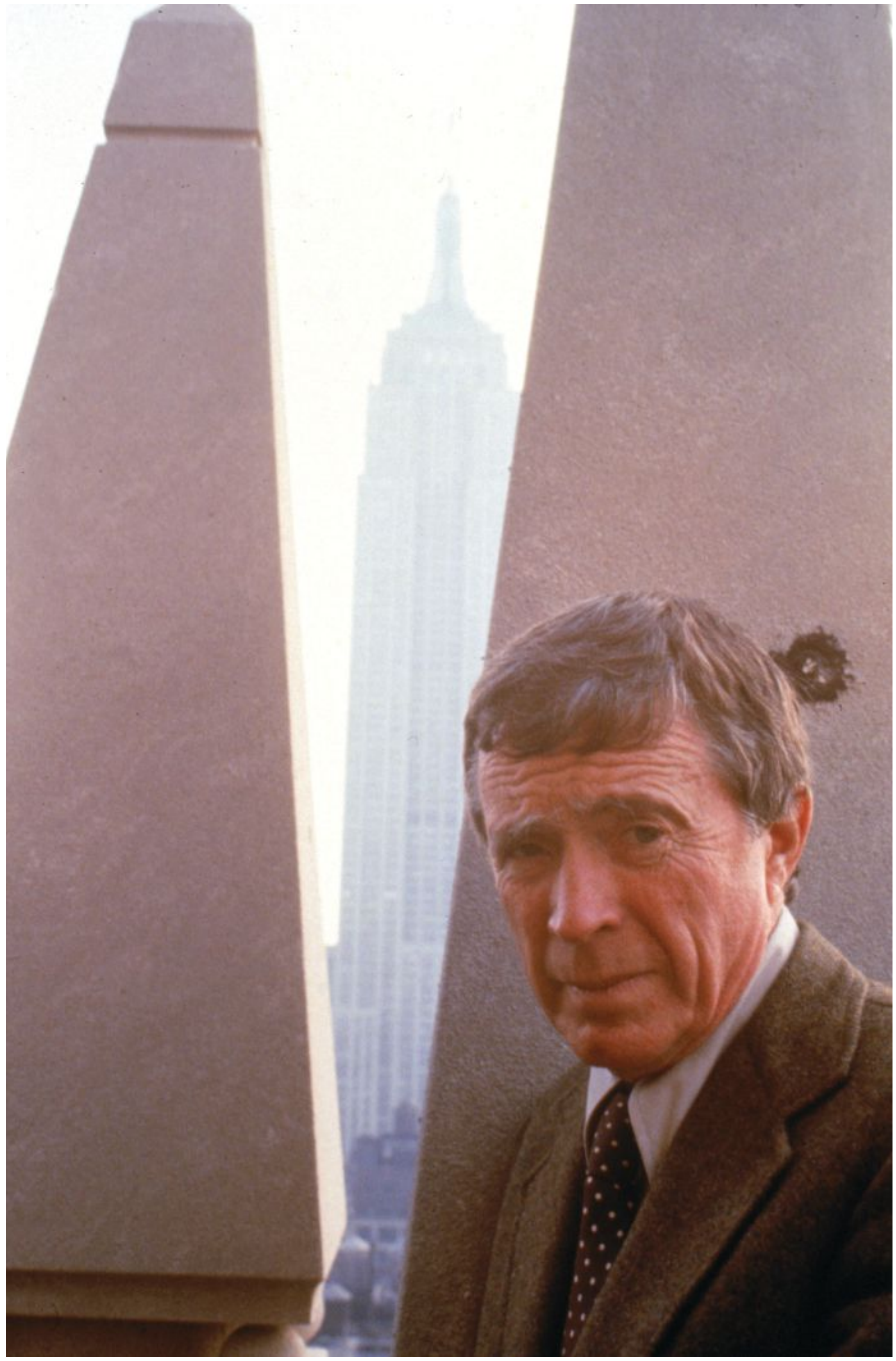

BERNARD GOTFRYD/GETTY IMAGES

Vincent Scully Dies at 97

Though not an architect by training, Yale University Sterling professor emeritus of history of art and architecture Vincent Scully was once called "the most influential architectural teacher ever" by Philip Johnson. A Yale graduate himself, Scully spent more than six decades lecturing and writing about the likes of Frank Lloyd Wright and Louis Kahn, while championing efforts for historic preservation and warning against urban redevelopment in the 1960s. Scully died on Nov. 30 due to complications associated with Parkinson's disease at his home in Lynchburg, Va. —KATHARINE KEANE

> *Read more about Vincent Scully's career at bit.ly/ScullyObit.*


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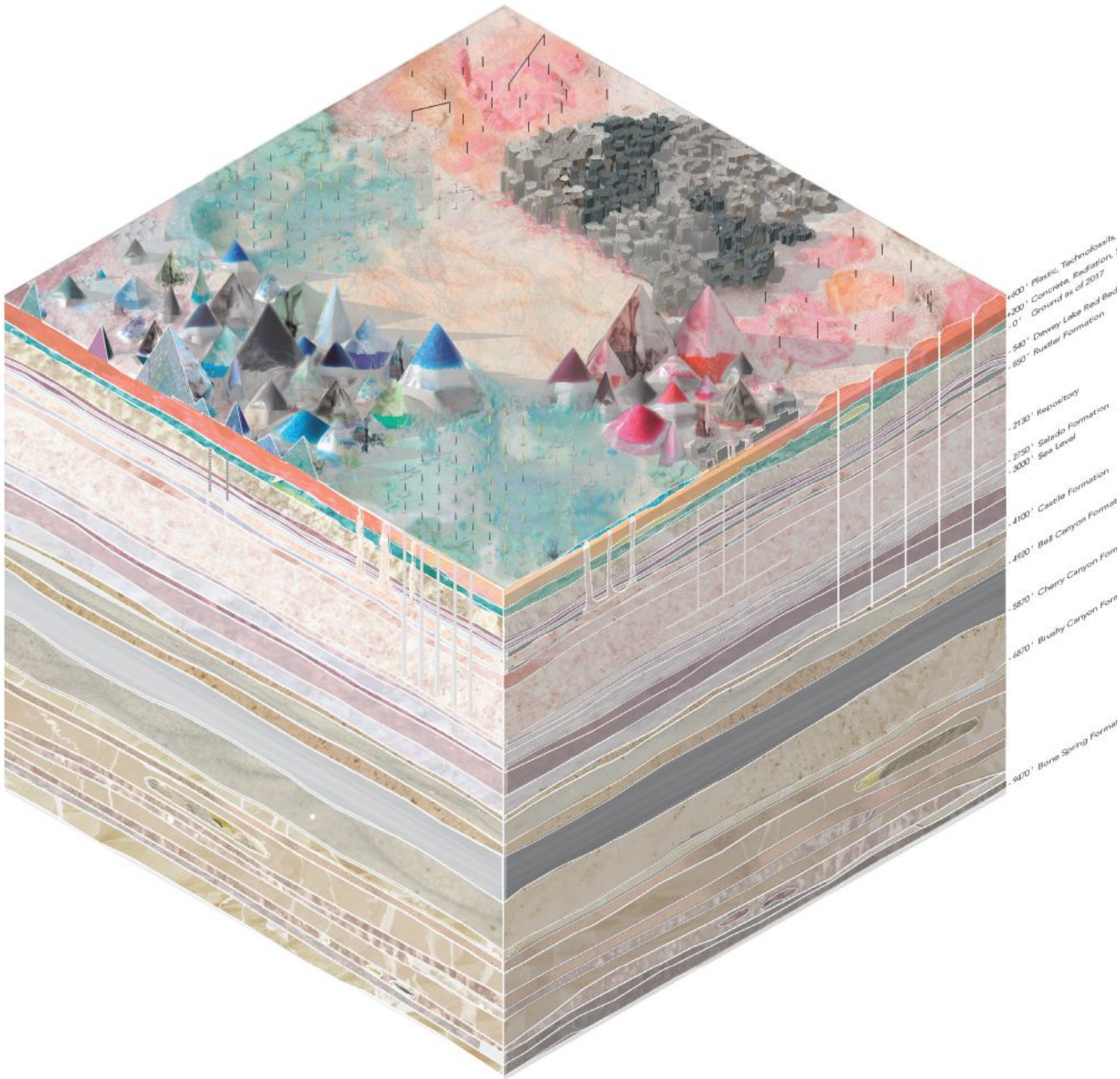

COURTESY AGENCY—AGENCY

A Monument for Containing And Protecting Against Nuclear Waste

Toxic waste from Cold War–era nuclear programs will take thousands, and maybe even millions, of years to fully decay. A recent ideas competition by architectural research initiative Arch Out Loud called for markers to "deter inadvertent human intrusion into the Waste Isolation Pilot Plant" in Carlsbad, N.M., that could exist for 10,000 years. The winning submission, Testbed by New York–based Agency—Agency (shown), proposes to install carbon dioxide sequestration technologies along with mineral extraction resources. Over time, these processes would create new geological forms that would become site markers. —KATHARINE KEANE

> Read more about the submissions at bit.ly/NuclearLandmarker.

COURTESY C.Y. LEE & PARTNERS

PoMo: Present at the Creation

To all the ink spilled about the postmodern revival there comes a new contribution: *Revisiting Postmodernism* (RIBA Publishing, 2017). The book offers two perspectives on the rise—and the repercussions—of this once-reviled, now re-emergent movement. In the first, Terry Farrell, who brought a PoMo flair to London with his TV-am television studios and Charing Cross Station redevelopment, revisits his career. Then Adam Nathaniel Furman, a young London designer, follows with a genre-expanding take, focusing on the Italians and architects like C.Y. Lee and his Chung Tai Chan Monastery in Taiwan (shown). —ERIC WILLS

> *Read more about Farrell and Furman's book at bit.ly/RevisitingPoMo.*

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ELANA LANGER

Design for Access

Unless you or a loved one has a disability, you probably haven't spent much time thinking about how some people navigate what for the rest of us are simple activities. "Access+Ability," which runs at Cooper Hewitt, Smithsonian Design Museum through Sept. 3, highlights this reality: Many of the items on display owe their creation to individuals who couldn't find a suitable product for their own use. The exhibition also reveals that a growing number of designers fortunately have woken up to the needs of this often overlooked group. Some of the objects make the utilitarian stylish, such as a hearing aid by Elana Langer (shown). —ERIC WILLS

> Read more about "Access+Ability" at bit.ly/DesignforAccess.

COURTESY CARMODY GROARKE

A Mesh Tent for Mackintosh's Hill House

As part of a years-long conservation project, London-based firm Carmody Groarke and the National Trust for Scotland revealed plans to temporarily cover Charles Rennie Mackintosh's Hill House in a semitransparent enclosure. Built in the early 1900s in Helensburgh, Scotland, for publisher Walter Blackie, the house was constructed using Portland cement, which proved not to be compatible with the Scottish west coast's humidity. The perforated mesh enclosure will protect the house during the restoration and allow its water-soaked walls to slowly dry. Elevated walkways inside will allow up-close views of Mackintosh's design. —AYDA AYOUBI

> *Read more about the conservation project at bit.ly/HillHouseProject.*


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COURTESY ARQUIVO NACIONAL, RIO DE JANEIRO, BRAZIL

Pioneering Women of American Architecture

Believed to be the second African-American woman licensed as an architect in the U.S., Topeka, Kan.–born Georgia Louise Harris Brown (1918-99) emigrated to Brazil because it offered greater opportunities for women of color. She is one of 50 women profiled in the new website Pioneering Women of American Architecture, launched by the New York–based Beverly Willis Architecture Foundation. Each was born before 1940, when "women struggled both to be allowed entrance into the architectural profession and to be recognized for their work," write foundation co-directors, Mary McLeod and Victoria Rosner. —KATHARINE KEANE

> *Read more about the website at bit.ly/PioneeringWomenBWAF.*

COURTESY ALLAN GREENBERG

Allan Greenberg Returns to Rice University

Houston's Rice University held a groundbreaking ceremony in December for a new 84,000-square-foot building designed by Allan Greenberg, AIA, whose eponymous firm has offices in New York City and the Washington, D.C., area. (He also designed Rice's Humanities Building.) The new structure for the Shepherd School of Music, in the neo-Byzantine style set for the campus by architect Ralph Adams Cram, will connect via a public plaza to the existing Alice Pratt Brown Hall by Ricardo Bofill, HON. FAIA. Together the two structures will become the university's new Music and Performing Arts Center, scheduled to open in 2020. —SARA JOHNSON

> *See more renderings of the new building at bit.ly/RiceMusicBuilding.*

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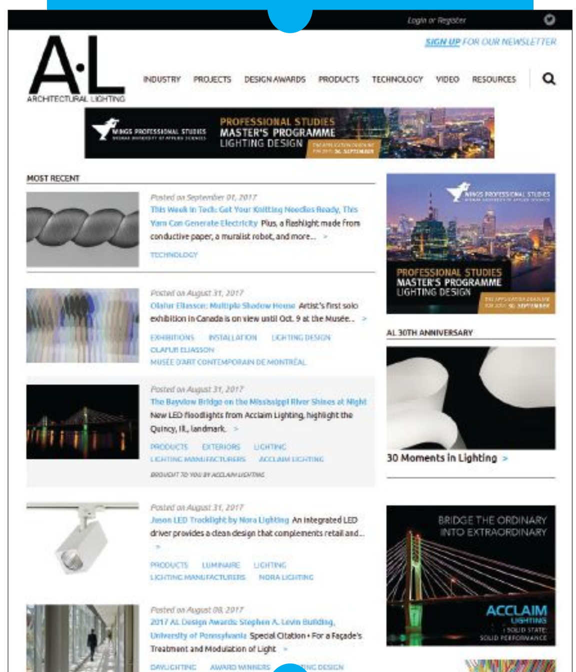

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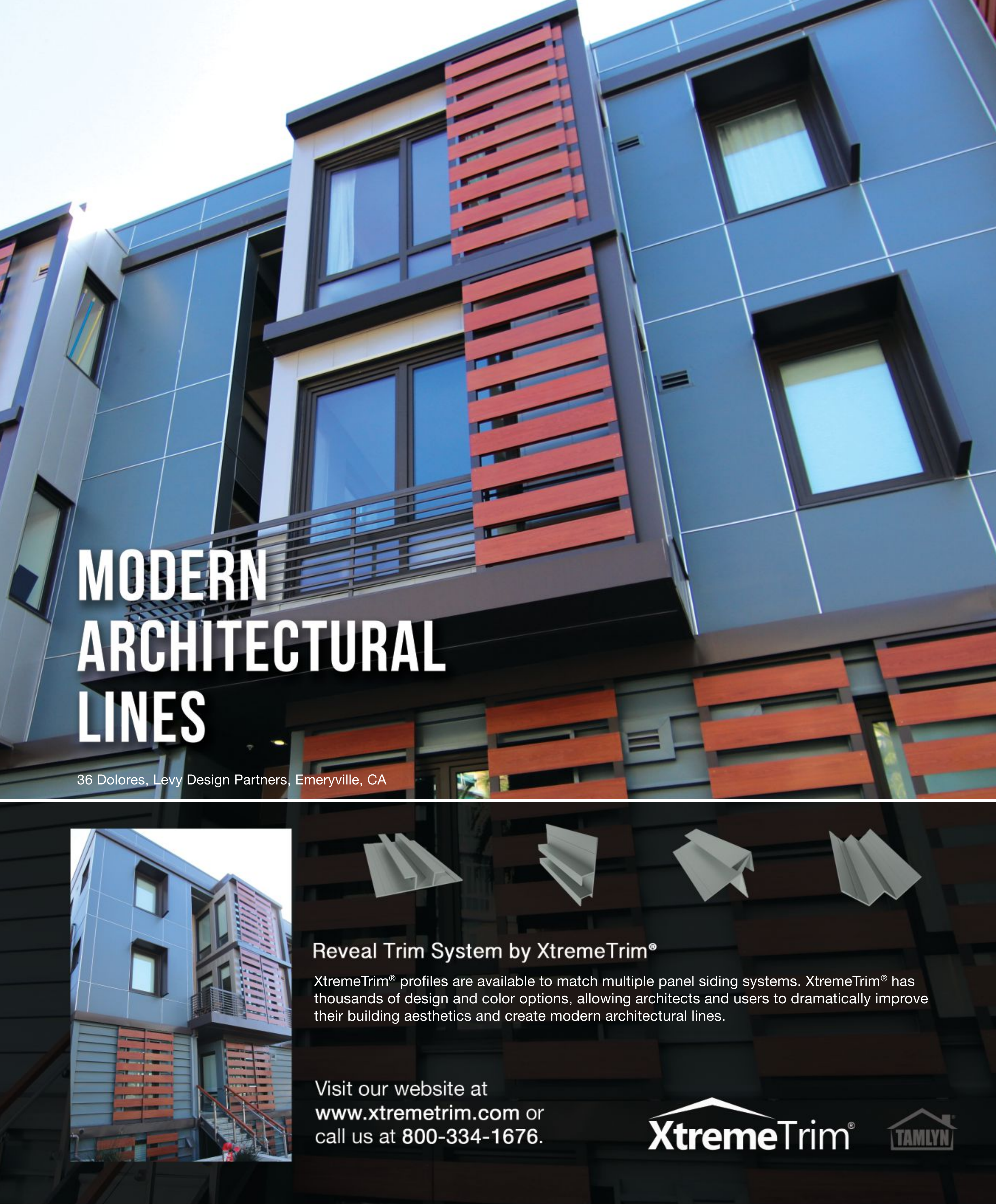
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Best Practices: Commissioning a Photographer

TEXT BY NATE BERG

Photography lets architects chronicle and promote their work. But not all photos—and all photographers—are created equal. Below, design and photography professionals lend some advice on finding the right artist, prepping for the shoot, and more.

Finding and Selecting a Photographer

Knowing what kind of photographer to hire requires knowing the photographic needs of a project. Francesco Breganze, founding partner of the New York–based interdisciplinary design practice Spazio Primario, breaks down those needs into four categories: editorial, technical, marketing, and photos for internal use.

While informal photos, such as those for tracking construction progress or pinpointing trouble spots, can be taken by design staff, portfolio or marketing images require a professional. And when it comes to finding the right person for a specific job, Breganze often relies on design colleagues for recommendations. "You need to find a photographer with your taste that can reflect the feeling of your project in their photos," he says. "That is why we constantly pay attention to [who took] our colleagues' photos in magazines and websites. I think that is the most powerful advertisement for photographers."

"You need to find a photographer with your taste that can reflect the feeling of your project in their photos."

—Francesco Breganze, founding partner, Spazio Primario

Katie Gutierrez, co-founder of the Coral Gables, Fla.–based interior design firm Errez Design Studio, has also found photographers through word-of-mouth, scouring photo credits, and reviewing online portfolios. "At the end of the day," she says, photographs are "all you have when you hand over the keys."

Negotiating Rights

Before the camera shutters start clicking, the terms of the shoot and its desired outcome should be established. "It's important to figure out what your rights are from the outset," says Erica Stoller, director of the Mamaroneck, N.Y.–based architectural photography firm and archive Esto, which represents more than a dozen architectural photographers and licenses their work.

Typically, Stoller says, the photographer retains the copyright to the images, licensing them to firms for specified uses for a limited length of time. Some architects may choose to license the photographs in perpetuity for long-term use in their own marketing materials or to provide for free to print and online publications, as well as for use on social media. Architects can reduce how much they pay for licensing fees by deciding which photos they will use more often and those that they may only need for a single use. Stoller says knowing up front if the photos will be used by any of the other project team members, such as an engineering firm or a product manufacturer, is also critical to determining fees and what components of the project the photographer should focus on.

Prepping the Shoot

The photo shoot itself will require a significant amount of preparation. Stoller, also the daughter of renowned architectural photographer Ezra Stoller, offers a checklist of things to consider ahead of time, including everything from scouting visits to determining the equipment and props needed for different seasons and times of day. The architect and photographer should work closely throughout the planning and preparation process to get the best results. "You want someone who understands what the design problem was, and how the design solved the problem," she says.

During the shoot itself, the designer should be an active participant. "It's a very demanding day or two," says Mary Burnham, AIA, partner at Murphy Burnham & Buttrick Architects in New York. Her firm often has the project manager and a marketing person on site during a shoot to guide the photographer. "We almost always go in with a set of floor plans and arrows where we think we want to shoot," she says. "You have to line up all the shots you want to get. There's not a whole lot of time for fooling around."

> For more strategies for commissioning a photographer, visit bit.ly/ARArchitecturalPhotographer.


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Detail: The R.W. Kern Center Timber Structure

TEXT BY TIMOTHY A. SCHULER

The R.W. Kern Center at Hampshire College in Amherst, Mass., was designed to be "rooted in its place," says Jason Jewhurst, AIA, a principal at Cambridge, Mass.–firm Bruner/Cott & Associates. Completed in 2016, the two-story, 17,000-square-foot building houses the school's admissions department, classroom and gallery space, and a coffee bar.

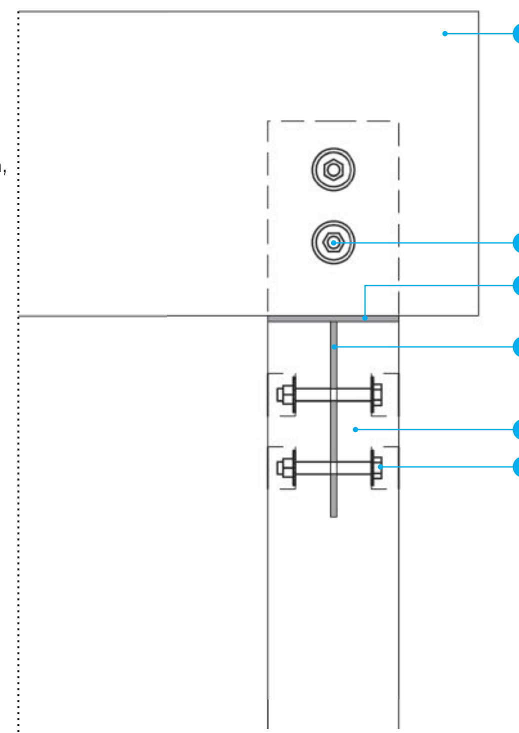
"We steered ourselves toward really honest materials," says Bruner/Cott principal Jason Forney, AIA. "So you have this palette of materials that are very much true to themselves." For example, the Kern Center features a half-dozen wood species, chosen specifically to cohere within the space: black spruce for the glulam; ash and birch for the doors; salvaged red oak for the flooring and monumental stair; pine for the ceiling; and cedar for the exterior.

Along with wood, curtainwall glazing predominates the building envelope. "It was important that the glass felt like a veil that wrapped the wood structure," Jewhurst says. "It was a good test for us to be minimal about the connections."

Equal attention was paid to simplifying joints between structural members. In the second-floor classroom, for instance, 5-inch by 12-inch glulam beams neatly join an equivalent-sized rim beam and a 5-inch-square post. A 5-inch-wide steel base plate is sandwiched between the end of the beam and the face of the rim beam, with knife plates centered in both the posts and beam, secured by just two lag screws and two bolts.

Besides the mostly hidden steel plates that attach to the aluminum mullions of the curtainwall system, the only steel visible is a small seat tab below the roof beam. Jewhurst credits Bruner/Cott project architect Christopher Nielson, AIA, who was "on the phone day and night, working through how minimal we could make these connections."

ROBERT BENSON



1. 5" × 12" glulam rim beam
2. 0.5"-thick steel beam strap and seat
3. 0.25"-thick steel knife plate
4. 5" × 5" glulam post
5. Ø0.5" × 4" bolt with Ø1.4375" washer and 2" countersink (typ.)

> *To learn more about the design of the R.W. Kern Center and its pursuit of Living Building Certification, visit bit.ly/ARRWKern.*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Next Progressives: Productora

EDITED BY KATHARINE KEANE

Location:
Mexico City and Los Angeles

Year founded:
2006

Firm leadership:
Carlos Bedoya, Wonne Ickx, Victor Jaime, and Abel Perles

Experience:
Neutelings Riedijk Architects, Flores and Prats Architects, Fernando Romero Enterprise, TEN Arquitectos, Central de Arquitectura, and others

Firm size:
14

Mission:
Precise geometries, clear legibility, and timeless buildings.

How the founders met:
Sharing a studio space in Mexico City doing small projects and competitions after our day jobs at other firms.

Origin of firm name:
Many of our friends worked in the advertising, movie, or music industries and they always talked about their *productora* ("production house" in Spanish). So we used the term to name our studio. Later, we started to rephrase its meaning. We now say it is the production that drives the design process at Productora. Instead of analyzing, reflecting, theorizing, and dissecting, we propose the immediate production of architecture as a tool to investigate context and generate a design proposal.

Favorite project:
A proposal for the contemporary art museum in Lima, Peru.

Second favorite project:
The Teopanzolco Cultural Center in Cuernavaca, Mexico. This project is the result of a competition we won in 2015, which we finished together with a good friend and great architect, Isaac Broid.

What should architects be discussing right now?
Architects should come to terms with the fact that architecture is much more related to tradition than to innovation, especially in the way buildings are produced, in the way cities operate, and in the way communities have histories and customs. If we can understand that, a place for smart alternatives likely exists.

Design aggravations:
Spider (point-fixed) glass curtainwalls, curved reception desks, oval sinks, frosted glass, synthetic wooden decks, electric cooktops, retractable projection screens, glass parapets, infinity pools, recycled containers, color-changing LED lamps, granite countertops, domotics (home automation), freestanding bathtubs, chamfered corners, and many more things.

Memorable learning experience:
Our first project in Los Angeles and the opening of our office in Los Angeles made us understand the enormous impact that local construction habits and customs have on design. It required us to rethink our whole design and building process.

Modern-day architecture heroes:
Mauricio Pezo and Sofia von Ellrichshausen of Concepción, Chile–based Pezo von Ellrichshausen.

Special items in your studio space:
A stool we spray paint a different color every year (it is silver now), the mock-up for the tower model at the current Chicago Architecture Biennial, and our office dog Lapiz (not really an item).

Skills to master:
Making tons of money.

Abel Perles, Wonne Ickx, Carlos Bedoya, and Victor Jaime

JUAN BENAVIDES

> *To learn more about Productora's work and inspiration, visit bit.ly/ARProductora.*

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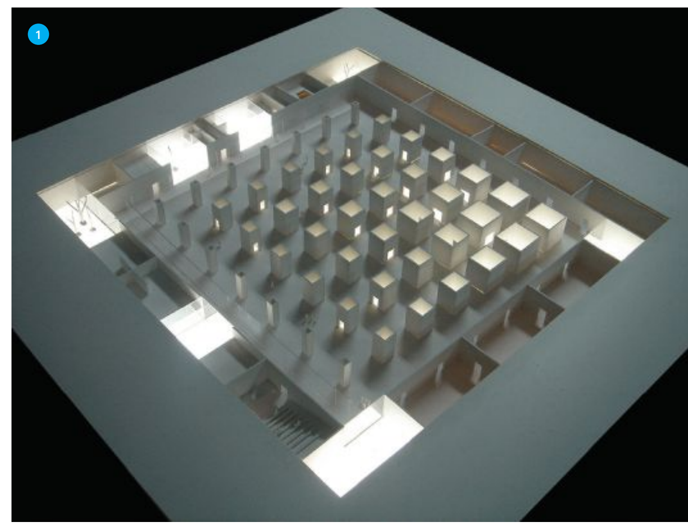

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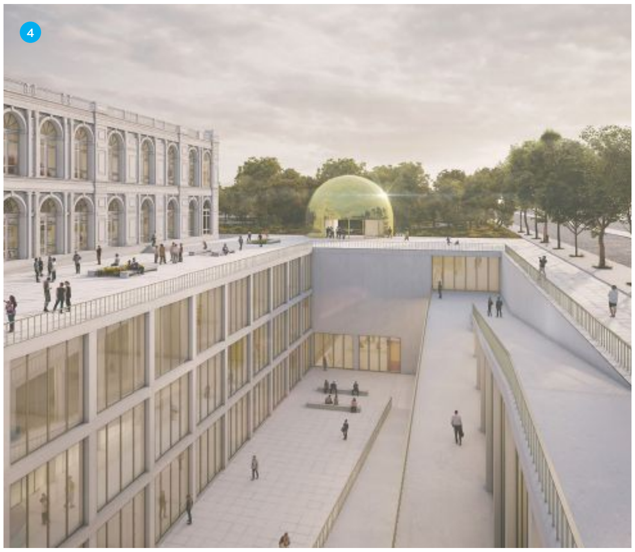
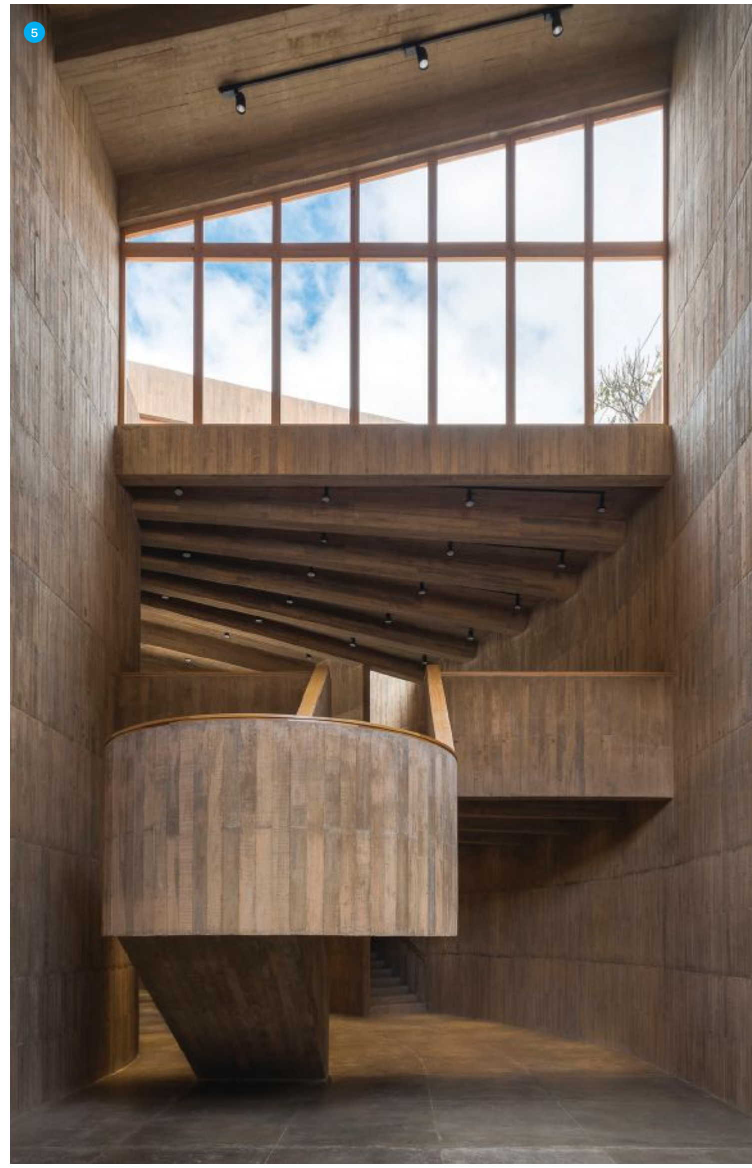




5: LUIS GALLARDO; 7: RORY GARDINER

1. Productora's 2006 Museo de Arte Contemporáneo de Lima proposal conceives of an underground structure with only a grid of geometric forms peaking through the desert sand. **2.** For the 2017 Teopanzolco Cultural Center in Cuernavaca, Mexico, the team of Productora and Isaac Broid were challenged to both enhance the surrounding archaeological site and create ample public space. The resulting complex comprises a rectangular volume that serves as a viewing area for the ruins and a triangular esplanade roof that minimizes the structure's visual impact. **3.** Productora opted to render its 16-foot-tall skyscraper model for the 2017 Chicago Architecture Biennial in red and blue—the same colors as the Bic pens used to sketch the concept. **4.** The firm's proposed expansion for the Lima Art Museum won honorable mention in the institution's 2016 open international competition. **5.** The Teotitlán del Valle Community Cultural Center in the Mexican state of Oaxaca features 12-inch-thick walls made of locally sourced concrete and controlled pathways to regulate temperatures. **6.** Productora proposed a grouping of buildings at the center of the Aalto University campus in Espoo, Finland, for the institution's School of Arts, Design, and Architecture. **7.** The firm remodeled and extended a 1920s bungalow in Los Angeles, creating a grid-like structure that contrasts with the original residence.

Products: How to Specify Concrete

TEXT BY SELIN ASHABOGLU

At its essence, concrete comprises three ingredients: cement, water, and aggregate. From these, architects can get an endless variety of concrete mixtures, tailored to a project's site conditions, location, climate, and performance requirement. But what differentiates one mixture from another?

Cement Type

Cement—a term often incorrectly interchanged with concrete—acts as a binding agent for the aggregate and generally comprises about 10 to 15 percent of the concrete mixture by weight. Portland cement—the most widely used binding agent—is a mix of crushed calcium compounds, silica, alumina, and iron oxide, and it comes in six common types: Types I through V, and White Portland cement. The amount of calcium silicate in each determines its performance.

For instance, Type I cement has a high calcium silicate content, which is good for early strength development in general construction projects. Type IV, on the other hand, has a low calcium silicate content and releases heat slowly during curing, limiting the concrete's internal temperature and making it desirable for massive projects such as dams. White Portland cement performs similarly to Type I, but is more expensive due to its light coloration.

Water-to-Cement Ratio

The water-to-cement (w/c) ratio of concrete is calculated by dividing the weight of the water in a mix by the weight of the cement. Ratios typically range from 0.45 to 0.60. The strength and durability of the concrete will increase as the w/c ratio decreases—that is, the lower the water content, the better the choice for high load-bearing projects. More water in a mix also results in more capillary pores in the concrete, which increases its vulnerability to freeze–thaw cycles, and thus cracking.

Concrete being poured into place at a construction site.

Aggregates

Rocks, gravel, and sand make up 60 to 75 percent of the total volume of the concrete mix. Fine aggregates have a maximum diameter of 0.3 inch; coarse aggregates should have a maximum diameter of 1.5 inches to ensure proper binding and coverage. Mixtures utilizing high proportions of fine aggregates are suitable for road surfacing, decorative concrete, and paving paths. Coarser aggregates can reduce costs and increase durability and strength by reducing the amount of voids between particles and, subsequently, the amount of cement needed.

Admixtures

Admixtures can be introduced into a concrete mix to enhance performance or placement. Water-reducing admixtures improve the workability of mixes with low w/c ratios. Retarding admixtures slow the curing of the concrete and are suitable for construction in warm climates where the ambient heat may hasten cure times. On the opposite end are accelerants, such as calcium chloride, which speed up curing when the weather is cold. Superplasticizers reduce the viscosity of concrete, which is good for pouring concrete in tight areas around rebar. Lastly, corrosion-inhibiting admixtures increase the durability of concrete in high-traffic applications.

Strength

The strength of concrete can be monitored during curing by testing concrete cylinders assembled on the jobsite in conjunction with its placement. According to American Concrete Institute guidelines, samples should be tested at least on the 28th day of curing to assess its potential ultimate strength. At this time, a compressive strength between 3,000 psi and 5,000 psi can be expected. If the project requires high strength earlier, a three- to seven-day test can be conducted to confirm that its performance matches expectations.

COURTESY LAYTON CONSTRUCTION

> *To read the full story online, visit bit.ly/HowToSpecifyConcrete.*

TARGETING CARBON IN THE FIGHT AGAINST CLIMATE CHANGE

AS THE BUILDING INDUSTRY WORKS TO DECREASE GREENHOUSE GAS EMISSIONS, REDUCING THE EMBODIED CARBON IN BUILDING PRODUCTS IS KEY

Presented by: USG

LEARNING OBJECTIVES

- Acknowledge the major impact that building and building products and materials are making on greenhouse gas emissions, particularly carbon, and climate change
- Recognize how the Architecture 2030 Challenge for Products focus on lowering embodied carbon is a critical aspect of reducing carbon emissions and lowering the impact of climate change
- Acknowledge the importance of building product manufacturers working to reduce the embodied carbon of their products and making life cycle assessment information easily available to specifiers
- Realize the key role that architects play in driving market change by including low/no carbon footprint product performance requirements in their specifications

CONTINUING EDUCATION

AIA CREDIT: 1 LU/HSW
AIA COURSE NUMBER: AR012018-1
GBCI CREDIT: 1 CE
GBCI COURSE NUMBER: 0920014956

Use the learning objectives above to focus your study as you read this article. To earn credit and obtain a certificate of completion, visit http://go.hw.net/AR012018-1 and complete the quiz for free as you read this article. If you are new to Hanley Wood University, create a free learner account; returning users log in as usual.

Threatening to trigger frightening levels of climate instability in the coming decades and eventually tip the planet's climate system into dangerous global warming, the continued release of high greenhouse gas emission (GHG) levels is a most serious issue. Scientific consensus has already established that increasing atmospheric levels of carbon dioxide—created by fossil fuels and energy production—is contributing to rising sea levels, intensification of weather-related events, and the degradation of natural resources.

In what is being described as the most comprehensive domestic climate science report ever produced, the recently-released U.S. Global Change Research Program's Fourth National Climate Assessment categorizes the possibility that human influence has been the dominant cause of the observed warming since the mid-20th century as *extremely likely*.

In the meantime, "climate change is leading to larger weather extremes and, as we have seen this year, more and more weather-related natural disasters," states Amarpreet Sethi, CEM, BEMP, HPDP, performance design leader, principal, DLR Group (Seattle, WA). "These disasters are not only costing us precious human lives, but also large expenditures in redevelopment."

In fact, as one recent NBC news article, "Extreme Weather, Climate Change Costing Taxpayers Billions," cites, U.S. Government Accountability Office data stating that the federal government has spent an estimated $350 billion over the past decade in response to extreme weather and fire events exacerbated by climate change.

And a second NBC news piece, "Climate Change Already Hurting Our Health and Economy, Report Warns," reports on a recent Lancet international medical journal study that states, "increasing temperatures have led to around 5.3 percent loss in labor productivity, and economic losses linked to climate-related extreme weather events were estimated at $129 billion in 2016."

Similarly, Dr. Nafeez Ahmed—an investigative journalist and noted international security scholar—in a *Motherboard* article titled, "Scientists Urge 'System Change' to Avoid Catastrophic Climate Change," reports, "these trends threaten national security, human health, food supply, natural ecosystems, and global economies. Climate change clearly is one of the biggest global crises of the 21st century."

"Leading climate scientists predict that if global temperatures increase by more than 2 degrees Celsius above pre-industrial levels, climate change will cross a tipping point, spiraling out of control and becoming irreversible," warns Erin McDade, program manager, Architecture 2030. "Eventually this would result, at the very least, in a planet uninhabitable to human beings."

Fortunately, scientists also believe that if global warming was limited to around 1.5 degrees Celsius, the planet has a good chance of mitigating the worst effects of climate change and avoiding catastrophic climate change.

Combating global warming—Accounting for close to half of the world's energy consumption, buildings are being targeted as a key strategy for reducing greenhouse gas emissions in the fight against global warming. Image courtesy: Shutterstock

ENTER THE BUILDING INDUSTRY

With close to half of total U.S. energy consumption attributed to the building sector alone, buildings shoulder a major responsibility for meeting GHG emission reduction goals.

"The built environment has a crucial role to play in meeting these targets," states McDade. "Buildings are the problem and buildings are the solution."

Heeding the call, Architect Ed Mazria, FAIA, Hon. FRAIC, created the Architecture 2030 Challenge, endorsed by the American Institute of Architects and adopted by the U.S. Conference of Mayors, the U.S. government, the Royal Architectural Institute of Canada, and the Ontario Association of Architects. Furthermore, a large percentage of leading architecture/engineering/planning firms in the U.S.—80 percent of the 10 largest firms and 70 percent of the top 20—have signed on.

Architecture 2030 Challenge—The Architecture 2030 Challenge calls for an aggressive reduction in fossil fuels and greenhouse gas-emitting energy in buildings, targeting carbon neutrality by the year 2030. Image courtesy: Architecture 2030 Corporation

When the industry began adopting the Challenge in 2006, an immediate 70 percent reduction below the regional average/median for that building type in fossil fuels, greenhouse gas-emitting energy, in all new building construction and retrofits was targeted. The 2030 plan then requires adopters to achieve a fossil fuel reduction of 80 percent by 2020, 90 percent in 2025, and carbon-neutral by 2030—meaning that no fossil fuel GHG emitting energy will be required to operate these buildings.

Upping the ante, the organization more recently introduced the Architecture 2030 Challenge for Products.

WHY BUILDING PRODUCTS?

Even though the majority of energy consumption and the associated emissions are created by ongoing building operations, the embodied energy and emissions from building materials, products, and construction are taking up a noteworthy percentage of total U.S. energy consumption and is estimated to be between 5.9 and 8 percent. Embodied energy is defined as the total energy consumed by all of the processes associated with the production of a building, from mining and processing of natural resources for manufacturing, transport, and product delivery.

As the industry has exclusively been focusing on improving operational efficiencies, and has even reached a point of being able to design zero net carbon buildings of any size and space type in almost any climate zone, an increasing reduction in operational emissions means that the relative impact of embodied carbon emissions is by definition growing, explains McDade.

"The more we hone our skills in addressing operational energy and carbon, the more we'll need to understand the types of impacts a product has over its entire life cycle," agrees Rand Ekman, AIA, LEED Fellow, associate principal, senior vice president, chief sustainability officer, HKS (Chicago, Ill.). "In other words, the A and D industry has been largely focused on building operations and not enough on developing more and better building products that reduce embodied carbon."

Furthermore, there is less than 35 years left before 2050 to fully phase out global fossil fuel emissions, yet the typical lifespan of a building is 80 to 100 years. "While looking at the impact of embodied versus operational emissions over an 80 to 100 year period weighs the coin toward operations, when we draw a line in the sand at 2050, that picture changes significantly," explains McDade.

"In fact," she continues, "our research indicates that for all the buildings constructed globally between now and 2050—a staggering 2 trillion square feet of floor space—projected operational emissions will account for 10 percent or less of the total carbon impact during that time period."

This means that embodied emissions will represent 90 percent, or more, of new building stock's total fossil fuel GHG emissions.

"As building operations have become more efficient, largely driven by voluntary rating systems and building codes, the impact of products has become a bigger piece of the carbon pie," agrees Tim Murray, AIA, LEED AP BD+C, director, sustainability, EYP Architecture & Engineering (Houston, Texas).

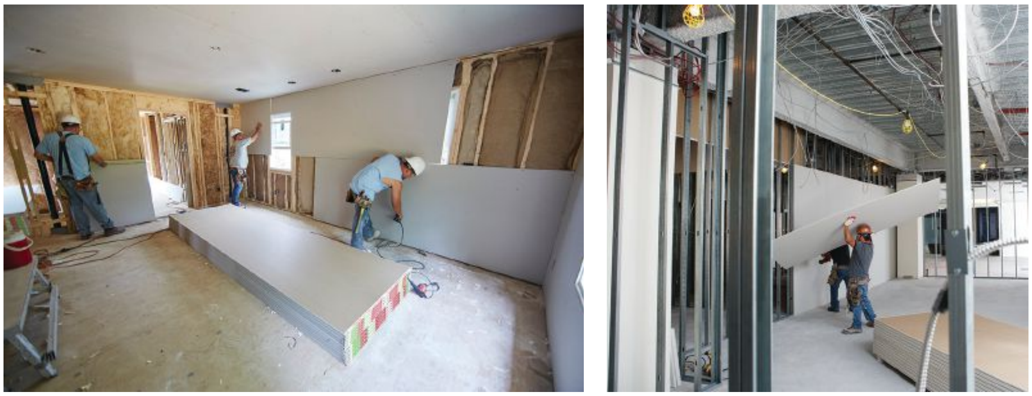
Consequently, the focus is shifting toward product development as an additional strategy without replacing operational efficiency.

While both operational and embodied emissions are crucial to meeting global climate targets, "it is clear that a concerted focus on reducing and eventually eliminating embodied carbon emissions is the next pivotal challenge for the building sector," says McDade. "Providing architects and contractors with low or no embodied carbon building products and construction practices is a crucial part of that challenge."

Based on this evolution of climate mitigation efforts, the 2030 Challenge for Products invites manufacturers to complete an International Standards Organization-compliant Environmental Product Declaration (EPD) or, minimally, a third-party verified Life Cycle Assessment (LCA) calculating the carbon-equivalent footprint of a product.

Although the Architecture 2030 Challenge for Products does not endorse specific building products, nor does it verify or certify that those products meet the reduction targets, the program recognizes companies that have committed to the Challenge's reduction goals and lists information about their products, including LCAs and EPDs, which show absolute, not relative carbon performance.

"The 2030 Challenge for Products builds on the success of the 2030 Challenge for Buildings,



Eco-friendly wallboard1, Eco-friendly wallboard2—The Architecture 2030 Challenge for Products invites manufacturers to complete an International Standards Organization-Compliant Environmental Product Declaration (EPD) or minimally, a third-party verified Life Cycle Assessment (LCA), to calculate the carbon-equivalent footprint of a product. Photo courtesy: USG Corporation

Sustainable wallboard—Strategies, such as the use of recovered gypsum and other recycled materials for the manufacturing of lightweight wallboard, require lower processing and extraction energy and often reduce transportation energy. Image courtesy: USG Corporation

but rather than focus on carbon emissions from building *operations*, this new Challenge addresses emissions that are *embodied in building products*," reports Alex Wilson in a *BuildingGreen* article, "Reducing the Carbon Emissions of Products Through the 2030 Challenge."

Offering some perspective on the building industry's evolving approach to lowering GHG emissions, Suzanne Drake, LEED AP ID+C, research director, senior associate, Perkins+Will (Philadelphia, Penn.) compares it to peeling back an onion. After beginning with the outermost layers—i.e., the building itself and its energy efficiencies—the layer inside addresses how the products themselves are manufactured.

"Products represent a fixed amount of carbon 'expenditure.' While building operations could—in theory—be improved over time, once a product is made, all the energy/carbon required to make it has been expended," she says. "These product challenges are simply raising the bar, pushing us to take the idea of responsible and sustainable design further than we have traditionally."

WHY EMBODIED CARBON IS A BETTER METRIC

One noteworthy aspect of the 2030 Challenge for Products is the fact that it targets reducing embodied carbon as opposed to the traditional embodied energy approach.

While creating a zero-embodied energy product is not possible, it is ultimately possible to manufacture a product with no embodied carbon by reducing the product's life cycle use of energy as much as possible and by meeting those remaining energy needs with non-GHG-emitting energy sources.

"There is nothing wrong with energy; it's how that energy is created—dirty or clean," explains Ekman.

The reason embodied carbon is a more meaningful metric is it directly relates to climate change by targeting the greenhouse gas emissions/carbon equivalents coupled with the materials that make up the building.

"Reducing embodied carbon of products has an immediate impact and sends a signal across the supply chain about what is important," he says.

Although energy and carbon emission reductions through operational energy saving is also important, those savings are only realized over time. By addressing the embodied carbon of materials, those reductions in carbon emissions of materials have an immediate "front-loaded" benefit, whereas the carbon reductions through energy-saving operations are only accrued over a long period of time.

"The goal is to reduce the *total* quantity of carbon dioxide getting into the atmosphere and do it as quickly as possible," explains Wilson. "A metric ton of carbon dioxide reduction today is worth more than a metric ton of savings spread over the next 50 years," he continues, "so reducing embodied carbon emissions of materials has a very important role to play in slowing global warming."

HOW THIS EFFORT IS EVOLVING

However, along with this newer focus on embodied carbon has come a somewhat steep learning curve.

"The metric used for operations and energy has been standardized, and expectations are more or less the same throughout the industry," explains Sethi. "However, when it comes to materials, multiple challenges still exist. There is still a lot more unknown in this area and there are also products for other disciplines—like mechanical and electrical—that have either not yet been identified or come at a much higher cost."

Getting the ball rolling, there are a number of cutting-edge manufacturers in certain industries that have already done significant work to create lower embodied carbon building products. For example, one company introduced eco-friendly wall and ceiling gypsum panels manufactured with 20 percent less CO_2 emissions, 25 percent less water, and a 20 percent reduction in transportation requirements due to its lighter weight.

"Products [like this] that balance environmental and economic interests will take root much faster in the marketplace," predicts Ekman. "This is a good example of effectively transforming a material type."

Building products also represent a tremendous opportunity for carbon sequestration, adds McDade. "In addition to naturally carbon-sequestering materials, cutting-edge manufacturers are transforming existing products—such as concrete into carbon sinks—and materials scientists are experimenting with innovative new carbon sequestering products with the hopes of broadening our low-impact materials palette."

While there are a handful of products and initiatives out there with a large focus on lowering embodied carbon, "unfortunately, this is far from universal and hasn't been done at a scale large enough to substantially impact new construction," laments McDade. "Architects need a much larger palette of low/no embodied carbon products to specify, and if we're going to meet global climate targets, they need it immediately, particularly from those systems that embody the most carbon such as structural materials and facades."

Keith Hempel, AIA, LEED AP BD+C, associate principal/design director, LPA Inc. (Irvine, Calif.), agrees, saying, "environmentally responsive product offerings are increasing and tools are being developed to help us better understand the impacts of our design decisions, but there is still a long way to go."

EDUCATION AND INITIATIVES

As manufacturers step up their R&D efforts to develop more low carbon product solutions, one critical component is awareness and education amongst the design and building community.

"If people—designers, architects, owners, contractors, developers, etc.—are not educated in how to read an LCA, what the metrics mean, or why they are important, then the choices don't mean much," cautions Drake. "We'll default back to what we're used to—using the cheapest product that gets the job done."

While the industry is beginning to pay more attention to the environmental and health and well-being impacts of the materials specified by designers, Drake still sees this as "the nascent stages of understanding and uptake."

Recognizing the importance of educating both designers and manufacturers on the role of embodied carbon in exacerbating climate change, leading experts and organizations are actively pushing for embodied carbon awareness to play a more universal role in the design of the built environment.

Visit http://go.hw.net/AR012018-1 to read more and complete the quiz for credit.

QUIZ

1. In order to avoid catastrophic climate change, scientist say that global warming needs to be limited to around what temperature increase within the next few decades?
   A. 0.5 degrees Celsius
   B. 1.0 degrees Celsius
   C. 1.5 degrees Celsius
   D. 2.0 degrees Celsius

2. The embodied energy of building products, materials, and construction is estimated to be at least what percentage of total global carbon emissions?
   A. 2.5 percent
   B. 5.9 percent
   C. 8.2 percent
   D. 9 percent

3. True or False: As building operations have become more efficient, the percentage of embodied carbon in building products has also decreased.
   A. True
   B. False

4. The Architecture 2030 Challenge for Products
   A. requires manufacturers to submit an ISO-compliant Environmental Product Declaration or a third-party verified Life Cycle Assessment.
   B. endorses low-carbon embodied building products.
   C. certifies no-carbon building products.
   D. All of the above

5. Responding to major concerns about the consumption of water in building product manufacturing, one company has created an eco-friendly wall and ceiling gypsum panel product manufactured with what percentage of less water?
   A. 10 percent
   B. 15 percent
   C. 20 percent
   D. 25 percent

6. The American Institute of Architect's Materials Matter program is
   E. a database of low-carbon building products.
   F. a carbon emissions calculator.
   G. a spreadsheet tool for predefined and customized product assemblies.
   H. an educational series giving in-depth knowledge and strategies for selecting healthy, sustainable materials.

7. True or False: At the present time, specifying low embodied carbon products requires a lot of time and research.
   A. True
   B. False

8. A recommended strategy for helping manufacturers reduce the embodied carbon energy in the products is
   A. enhancing energy management in product manufacturing.
   B. improving resource utilization.
   C. developing sustainable product development and manufacturing solutions.
   D. All of the above

9. While all building team members are responsible for reducing the embodied carbon in today's building products, which professionals have the potential ability to exert the greatest influence on this process?
   A. Building owners
   B. Architects
   C. Contractors
   D. Lawmakers

10. 75 percent of global carbon emissions come from what percent of the Earth's surface occupied by urban communities?
   A. 2 percent
   B. 20 percent
   C. 25 percent
   D. 35 percent

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PHOTOGRAPHY: DANA HOFF

Telling Stories

Sharing the details behind the design.

Katherine Ball, AIA, is a creative writer and researcher at LS3P's Raleigh, N.C., office; she's also a licensed architect. You seldom see architects go from designing projects to writing about them, but for Ball it's the culmination of a winding career path—from public school teacher to design school—that ended up combining her two passions. Now she uses her architectural knowledge to turn bullet points from a project manager into detailed narratives for various audiences. "Our CEO leads with the mantra 'Design matters,'" she says, "and I start with that premise in telling each story." As she puts it: "Each piece of writing is its own design process."

As told to Steve Cimino

My career path is a bit unusual; I was a teacher for 10 years before switching to design school. After graduation and about three years as a design professional, I spotted an open creative writer position at LS3P. Writing was my long-term goal, but I didn't expect to find a job writing about architecture, particularly so close to the beginning of my career. And though this writing job didn't require me to be licensed, my boss was extremely encouraging and worked with me to finish the last of my intern hours.

Understanding both the architectural lexicon and the design and construction process from Day One has been an invaluable asset. Sometimes when I'm tasked to write about a design, a project manager will send over a few bullet points and a set of photographs; I have to extrapolate everything else. Because of my training, I'm usually able to pick a project apart and put it back together as a cohesive story.

Though we often create pieces tailored to specific industry audiences, we also strive to tell stories that have appeal outside of the field. Internally, our architects don't always get to see what teams from other offices are doing, so we try to highlight "transformation stories" about projects at all scales that made a difference. We then share them externally on our website, where we hope to communicate the real value that architecture creates for the people who will ultimately use it.

We work in just about every market sector: healthcare, K–12, higher education, commercial, and at least a dozen more. The things that matter about each design may be different for each project type. For healthcare, it's: "What makes this place safer for patients, a better place to heal, or better for doctors and nurses to function?" For K–12 schools, it's: "What produces the best learning environment?" For office spaces, it's: "What makes a worker's day better? What makes this a better workplace for the owners?"

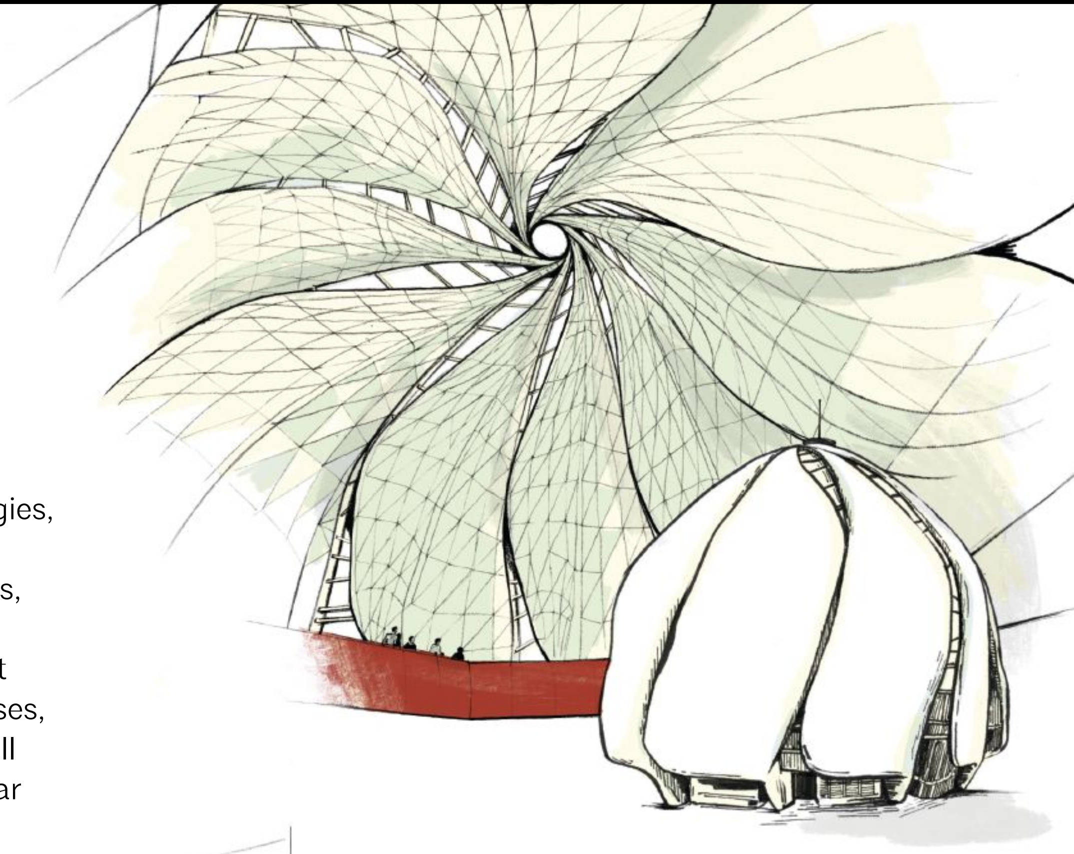
Storytelling lets us shine a spotlight on the thought process behind the designs; people are at the center, and each project matters a great deal to someone. Getting to articulate why is the fun part. AIA

AIANow

By Steve Cimino
Art Direction by Jelena Schulz

We the Public

Every year the AIA Technology in Architectural Practice Knowledge Community recognizes projects and research in which innovative technologies, techniques, and progressive practices feature prominently. These two projects, which received citations in the 2017 AIA Innovation Awards, sit on different continents, and serve disparate purposes, but both exemplify the thinking that will drive architecture through this new year and beyond.



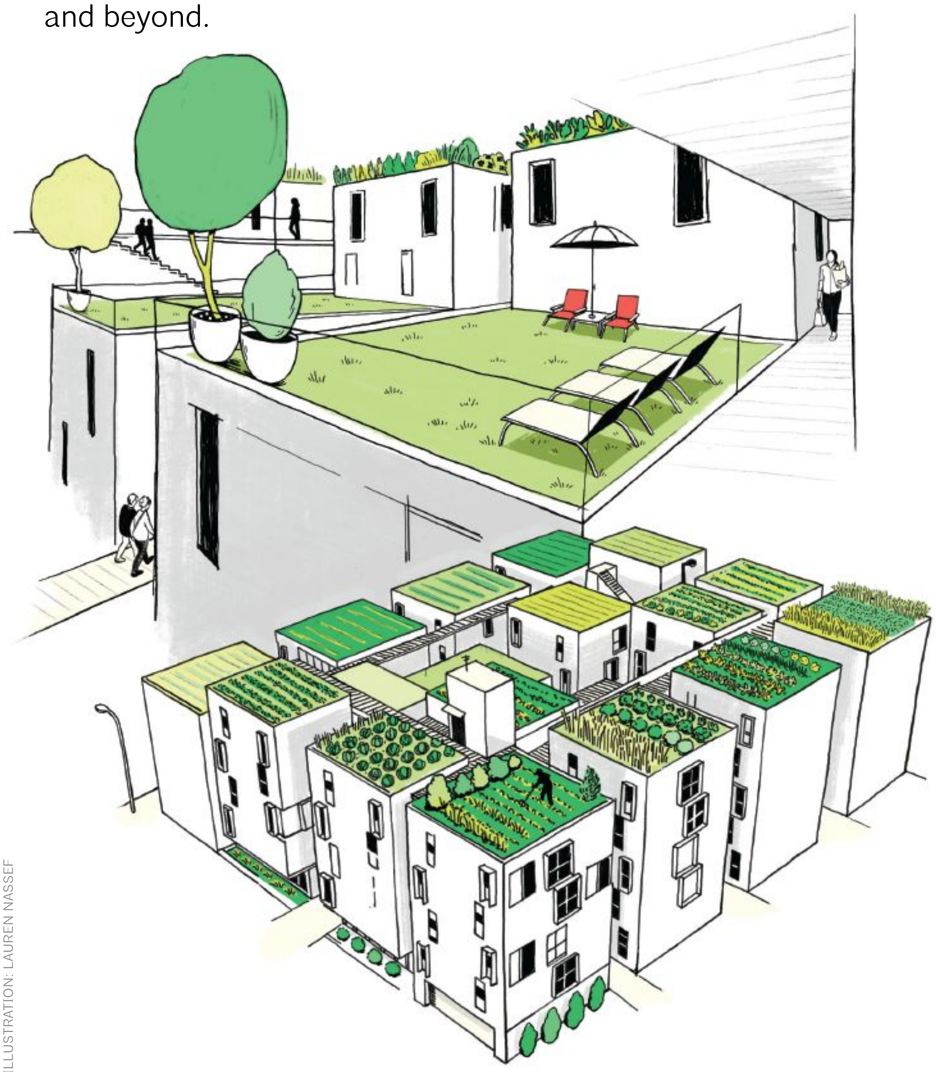


ILLUSTRATION: LAUREN NASSEF

Bahá'í Temple of South America: Just outside Santiago, Chile, this house of worship has nine sides, each made of a glass veil, that frame an open and accessible space for 600 visitors. As its architects from Hariri Pontarini Architects say, "To create a building alive with light, we invented this new material utilizing cast glass, which takes light and absorbs it. When the Temple receives just a kiss of light, a prayer is answered."

Garden Village: Designed primarily for students, this apartment building in Berkeley, Calif., was constructed using modular building technology. It is made up of 18 distinct building volumes, spread out but linked by exterior walkways. To create a communal, interconnected student village, the Nautilus Group in association with Stanley Saitowitz | Natoma Architects "threaded the 77 units with a network of gardens, common space, and a professionally operated urban roof farm."

AIAKnowledge

ILLUSTRATION: MICHAEL KIRKHAM

Percent of firms in 2017 that offered a salary increase to architecture staff upon licensure.

Even more firms are now rewarding staff for attaining licensure than they were just a couple of years ago: 80 percent, up from 74 percent in 2015. However, salary premiums are not the same across different sizes of firms—64 percent of those with 100 to 249 employees and 39 percent with 250 or more employees offer salary premiums for licensure, compared to an average of 81 percent for smaller firms. There was also a big change in the size of the salary premiums: While the share of firms that provided a meager 1 percent premium was constant from 2015 to 2017 (staying at 9 percent), there was a 7-point jump in the share of firms who offered a much more generous 10 percent or more increase—from 11 percent of firms in 2015 to 18 percent in 2017. AIA

—Michele Russo

AIAFeature

How Many Architects Does Our Economy Need?

A special report on workforce pressures for firm leaders.

By Kermit Baker, HON. AIA

A perennial concern for architects is whether or not there are sufficient numbers of practitioners to serve the evolving needs of the profession. It seems as though the "sweet spot" of staffing is elusive—what seemed like a surplus of architects yesterday has morphed into a deficit today. Architecture firms, most of which fit the definition of small businesses, are not well-equipped to continually rightsize their staffing. Downsizing is an extremely painful experience for both firm owners and employees. Adding staff under the pressure of growing workloads is almost as difficult, given the training time typically required before new staff are fully productive.

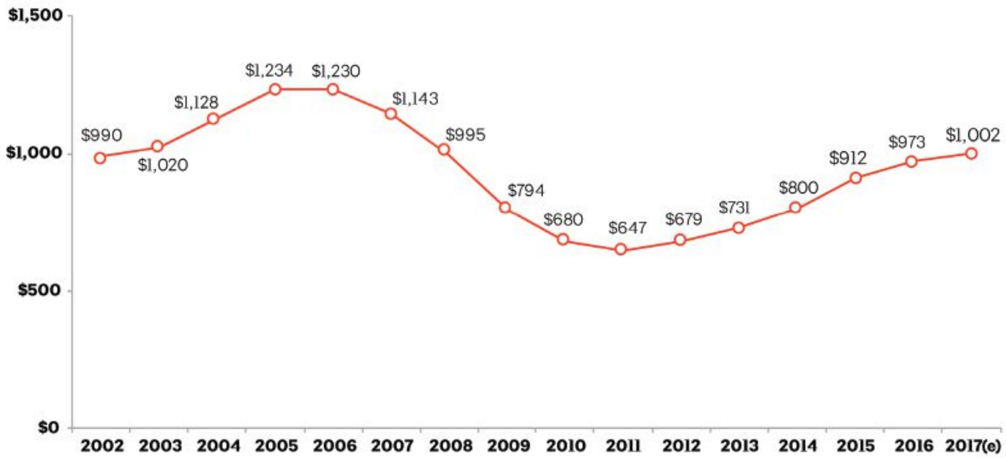
Architecture firms have developed several coping mechanisms to deal with their need to adjust staffing to shifting project workloads. When there are insufficient workloads, in addition to reductions in staff, firms may reduce the hours that regular staffers work, rely more on contract or part-time workers, or freeze or even reduce compensation. When workloads are excessive, in addition to adding staff, firms might offer overtime, outsource work to other firms or offshore service providers, extend the proposed project schedules, cut back on design services offered, or even not bid on projects that might otherwise fit their skill set.

None of these strategies to cope with staffing are ideal, either from the perspective of an individual firm or for the overall profession. We lack a methodology for thinking about current staffing requirements across the profession and, more importantly, about what we'll need five or 10 years from now. These concerns motivated us here at the AIA to think about a process for estimating our current needs and projecting our likely future needs. Given that many of the variables of projecting future needs are likely to change—new design software will alter how productive we are, new services for clients will be proposed, and more international work will be done by U.S.-based firms—these projections will need to be continually enhanced and updated.

Our approach here attempts to estimate the current need for architectural staffing at firms by examining the historical relationship between construction activity and architecture

Figure 1: Architects work in a very volatile sector of the economy

Annual spending on residential and nonresidential facilities, in billions of 2017 dollars



Note: Construction categories included are single-family and multifamily residential, lodging, office, commercial, healthcare, education, religious, public safety, amusement and recreation, transportation, communication, and manufacturing. Constant dollar estimates calculated with CPI—all items.

positions. Additionally, these needs over the coming decade are projected by estimating the additional staff that will be required to accommodate future growth in construction activity, as well as to replace current staff who will be leaving the architecture workforce.

Our major conclusions are twofold. First, while in the past there have been major gaps nationally between existing architectural staff and the number required to handle current workloads, at present this gap is at historically low levels. Second, we'll need about 25,000 additional architectural staff over the coming decade to handle growth in the construction industry and replace those who will leave the workforce. This need accounts for about half of all future graduates of accredited architectural programs nationally who are eligible to work in the United States.

What's the Current Need for Architecture Staff?

Domestically, the amount of staff needed is largely driven by the amount of residential and nonresidential building activity. Unfortunately from the perspective of determining the need for architectural positions, the business cycle of the construction industry varies considerably, causing the amount of activity to change significantly. While this past cycle was more extreme than most, it does still illustrate how quickly the levels of building activity can change. For example, construction spending for homes and buildings declined by almost half between the 2005/2006 high and the 2011 low, and spending through 2017 is up more than 50 percent from that low point *(Fig. 1)*.

Architect positions at firms reflect this volatility in construction activity. For the past cycle, the AIA estimates that the number of architecture positions at U.S. firms declined by almost 30 percent between the high in 2007 and the low in 2011. Through 2017, architecture positions have increased by almost 25 percent from that 2011 low. While dramatic, these changes have been less extreme than those in the underlying construction activity, suggesting that firms might not totally adjust their staffing to account for changes in overall market activity levels *(Fig. 2)*.

Construction cycles also appear to influence the output of architects. During periods of strong growth in construction spending, the value of construction activity per architect rose; during construction slowdowns, the same metric declined. Over the past decade and a half, an inflation-adjusted average of

Figure 2: Number of architecture positions at U.S. firms has been slowly recovering after steep decline during the recession

Estimated number of architecture positions at U.S. architecture firms, in thousands

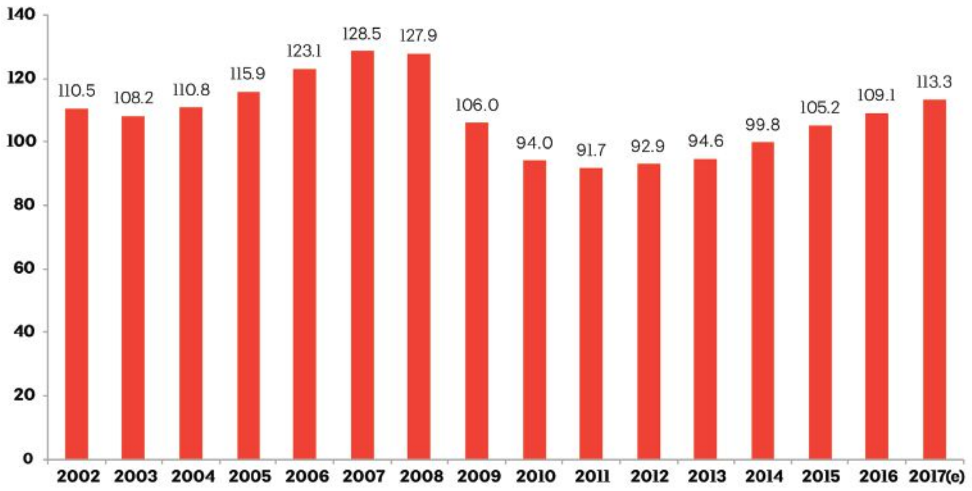
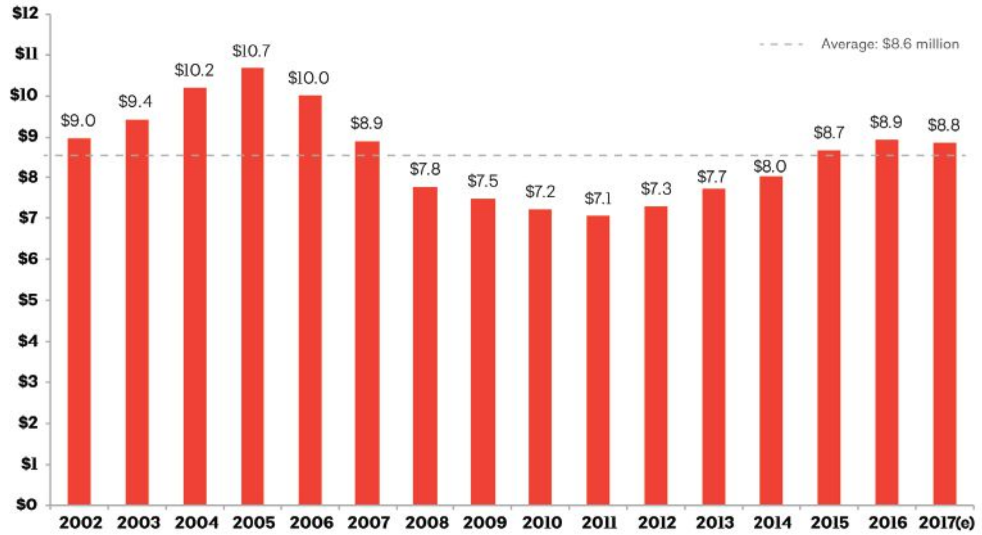


Figure 3: Architectural staffing positions don't adjust as quickly as construction activity, causing average output to fluctuate

Estimate of construction activity per architectural position, in millions of 2017 dollars



$8.6 million of building construction has been generated annually by each architectural position in the U.S. Since this average was calculated across years of strong growth as well as steep declines in construction activity, it is used here as an estimate of the typical relationship between architectural staffing and construction activity. On average, we would expect to see a continuing average of $8.6 million of construction activity generated every year for each architectural position *(Fig. 3)*.

Over the past 15 years, there have been periods of considerable discrepancy between the actual number of architectural positions at U.S. firms and the estimated number of positions needed to produce the total amount of construction activity nationally. During the construction boom of 2002 to 2007, there

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Figure 4: While understaffed during boom and overstaffed during bust, labor needs are more in balance at present

Annual estimated architectural positions needed vs. actual number of positions, in thousands

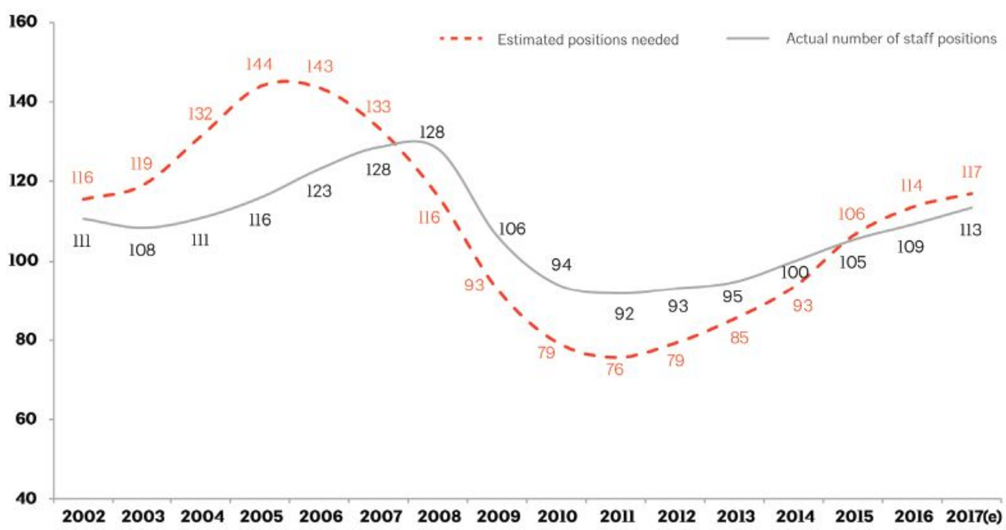
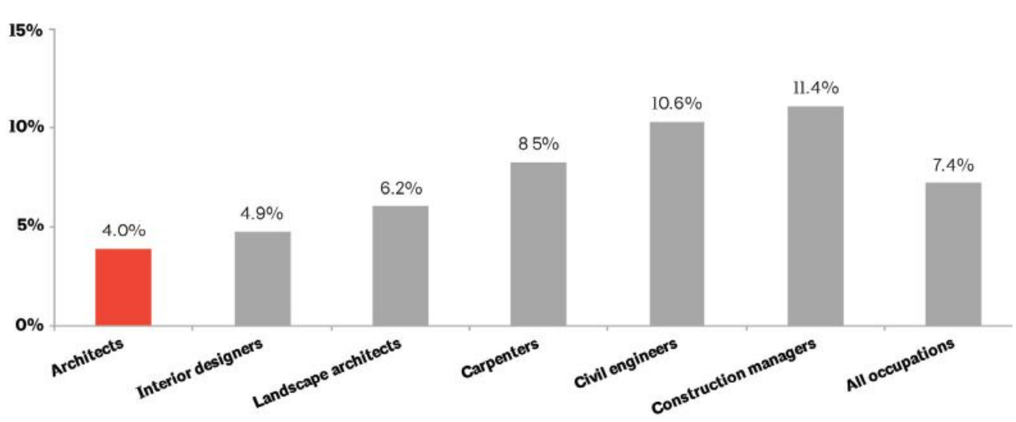


Figure 5: Architecture positions are projected to increase by 4 percent this coming decade, a slower pace than in related occupations

Projected change in employment, by percent, 2016–26



was a significant estimated undersupply of architectural positions. During the downturn of 2008 to 2014, an apparent oversupply existed, with more positions than were estimated to be needed. Beginning in 2015, market conditions shifted to another apparent undersupply of architectural positions, estimated at just under 4,000 nationwide at the end of 2017 *(Fig. 4)*.

This analysis of estimating architectural needs by the amount of construction activity ignores many other complicating factors we face in estimating the need for architectural staff. While difficult to explicitly build into any analysis, the following factors are among those that help refine the estimates of the number of architectural positions required in our economy:

- **Location** where architects are needed and where they are available
- **Characteristics of projects,** such as new construction vs. building renovations, or complex vs. more straightforward design solutions
- **Staff productivity** improvements as a result of experience, training, or new technologies
- **Skills required** by a firm, compared to those available in the applicant pool
- **Range of services** offered by the firm, such as facilities planning, predesign, and post-occupancy
- **International work** done by U.S. firms that isn't reflected in the construction figures
- **Design work** done by paraprofessionals or other design professionals that might otherwise be done by architects

How Many More Will We Need Over the Coming Decade?

Moving forward, our economy will need additional architectural staff to both accommodate a growing construction sector and replace current architects who are leaving the workforce, most notably due to retirement. Comparing these needs to the number of architects entering the workforce—principally graduates of professional architectural programs who are seeking careers in private practice—will determine whether we're likely to have a deficit or surplus of architects.

The U.S. Department of Labor projects that over the coming decade (2016–26), overall employment in our economy will grow by 7.4 percent. Many of the fastest-growing occupations will be in the areas of technology (e.g., software developers), healthcare (e.g., home health aides), and alternative energy (e.g., solar photovoltaic installers).

Architect positions are projected to grow only 4 percent over the next 10 years, slower than the overall growth rate and even somewhat slower than related design professional positions such as interior designers and landscape architects. Many construction-related positions are expected to grow at a faster pace, likely due to the present extreme worker shortages in many construction specialties *(Fig. 5)*.

More significant than generating a need for future architects is replacing current employees who will leave the workforce, particularly due to retirement. As with the overall U.S. workforce, the architecture profession is aging. Because 13 percent of current architect members of the AIA are at least 65 years old and an additional 22 percent are between 55 and 64, we can expect significant numbers of architects to retire in the coming years. According to an AIA survey of firm leaders conducted in the summer of 2015, architecture firms expect that almost 10 percent of their current professional architecture staff will retire or significantly curtail their involvement in the firm over the next five years *(Fig. 6)*.

Given the considerable amount of the current architect population who are nearing traditional retirement ages (35 percent of whom are 55 or older), it might be expected that the share of architects retiring over the coming decade would be even higher. Complicating this is that many workers, including architects, are working beyond traditional retirement ages. This may be because of financial losses during the Great Recession, or, as longevity increases, concern over having enough money for a longer retirement. The Labor Department projects that the share of the U.S. labor force that is 65 or older will grow substantially over the coming decade. Some of this is that more baby boomers will move into this age range, but more older workers are also staying in the workforce longer. A decade from now, more than one in 10 persons 75 and older are projected to still be in the workforce.

The additional architects needed to both accommodate future growth in the industry and replace those leaving the workforce will come primarily from the pool of graduates of architecture programs. Just over 6,000 professional architecture degrees were awarded in 2016, according to the National Architectural Accrediting Board (NAAB). While this figure is about 3 percent below the average number of degrees awarded during the prior five years, those previous years may have seen inflated numbers of degrees due to the recession, when students used a weak labor market as an opportunity to go back to school to earn an architectural degree.

Not all of these graduates are currently eligible to seek permanent employment in the U.S. About 15 percent of professional architectural degrees awarded in 2016 went to nonresident aliens, according to the NAAB, and that share has doubled since 2009. Additionally, not all graduates are looking to pursue careers in private practice. According to a 2016 survey of post-graduate plans for architecture students, more than half were planning for a career in private practice and another 12 percent were planning on pursuing a different career in academia, while almost a third were planning on further education or were undecided about their career path *(Fig. 7)*.

On net, there will be a projected need for approximately 25,000 new architecture positions over the coming decade—5,000 due to industry growth and 20,000 due to retirements and other losses to the architecture labor force. This need will be met by the estimated 60,000 professional degree recipients over the coming decade; about 50,000 of whom will be eligible to seek permanent employment in the U.S., with more than half of them immediately seeking a career in private practice post-graduation and another 15,000 who may eventually seek a career path in private practice.

Figure 6: Like our overall population, the architect profession is aging

Age of AIA architect and associate members, 2015

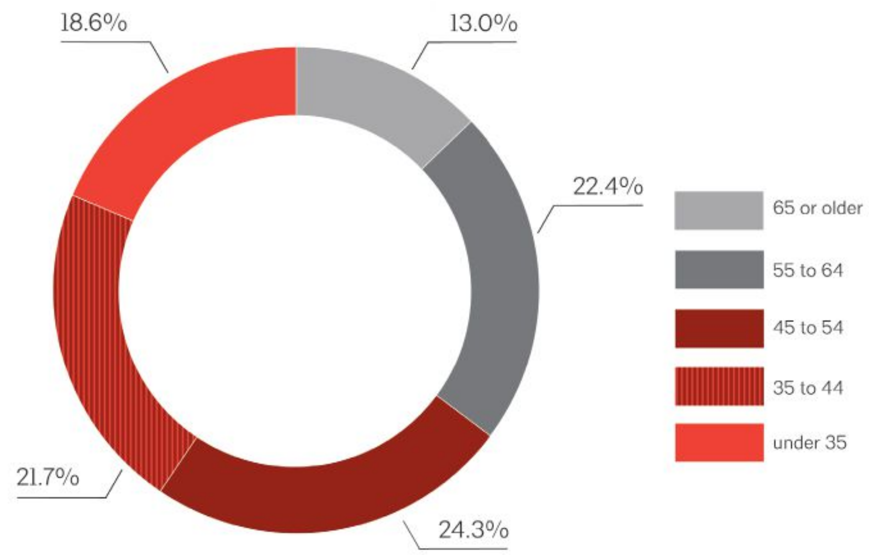
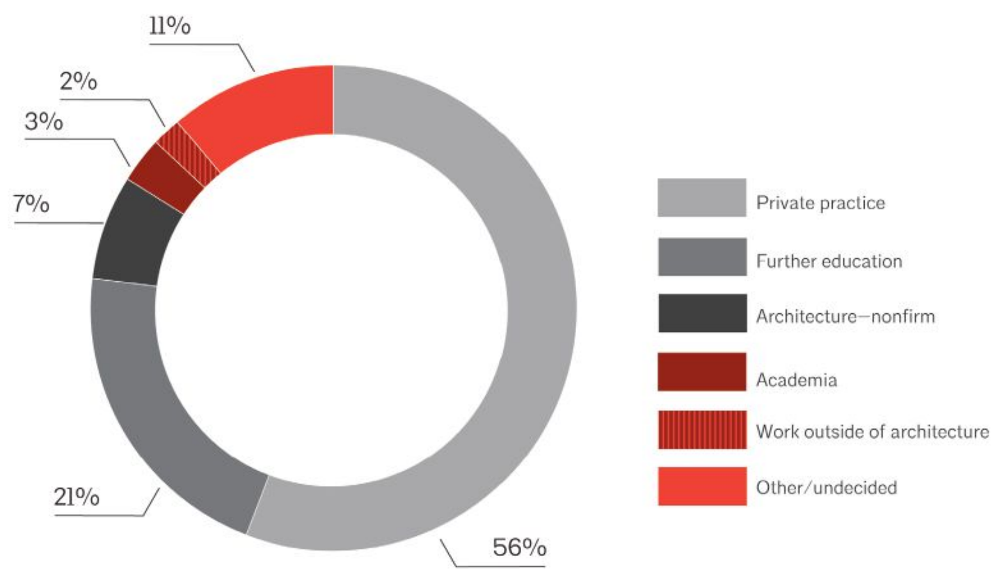


Figure 7: Most architecture students plan to continue in the profession and work in private practice

Architecture student plans after graduation, by percent



AIA Feature

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What are the Implications for the Profession?

Currently, the gap between available architects and those needed to support growth in our economy has narrowed and may disappear in the coming years as we get further into the current construction cycle. Over the coming decade, the need for architects should be accommodated by architectural graduates entering the workforce. If either the Labor Department projections for the number of architects needed to accommodate growth or the retirement rates for architects currently in the labor force are overly conservative, there should still be sufficient numbers of graduates to accommodate what will be needed.

However, in addition to managing the inevitable volatility in demand for architectural services across the business cycle, another issue may prove to be more challenging: the potential mismatch between the training of candidates looking to fill positions and the skills that firms are seeking.

Architecture firms regularly note the difficulty of matching the skills that they need with those possessed by available candidates. Sometimes this concern is caused by the general level of experience of applicants, and other times it is specific skills. A 2015 AIA survey of firms looking to fill architectural positions found that more than half reported that finding candidates with either the required technical skills or project management skills was a major problem, while another third indicated that finding candidates with experience in the specialties that the firm offered was difficult. And this concern does not appear to be easing. According to an AIA firm leader survey conducted in late-2017, almost 80 percent of architecture firms felt that over the next few years there would be shortages of architecture staff to meet the needs of firms in their area. **AIA**

AIA chief economist Kermit Baker, HON. AIA, is a senior research fellow at Harvard University and project director of its Remodeling Futures Program.

Data Sources. Figure 1: U.S. Census Bureau. Figure 2: U.S. Department of Labor payroll survey, with AIA estimates that architecture positions account for 60 percent of overall staff positions at firms. Estimates do not include architecture staff at firms with no payroll positions. Figures 3 and 4: AIA estimates from U.S. Census Bureau construction spending data, and AIA estimates of number of architectural positions. Figure 5: U.S. Bureau of Labor Statistics; Occupational Outlook Handbook: 2016–2017. Figure 6: Estimates from the American Institute of Architects membership file. Figure 7: Design Intelligence as reported in *Architectural Record*, September 2016.

AIA Perspective


PHOTOGRAPHY: GABRIELLA MARKS

A Threshold Moment for Architecture

Without a doubt, the word that best describes the frenetic events of 2017 is “disruption.” Executive orders on immigration disrupt global architectural practice and the flow of international students to our nation’s architecture schools. Abandoning the Paris climate accord disrupts decades of policy promoting improved building performance. Within a single month, Hurricanes Harvey, Irma, and Maria disrupt the lives of millions—including thousands of architects—for years or even decades to come.

With 2017 a year of disruption, it is imperative for architects to make 2018 a year of possibility. Indeed, there are compelling reasons to believe that 2018 can be a threshold moment for architecture. Here are three.

First and foremost, the urban era is dawning. Today, for the first time in human history, the majority of the world’s population lives in cities. Happening even more rapidly than population growth, urbanization is accelerating at a breakneck pace. By the end of the century, the U.N. projects that 84 percent of the world’s population will live in cities. For architects, nothing is more significant. Cities will shape the future of our profession and of humanity.

Second, in field after field, research is focusing on environmental influences. In education, improved test scores and learning outcomes are linked to better school design. In the workplace, increased collaboration, creativity, and productivity are linked to environmental quality. Perhaps most dramatically, environmental factors have been shown to contribute directly to the major public health challenges facing our nation. At the top of the list are obesity, diabetes, and heart disease. Architects don’t have to seek relevance but to seize it. As Winston Churchill said: “First, we shape our buildings; thereafter, they shape us.” By shaping the built environment, architects shape lives.

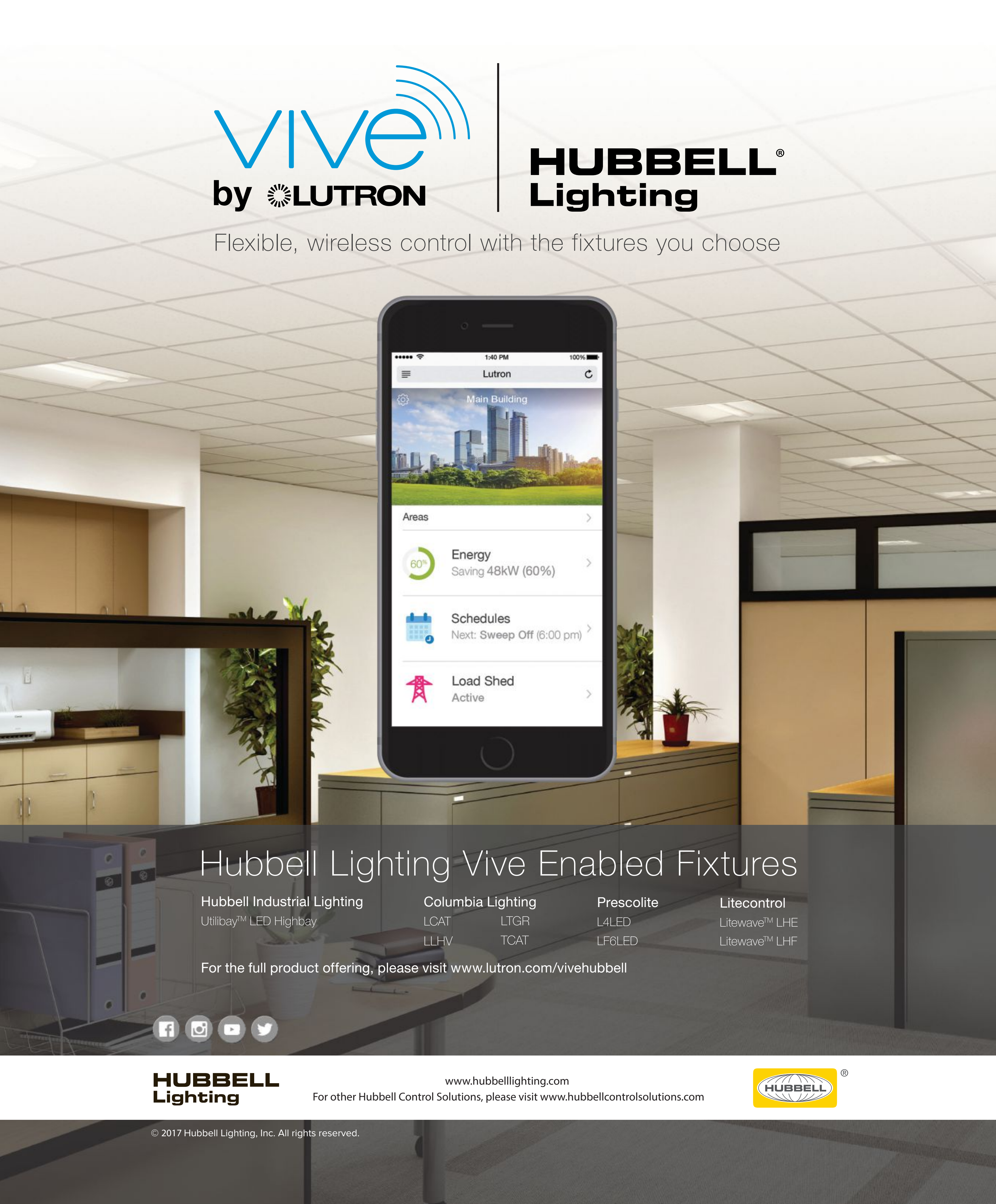
And lastly, our profession is called upon to resolve—not improve, but resolve—its systemic inequities and lack of diversity. We must, because it is the right thing to do. 2018 marks the 50th anniversary of Whitney M. Young Jr.’s speech to the AIA Convention in Portland. Since then, the percentage of African-American participation in the profession has not measurably increased. Young’s challenge to architects remains. We must, because it is required if our profession is to build its capacity to serve those whose need is the greatest.

Twentieth-century architects shaped the modern world. America’s cities and towns became the greatest engines of commerce and progress since the dawn of civilization. Yet, as the 21st century hits its stride, we must recognize that the world they built also produced intractable social, economic, and environmental problems. Looking ahead, architects need better principles and practices to address the crucial, even existential, issues now confronting our world. We need a blueprint for better.

The historian Arnold J. Toynbee made the following observation: “The twentieth century will be chiefly remembered by future generations not as an era of political conflicts or technical inventions, but as an age in which human society dared to think of the welfare of the whole human race as a practical objective.”

In the last century, universal human progress became conceivable. The dawning of the urban era, the relevance of the built environment in shaping people’s lives, and our profession’s responsibility to serve our communities fully makes the well-being of everyone, everywhere, our 21st century imperative. In 2018, let’s work together to overcome obstacles and embrace limitless possibilities. The future of architecture will be shaped by our efforts. **AIA**

Carl Elefante, FAIA, 2018 AIA President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100%
Lutron
Main Building
Areas
60%
Energy
Saving 48kW (60%)
Schedules
Next: Sweep Off (6:00 pm)
Load Shed
Active
Hubbell Lighting Vive Enabled Fixtures
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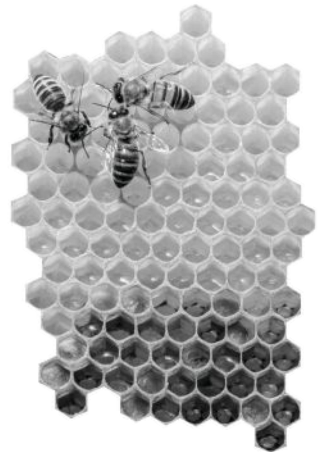
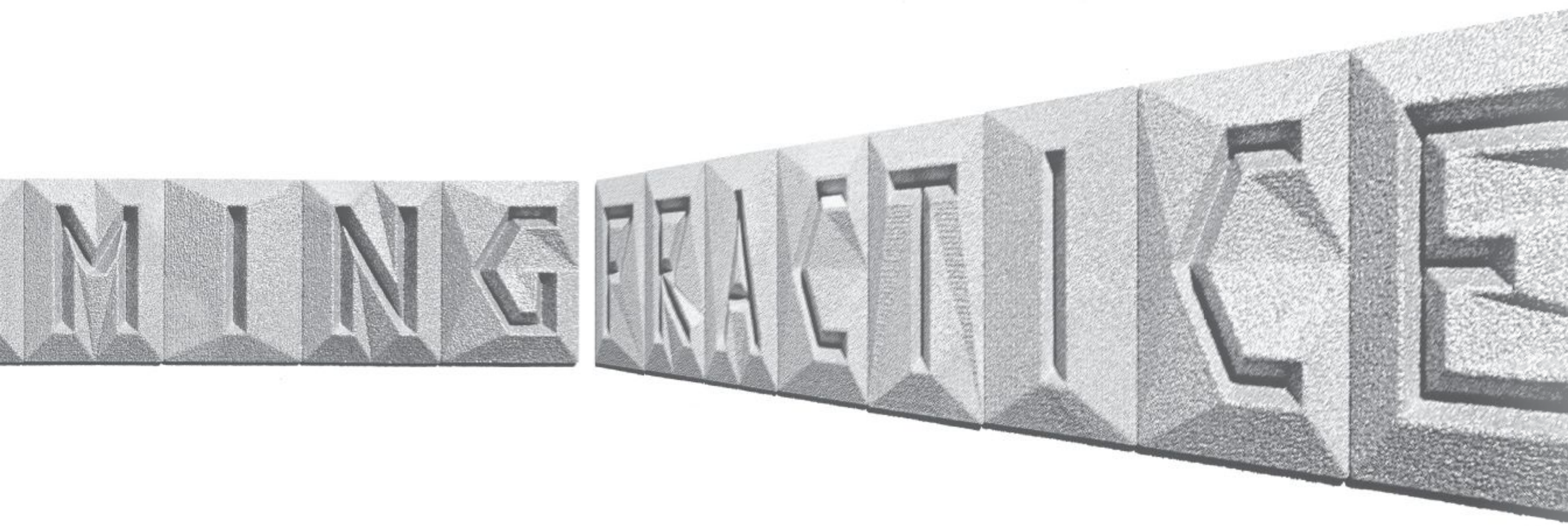


What's Next:

IN SOME SECTORS, DISRUPTION IS SO PERVASIVE THAT IT'S PRACTICALLY A CLICHÉ. SOON IT WILL BE ARCHITECTURE'S TURN. MEET THE CHAMPIONS WHO ARE PREPPING FOR THE INEVITABLE.

INTRO BY WANDA LAU
TEXT BY MURRYE BERNARD, AIA, EDWARD KEEGAN, AIA, AND WANDA LAU
LETTERING BY THE LIVING FOR AUTODESK'S MARS OFFICE; PHOTOGRAPHED BY JEFF ELKINS


MING PRACTICE

WHEN THE FUTURE OF ARCHITECTURE PRACTICE COMES UP AT CONFERENCES OR IN CONVERSATION, SOMEONE INVARIABLY PULLS OUT A CHART COMPARING THE PRODUCTIVITY OF VARIOUS INDUSTRIES SINCE THE MID-20TH CENTURY. AND WHILE THE NUMBERS FOR AGRICULTURE AND MANUFACTURING SKYROCKET, CONSTRUCTION'S REMAIN DISMALLY FLAT. ANOTHER POPULAR TAKE ON THE SAME POINT JUXTAPOSES TWO PHOTOGRAPHS OF LABORERS FRAMING A HOUSE, ONE DATED TO THE 19TH CENTURY AND THE OTHER FROM THE 21ST CENTURY, WITH THE PRESENTER DRYLY ASKING, "DO YOU SEE ANY DIFFERENCE?"

AS YALE SCHOOL OF ARCHITECTURE LECTURER AND FORMER AUTODESK VICE PRESIDENT PHIL BERNSTEIN PUTS IT, QUOTING RESEARCH BY ONE OF HIS STUDENTS: "THE BUILDING INDUSTRY IS SUBOPTIMIZED TO THE POINT OF FAILURE."

A 2017 MCKINSEY GLOBAL INSTITUTE (MGI) REPORT IDENTIFIED NUMEROUS REASONS FOR THE BUILDING INDUSTRY'S LAGGING PERFORMANCE. THREE IN PARTICULAR SHOULD SOUND FAMILIAR TO ARCHITECTS: A BIDDING ENVIRONMENT THAT PRIORITIZES COST OVER RESULTS; A DESIGN PROCESS THAT FAILS TO LEVERAGE OPPORTUNITIES FOR STANDARDIZATION; AND TIGHT PROFIT MARGINS THAT PRECLUDE INVESTMENT IN DIGITAL TECHNOLOGY, DATA MANAGEMENT, AND WORKFORCE TRAINING. ON THE BRIGHT SIDE, THE REPORT ESTIMATES IF THE U.S. CONSTRUCTION SECTOR'S PRODUCTIVITY MATCHED THAT OF THE OVERALL ECONOMY, IT COULD INCREASE REVENUES BY MORE THAN $500 BILLION ANNUALLY.

THE PROFESSION ISN'T JUST LOSING OUT FINANCIALLY; IT'S ALSO BLEEDING TALENT. WHILE THE NATIONAL COUNCIL OF ARCHITECTURAL REGISTRATION BOARDS REPORTS THAT ACCREDITED U.S. SCHOOLS HAVE GRADUATED AN AVERAGE OF 6,152 STUDENTS PER YEAR SINCE 2009, THE AVERAGE NUMBER OF DESIGNERS COMPLETING THE ARCHITECT REGISTRATION EXAMINATION PER YEAR DURING THAT TIME IS JUST 3,560. THAT'S A DISMAL PROPORTION, EVEN TAKING INTO ACCOUNT THE SIX OR SEVEN YEARS IT TAKES MANY GRADUATES TO ACHIEVE LICENSURE.

WHAT HAPPENS TO ALL OF THOSE CREATIVE MINDS? ONE OF THEM, AIA PRACTICE INNOVATION LAB CHAIR EVELYN LEE, FOUND THAT THE PROMISE AND PACE OF DESIGN STUDIO DID NOT MATCH THE BACKWARD REALITIES OF PRACTICE. AFTER SPENDING HER INTERN DAYS AT AN ARCHITECTURE FIRM FIELDING COMPLAINTS FROM CLIENTS WHO COULD NOT "PLUG IN THEIR COFFEE MACHINES" BECAUSE THEY COULDN'T REACH THE NEWLY RELOCATED ELECTRICAL OUTLETS, LEE NOW WORKS AT A COMMERCIAL REAL ESTATE CONSULTANCY.

EVERYONE NEEDS TO PAY THEIR DUES, BUT THERE'S NO ESCAPING THE FACT THAT OTHER FIELDS ALLOW YOUNG DESIGNERS TO ENGAGE MORE IMMEDIATELY, WITH GREATER IMPACT. WITH TODAY'S SEEMINGLY ENDLESS TECHNOLOGICAL RESOURCES, INNOVATIVE PRACTITIONERS CAN CUT THEIR LOSSES, BROADEN THEIR SKILL SETS, AND JOIN SECTORS THAT ARE ALREADY ACING THE PRODUCTIVITY CURVE. ACCORDING TO WEWORK SENIOR VICE PRESIDENT FEDERICO NEGRO, "HALF OF THE STUDENTS" WHO ATTENDED A RECENT TALK OF HIS AT THE YALE SCHOOL OF ARCHITECTURE "WEREN'T ASKING HOW TO GET INTO BIG OR FANCY ARCHITECTURE FIRMS, BUT RATHER HOW TO GET INTO GOOGLE AND AIRBNB."

SILICON VALLEY WILL BE HAPPY TO TAKE THEM – AND TO EAT THE REST OF YOUR LUNCH WHILE THEY'RE AT IT. AS GEORGIA TECH ARCHITECTURE CHAIR SCOTT MARBLE OBSERVES, THE ELON MUSKS OF THE WORLD, HAVING CONQUERED THE DIGITAL ARENA, ARE EYEING THE BUILT ENVIRONMENT AND ITS ENORMOUS DATA POTENTIAL. THE INFUSION OF TECHNOLOGY AND CASH INTO THE AEC SPACE FROM THESE OUTSIDERS WILL, MARBLE SAYS, "HAVE A PROFOUND IMPACT ON THE STRUCTURE AND POTENTIAL OF THE INDUSTRY AT LARGE."

ARE DARK TIMES AHEAD FOR ARCHITECTURE PRACTICE? DEMAND CERTAINLY SHOWS NO SIGNS OF DECREASING IN THE LONGER TERM: THE MGI REPORT ALSO PREDICTED ANNUAL SPENDING ON BUILDINGS AND INFRASTRUCTURE TO INCREASE FROM $10 TRILLION IN 2017 TO $14 TRILLION BY 2025. THE CHALLENGE IS TO ENSURE THAT ARCHITECTS ARE IN THE BEST POSITION TO MEET THE DEMAND. WITH THAT IN MIND, THE INDIVIDUALS AND ORGANIZATIONS FEATURED ON THE FOLLOWING PAGES ARE ADOPTING 21ST CENTURY MODELS OF ENTREPRENEURSHIP, EMBRACING DEMOGRAPHIC AND SOCIOECONOMIC CHANGE, DEVELOPING NEW TECHNOLOGIES, AND FUNDAMENTALLY RETHINKING PROCESS AND PRODUCT. THEY HAVE NOT ONLY HEARD THE WAKE-UP CALL, BUT IN MANY CASES AND IN MANY WAYS THEY ARE THE WAKE-UP CALL.

*Than standard bowls. Source: Test Report No. 109-141486-002, comparing VorMax® against conventional under-the-rim-dispersal toilets from major retailers. LYSOL® is used under license to American Standard.

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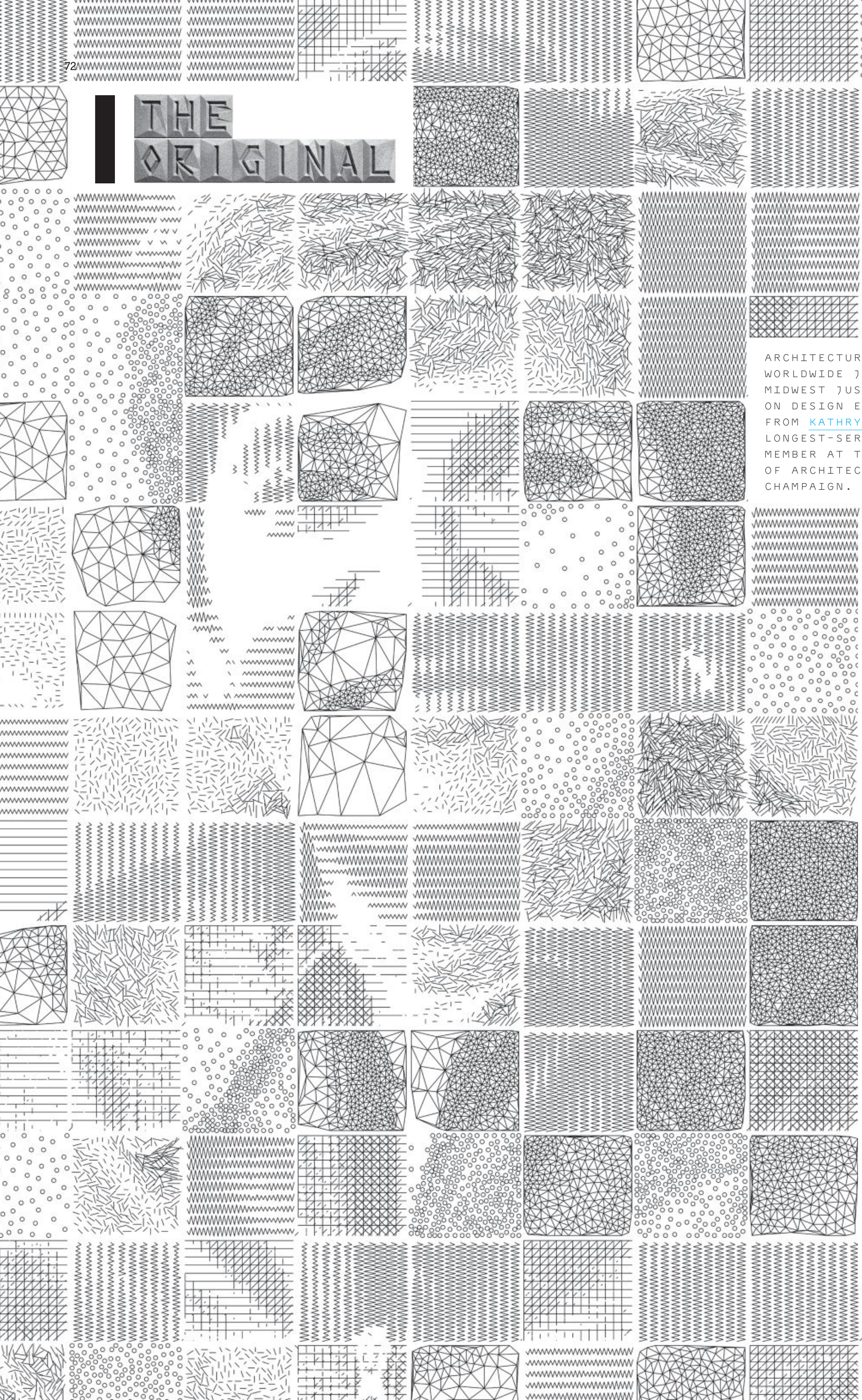
BORN IN PORCELAIN VALLEY

THE ORIGINAL



ARCHITECTURE STUDENTS WORLDWIDE JOURNEY TO THE MIDWEST JUST TO TAKE COURSES ON DESIGN ENTREPRENEURSHIP FROM KATHRYN ANTHONY, THE LONGEST-SERVING FEMALE FACULTY MEMBER AT THE ILLINOIS SCHOOL OF ARCHITECTURE IN URBANA-CHAMPAIGN.

For nearly 40 years, Kathryn Anthony has championed the role of architects in everything from starting businesses to tackling gender, race, and social issues through her teachings, public appearances, and books. Her Entrepreneurship in Design, Diversity, Environment and Behavior course at the University of Illinois at Urbana-Champaign asks students to examine connections among its namesake topics, equipping them "with the tools to [become] more effective leaders in the profession and to become more influential citizens whose work can have a significant impact on society," she explains. Students are required to leave—figuratively and physically—the strictures of design studio and interface with the university's Gies College of Business and the College of Engineering Technology Entrepreneur Center, as well as enterprising peers and alumni in Illinois and around the globe.

"This class provides a vehicle for students to jump-start alternative careers related to design," Anthony says. Alum Jordan Buckner recently launched a company that makes caffeine-infused energy snacks called TeaSquares ▹▹▹

◂◂◂ (get it?) which has been included in *Forbes*' 2018 edition of its "30 Under 30, Food and Drink." "Studying architecture was crucial to my success as an entrepreneur, and participating in this class helped me identify how to translate those skills into the business world," Buckner says.

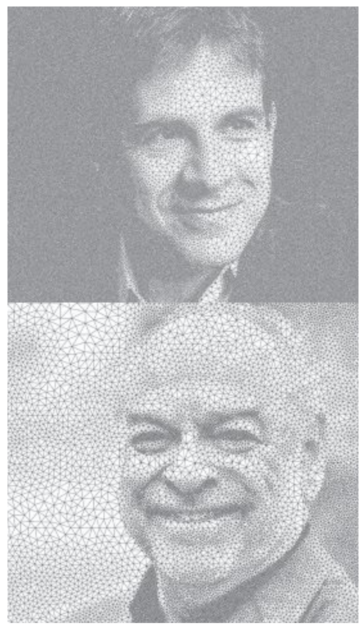
But the class also benefits those who choose to stay within architecture, giving students "an opportunity to see themselves as entrepreneurs in designing their own career trajectories," Anthony says. Course alum and CannonDesign senior associate Annie Sit, AIA, says that Anthony challenges architectural education to "emphasize design in a physical sense" and demonstrates to students how entrepreneurial leaders "observe problems from their daily lives, utilize their skills to solve problems, and improve lives and create value for society."

Another lesson Anthony harps on from day one of her classes is the necessity of networking, a core tenet of business schools but something rarely mentioned in design school, to the latter's detriment. "You can help [others], they can help you," she says, before breaking from the business mindset: "It's important to have good friends."

In recent years, Anthony has incorporated social media into her curricula, creating Facebook groups for her graduates to expand their communities and her own. Throughout her influential and far-reaching work, Anthony always returns to her timeless ethos: "Don't go back to your architectural cocoon. And lend a hand to people who aren't like you." —E.K.

THE INCUBATOR

MIT'S FAMOUS $100K ENTREPRENEURSHIP COMPETITION HAS SPAWNED HUNDREDS OF COMPANIES. THE MIT DESIGNX PROGRAM PROMISES TO GIVE ARCHITECTURE STUDENTS A PIECE OF THE ACTION.



GILAD ROSENZWEIG
DENNIS FRENCHMAN

Now in its second year of operation, the Massachusetts Institute of Technology (MIT) DesignX accelerator is an amped-up incubator that provides 24/7 workspace, mentorship, $15,000 in equity-free seed funding, and a business-focused curriculum for promising startups in the built space. "DesignX asks students to identify opportunities and problems that exist—or even more importantly, that will soon exist—in the realm of cities, design, development, art, and more," says executive director Gilad Rosenzweig. "We want them to develop solutions—either products, services, or platforms—that can scale and make a large impact."

Teams are admitted into the accelerator via a pitch competition open to the public. Each startup is required to have at least one member from MIT's School of Architecture and Planning (SAP), which encompasses students in design, real estate, and the avant-garde Media Lab. Successful teams are sponsored for one calendar year during which they go through two SAP courses; a boot camp that focuses on team organization, team building, legal issues, business planning, customer identification, and selecting a beachhead market; and a course to develop user personas, a value proposition, and a business model. The work typically bridges the students' graduation and entrance into the professional community.

The eight teams comprising the DesignX 2017 cohort ventured into affordable housing, virtual reality, sewage, spatial computation, real estate development, and other markets. Ten new teams are on deck for DesignX's tutelage this year; focus areas include sleep research, indoor agriculture, and disaster preparedness.

A central tenet of DesignX is that designers need to incorporate business thinking into their work. The architecture graduate students find themselves in the unfamiliar position of competing for startup seed money. "Even two years ago, this was considered only the realm of computer science and business graduates," Rosenzweig notes.

The studio component is how the DesignX experience builds on the traditional structure of architectural education. However, Rosenzweig says, "the next generation of architects needs the skills of a design, technology, and business entrepreneur" to take on the dramatic changes in cities, climates, and demographics expected this century. His partner in DesignX, faculty director Dennis Frenchman, believes that the specific design strategies used in studio may hold the key: "What do you do when you don't have enough information? You move ahead." —E.K.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THE CAPITALISTS

WITH TTWIIN, THORNTON TOMASETTI HAS FOUND AN AVENUE TO SUPPORT—AND RETAIN—ASPIRING, IN-HOUSE ENTREPRENEURS, WHILE GARNERING A STAKE IN THE POTENTIALLY PROFITABLE RESULTS.

In 2015, the then-newly merged firms of New York–based engineering firm Thornton Tomasetti (TT) and Weidlinger Associates established TTWiiN (a play on Thornton Tomasetti Weidlinger Innovation accelerator), a privately held company that provides venture capital funding for startups in exchange for equity and board seats. Around the same time, TT formalized a research and development (R&D) approach that considered proposals from employees to become standalone companies with TTWiiN's help.

This appealed to JONATAN SCHUMACHER, who joined TT in 2010 as director of CORE Studio, the firm's R&D incubator, building custom software, apps, and computational models and strategizing design and fabrication workflows. With TTWiiN's backing, he could take his work one step further.

In 2016, Schumacher and CORE colleague Maximilian Thumfart co-founded Konstru, a secure cloud-based platform that allows architects, engineers, and contractors to share BIM models and data across popular AEC software and analysis tools. "The main difference between an R&D and computational group like CORE and an accelerator such as TTWiiN is the due diligence process that the ideas have to undergo," Schumacher says. "The motivation for internal groups often relates to marketing, while the motivation for a venture capital–funded entity is to develop products that can generate revenue."

As such, Schumacher has faced a learning curve as the head of his stand-alone company. "Instead of providing services, we're providing a product, and instead of consulting, we have to sell ourselves."

Though several mid-to-large-sized AEC firms have formed in-house research and technology teams comparable to CORE, Schumacher says Silicon Valley–style tech companies are taking the lead in forming new practice models—and they are aggressively recruiting architecture graduates. "Design is going to get a lot more efficient because large firms and companies outside of the AEC industry are learning how to do it themselves."

The intrapreneurship model allows TT "to experiment with technology and the productization of services," Schumacher says. And the firm isn't the only one in the AEC space funding innovation from the outset. Another global, multidisciplinary firm recently threw its hat into the ring: the Bjarke Ingels Group, which joined with Mikro Invest in a venture named Jumbo. —M.B.


Dryer Vents
Model:SB-P
4"& 6" Aluminum
Model:SFB-P
4"& 6" Aluminum
Model
SFZC
4"& 6" Aluminum
Model
RCC-S
4"& 6" Stainless Steel
Vent Caps
Model
SX
3"-8" Aluminum
Model
KX
3"-6" Aluminum
Model
SFX-S
4"& 6" Stainless Steel
Model
SXL
10"-16" Aluminum
Model
SFZ
4"& 6" Aluminum
Model
SFX
3"-12" Aluminum
Model
SX-S
4"& 6" Stainless Steel
Model
RCA-S
4"& 6" Stainless Steel
Fresh Air Grilles
Model
JRC
4"& 6" Aluminum
Model
JRA
4"& 6" ABS Resin
Model
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THE FOUNDERS OF COVE.TOOL ARE DELEGATING THE TEDIUM OF DATA-CRUNCHING TO MACHINES, A GROWING TREND THAT WILL FREE ARCHITECTS TO DIRECT THEIR CREATIVE TALENTS ELSEWHERE.

THE ALGORITHM

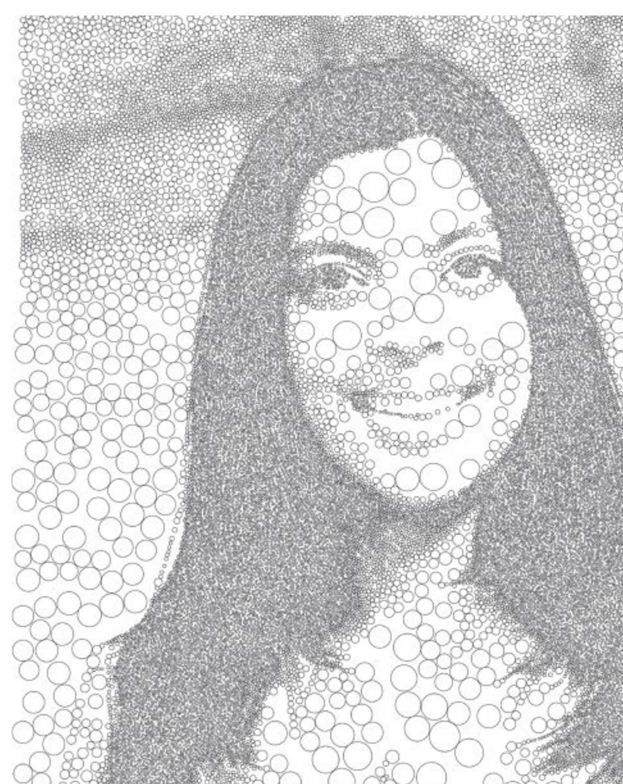
Architects who harness technology to automate repetitive tasks, such as compiling door schedules, can become more efficient workers. Architects who can author and share these tools can become entrepreneurs. After cofounding the Atlanta-based sustainable design consulting firm Pattern R+D, Patrick Chopson, AIA, and SANDEEP AHUJA saw a need for a decision-making tool that could churn through building performance calculations and output results in a user-friendly manner. "Our Pattern R+D clients were impressed with our ability to analyze millions of options and only present those that resulted in both cost and energy savings," Chopson explains.

So they developed Cove.tool, a cloud-based program in which subscribers input building features and design options—for example, glazing, shading, and insulation—and project parameters, such as job location and construction schedule. The software then pinpoints the combinations of parameters that offer the required performance within the prescribed budget. According to Chopson and Ahuja—who are the CEO and COO of the eponymous startup, respectively—Cove.tool reduces a project's initial cost by an average of 2 to 3 percent, or can improve building performance by 40 percent in exchange for a 3 percent cost premium.

If architects are serious about reducing the energy consumption of buildings, Chopson says, then "we have to change the way we practice architecture." Ahuja adds that she "was unsatisfied with talking about green architecture without knowing if the decisions I was making were actually helping." She points out that other industries provide metrics on their products—think miles per gallon and nutritional information. "By bringing the same data- and metric-driven approach to architecture, I have a chance at affecting climate change."

Chopson predicts that architects will increasingly rely on automation to manage project data, check code compliance, and assess aesthetics. "This data-driven design approach will remove the mundane and repetitive [work] from architects' roles and allow them to focus on design." He and Ahuja continually hone their coding skills using free online resources. "I'm convinced that if you can't code, you can't find solutions, and you're stuck with something from the past," Ahuja asserts.

Chopson agrees. "In order to push transformative change in an industry, one must to look beyond 'business as usual' and find crossovers with other industries. The second step is to identify your skeptics and make them believers by proving your value." —M.B.



THE 800-POUND GORILLA

BILLION-DOLLAR SOFTWARE DEVELOPER AUTODESK IS ANGLING FOR AN EVEN BIGGER STAKE IN THE BUILDING INDUSTRY WITH INITIATIVES IN AUTOMATION, MACHINE LEARNING, AND DATA MANAGEMENT AND EXCHANGE … ALL BY WATCHING DESIGN INNOVATION IN ACTION.

Autodesk is the AEC industry's predominant software provider, with its workhorses AutoCAD and Revit providing the basis for most domestic architectural firms' production. But even with 200 million-plus users and a 2018 projected revenue of more than $2 billion, Autodesk is not resting on its laurels. The San Rafael, Calif.-based company is quickly evolving to "do more, better, with less," as president and CEO Andrew Anagnost stated at Autodesk University in November. "We believe that humans and technology—whether that's robots or Revit—can accomplish a lot more working together than working alone."

The "more" in that statement includes projects in cloud-based computing, artificial intelligence-led generative design, and machine learning, as well as the new Autodesk BUILD (Building, Innovation, Learning, and Design) Space—a 34,000-square-foot incubator in Boston where the company has an enviable early-stage view onto the future

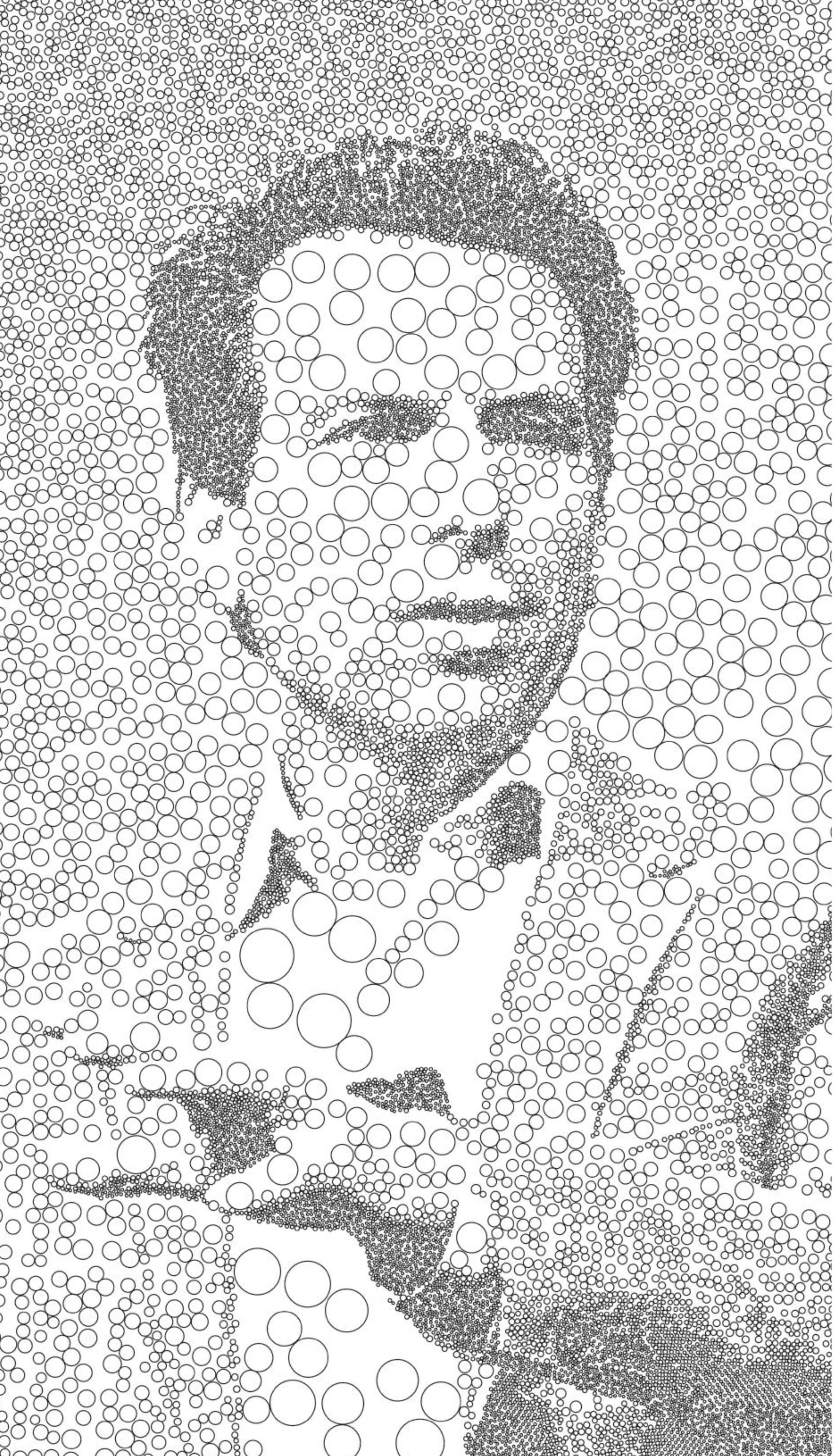
RICK RUNDELL
ANDREW ANAGNOST

models and tools of design practice. Since October 2016, BUILD has hosted research initiatives by approximately 500 people from 70 architecture schools, startups, and design firms. Users get space and access to high-tech equipment, including 3D printers, CNC milling machines, robotics, and computing resources—for free.

In exchange, Autodesk staff get to observe and interview BUILD residents as they "figure out how to execute ideas," says Autodesk senior director and technology and innovation strategist Rick Rundell. "The goal is to understand how our tools can be used." All occupants use software in their work, which has spanned programming, automation, the 3D printing of ceramics and concrete, and the full-scale fabrication of high-rise timber connections. However, as Rundell quickly adds, they aren't confined to the sponsor's own products. In fact, he explains, "it's interesting to see how they use non-Autodesk tools."

By outfitting the maker space and its wood and metal shops with the latest industrial and fabrication tools, Rundell says, Autodesk is removing some of the high amounts of risk and investment required in building research and development. "When I was in practice," he recalls, "we made drawings from software." Now architects can drive the machines that make everything from prototypes to finished products, a direction that he sees more design practices taking. All of this aligns with the company's bet, as Anagnost noted at Autodesk University, that automation will give designers "an opportunity to do more … [and go] from design to make, at the push of a button."

Autodesk is already expanding BUILD's footprint in Boston and leveraging industry partnerships to fabricate portions of the new space. "Numerically driven machines are popping up on site" and operating under the guidance of designers' digital directions, Rundell says. The process underscores his advice to practitioners to embrace disruption—of themselves. "Architects won't be able to afford to leave means and methods to the builders," he says. And that's where BUILD offers Autodesk another leg up on the industry. —E.K.



THE LAB RATS

BY ESTABLISHING A RESEARCH ARM THAT ENCOURAGES ARCHITECTS TO DIVE INTO TECHNICAL INVESTIGATIONS, PAYETTE HOPES TO FOSTER A KNOWLEDGE-SHARING COMMUNITY.

Seven years ago, Payette decided to expand its practice capabilities and make more informed design decisions using in-house research. The Boston-based firm hired ANDREA LOVE, AIA, to fill its newly created position of director of building science, adding itself to the growing legion of architectural practices with strong research bents, such as Perkins+Will, SHoP Architects, and KieranTimberlake.

Newly armed with a post-professional M.S. in architecture studies from the Massachusetts Institute of Technology, Love was up for the challenge. "It has been an exploration in how to change a firm's culture," says Love, who is also a principal at Payette. "How do you build energy literacy so people talk about the performance of a building in the same way they would consider the fuel economy of their cars?"

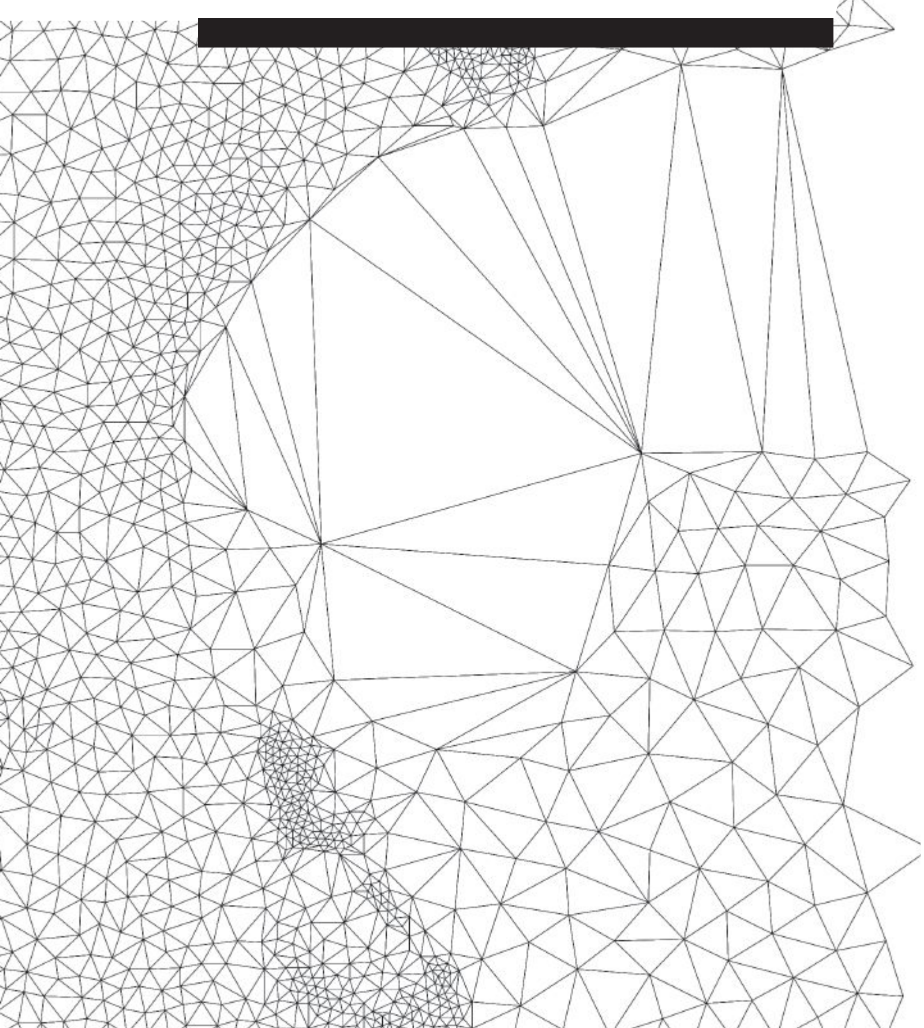
While she doesn't work in a traditional design capacity, Love influences every project ▸▸▸

within the office. She helps teams understand the impacts of their design decisions by integrating performance modeling tools into their workflow. She also leads the firm's efforts on meeting the requirements of the AIA 2030 Commitment.

Moreover, Love is cultivating a research environment. Nearly half of the firm's 150 staff members have participated in internal research initiatives, committing an average of two hours per week over the course of several months. Each investigation pairs junior architectural staff with senior members, presenting a learning and mentorship opportunity. "This model has expanded our capabilities in that we are able to design better buildings that use less energy and are more comfortable," Love says. "By having the staff participate in research, we are able to distribute knowledge utilizing the same software."

As a sign of its commitment to experimentation, Payette has allocated resources to purchase new tools and technologies, such as an infrared camera, without trying to commoditize its studies. It has published a white paper on the thermal performance of façades, which was funded by an AIA Upjohn Research Initiative grant, and offers an online glazing and winter comfort tool as well as a plug-in for Rhino that tracks the impact of glazing design on thermal comfort.

"We are trying to disrupt change," Love says. "By sharing all of our research freely, as in academia, we are not only advancing the industry's knowledge but also benefiting by becoming known as experts on a particular topic." —M.B.



THE INTERLOPER

WEWORK'S PREDOMINANCE IN CO-WORKING OFFICE SPACE WEIGHS HEAVILY ON THE REAL ESTATE INDUSTRY, BUT AS ITS REACH EXPANDS TO SERVICES SUCH AS ENTERPRISE DESIGN, THE ARCHITECTURE PROFESSION ALSO HAS REASON TO WORRY.

By offering flexible, attractive, and affordable office spaces, WeWork has cornered the co-working market faster than anyone would have expected. Founded in 2010 with a single location in New York, the privately held company now boasts 200 locations totaling more than 10 million square feet of leased space in 64 cities and 20 countries. And counting.

Yet WeWork is not all about work: It wants to streamline every facet of life with typology-bending developments such as WeLive (housing), Rise by We (fitness and wellness), and WeGrow (an elementary school with a focus on entrepreneurship). But what should really raise architects' eyebrows is WeWork's growing stake in large-scale workplace solutions—from office layouts and interior design to branding and signage—for desirable clients such as Spotify, Microsoft, Pinterest, Sprint, and Salesforce. And let's not forget the company's allure to design talent: Nearly 400 architects and interior designers, engineers, researchers, product designers, graphic designers, user experience designers, and real estate specialists are already on its payroll.

Integral to WeWork's success is its 2015 acquisition of Case, the building information and technology consultancy, which had counted WeWork among its clients. The brain trust included Case partners David Fano and Federico Negro, now WeWork's chief growth officer and senior vice president, respectively, and Daniel Davis, now WeWork's director of research (and an occasional contributor to ARCHITECT).

With a diverse portfolio and workforce, WeWork is not only commandeering the real estate market but also hacking the business model of established AEC firms. By serving as both landlord and property manager, WeWork has unfettered access to 175,000 members willing to provide post-occupancy feedback. "We're primarily focused on trying to understand the relationship between people and spaces, and how the design of our spaces works for the people who inhabit them," Davis says. "Instead of using intuition and rules of thumb, WeWork uses data to quantify what makes a good office."

Bolstering this effort is an interdisciplinary staff that can convert newly acquired properties into revenue machines at breakneck speed. Davis outlines the process: "As soon as we lease a space, we laser scan it so we can maximize the layout. We use Revit and have established a BIM workflow—a data pipeline that flows from the real estate department to the design team—that allows us to extract information and ensure consistent management of all our properties." Once members start to settle in, his team begins reviewing usage patterns to see "what's working and what's not."

Conventional firms need to think more across disciplines, Davis maintains. "Architecture school isn't particularly good at preparing us to work collaboratively—it's geared toward promoting the idea of the individual genius," he says. "You have to let go of that to get to the next level of design." —M.B.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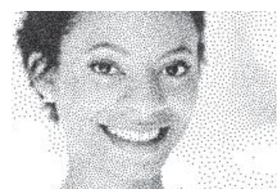
I THE YOUNG AND THE RESTLESS

THEY'RE EDUCATED, MOSTLY LICENSED, AND HUNGRY FOR CHANGE. THE 60 EMERGING PROFESSIONALS WHO PARTICIPATED IN THE AIA'S PRACTICE INNOVATION LAB HAVE NO SHORTAGE OF IDEAS FOR HOW ARCHITECTS CAN REINVENT THEIR BUSINESSES.

Evelyn Lee, AIA, often says that "the profession is three recessions away from extinction," but her half-hearted quip seems, of late, more like an omen. Past experiences in program management and business consulting have made the regional workplace manager at Newmark Knight Frank's San Francisco office realize how architects' capa-



MILAN JORDAN

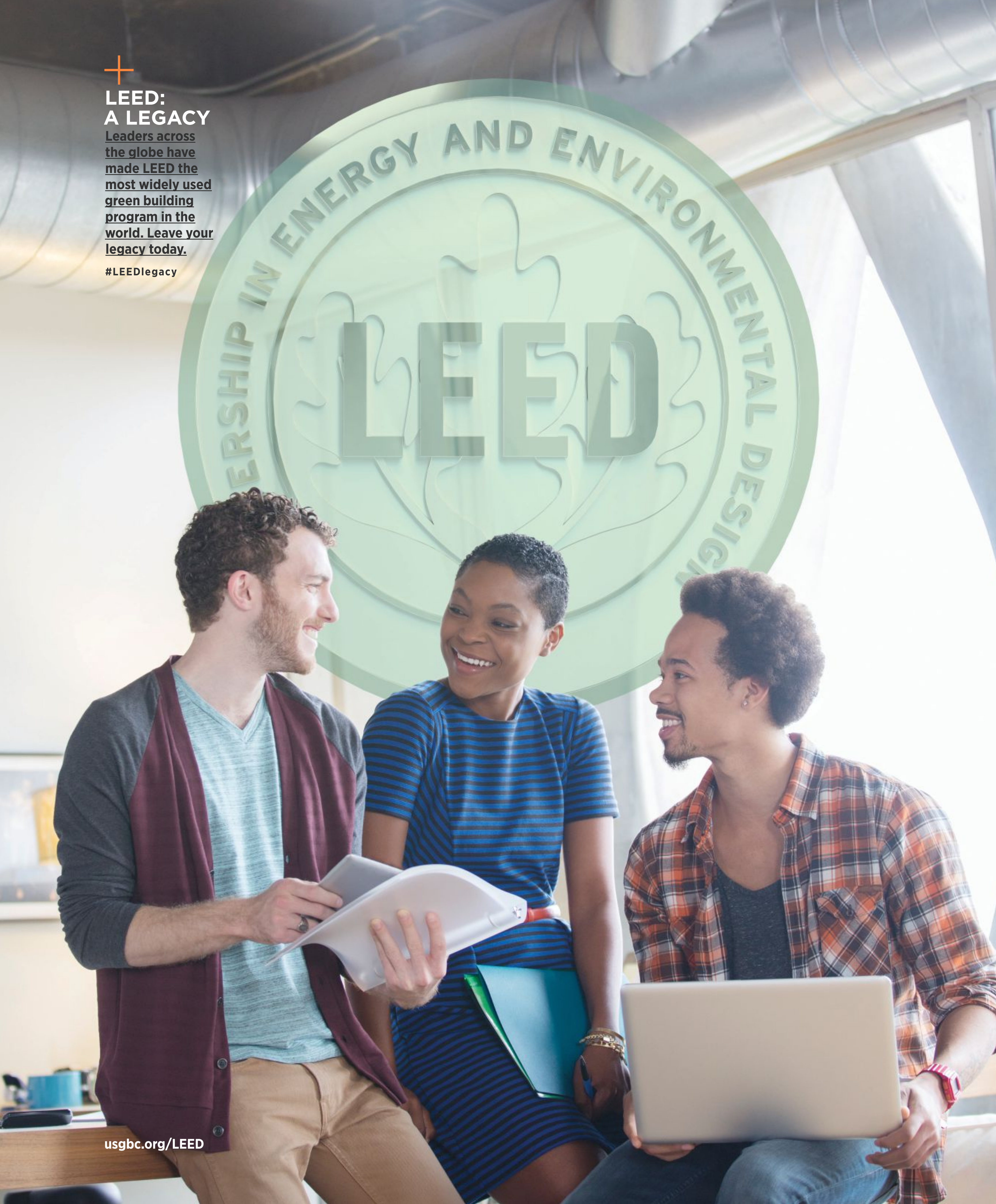
EVELYN LEE

bilities beyond drawing buildings were unfamiliar to many people—including architects themselves. From leading focus groups to reorganizing workplaces and planning future operational and maintenance budgets, architects often do the work of highly paid consultants "for free," Lee says, and they overlook these services' potential to unmoor their practices from tempestuous construction cycles.

As chair of the 2017 AIA Young Architects Forum (YAF), Lee took her leadership prerogative and turned the quinquennial YAF summit into the Practice Innovation Lab, a three-day event that culminated with 10 six-member groups pitching new business models *Shark-Tank* style. Ideas included Design on Demand, an "Uber, but for architects"; post-occupancy information service MOM+DAD (Monitoring, Operations, and Maintenance + Design, Analytics, and Data); Daedalus, which pairs crowdsourced funding with crowdsourced design; and the event's winner, JAMB Collective, a network that pools the resources of small and midsize firms to offer the services and equipment that large firms can afford—"like a super AIA," says Milan Jordan, ASSOC. AIA, manager for the AIA's Center for Emerging Professionals.

The draw of the Practice Innovation Lab—several of the 154 applicants had never participated in an AIA event—highlights the dissatisfaction many emerging architects feel about their career prospects. Lee suspects that many firms sense the changing tide, but not its urgency. Instead of looking for ways—and talent—to expand their menu of services for long-term success, she says, "they're just trying to hire for the work they have on the table."

Lee and Jordan hope to ride the wave of enthusiasm that followed the Practice Innovation Lab by promoting and repackaging the workshop at local and national AIA events. The Institute is taking note, Jordan says. The AIA recently created a Center for Practice that will, among other aims, "identify and advance areas of new business opportunities, new business models, new skills, and new markets" for architects. Lee remains cautious in her expectations. "It's clear this is going to be a slow and painful process for the profession," she says. "We need to keep the conversation going." —W.L.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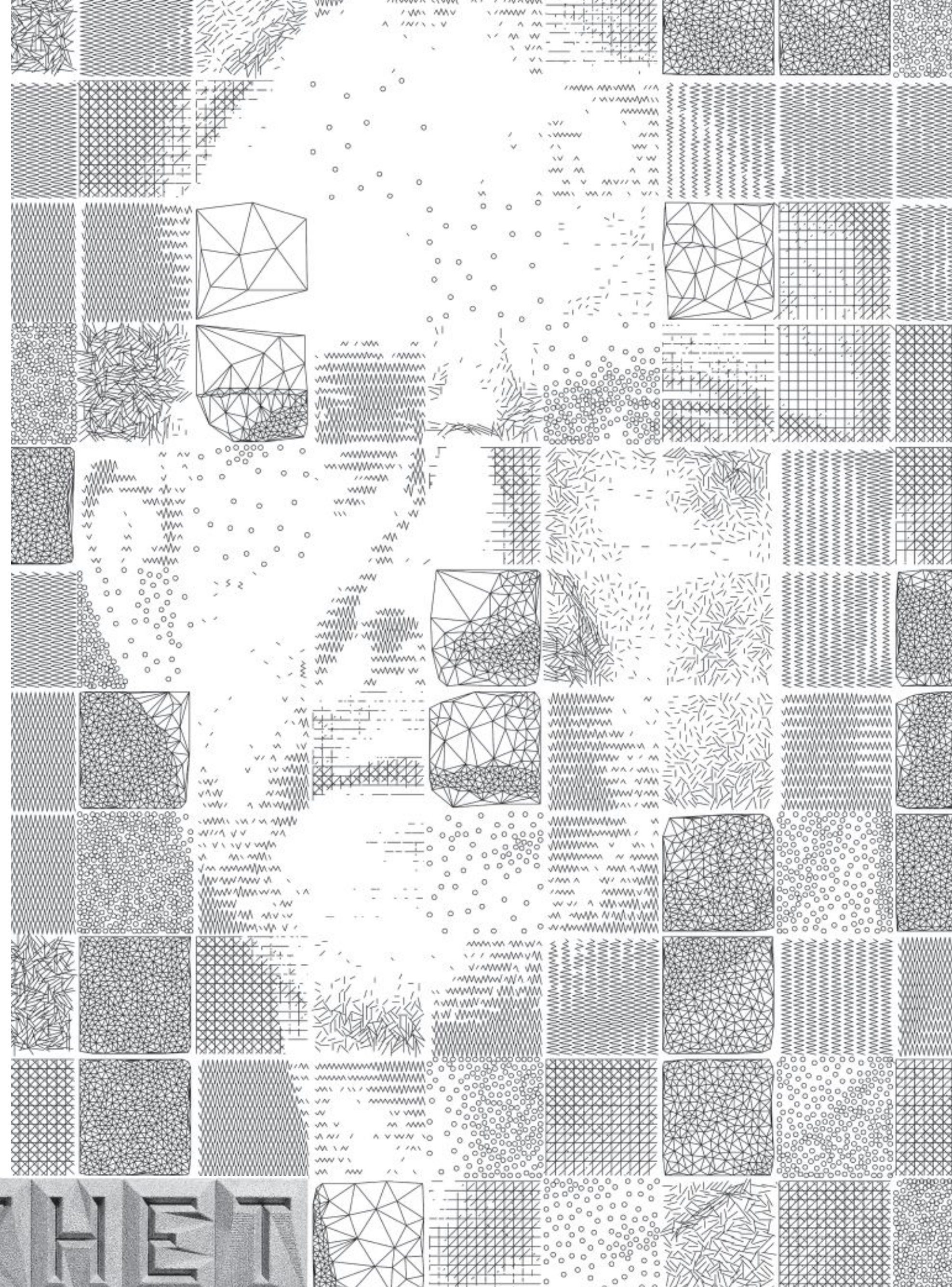

Phil Bernstein, FAIA, may be architecture's best-known technologist. During his 16-plus years as the vice president for strategic industry relations at Autodesk, he advocated for its 2002 purchase of Revit, which propelled the AEC industry from geometry-only CAD software to object-oriented, information-rich BIM. Now Bernstein, having left Autodesk to focus on teaching, writing, and research, is tackling the inefficiencies of the construction industry, asking his students at the Yale School of Architecture to challenge conventional models of practice and himself consulting with AEC firms on strategic issues such as firm organization, technology use, competitive positioning, and process improvement. "I'd like to establish some new 'first principles' underlying concepts like integrated design and outcome-based delivery systems," he says, "and help define our path in a world where big data, simulation, analysis, and algorithms must be a part of competent practice."

THE PROPHET

THE BUILDING INDUSTRY HAS AN ABYSMAL RECORD OF SCHEDULE AND BUDGET MISHAPS, SAYS PHIL BERNSTEIN, A LECTURER ON PROFESSIONAL PRACTICE AT THE YALE SCHOOL OF ARCHITECTURE. BUT THE SMART USE OF DATA AND TECHNOLOGY COULD CHANGE ALL THAT.

In the future, firms will need to confront a series of technological issues. Bernstein, who half-jokes that architects essentially used to dare contractors to build a physical structure from their 2D drawings, wants to see design and construction processes get cozier. Information in the form of big data, analytics, and performance simulation will affect the outcomes of designers' work more or less in real time, he believes. And firms will need to develop strategic partnerships with key players—including, but certainly not limited to, contractors and computer scientists—in order to improve the building process, particularly as construction itself becomes more industrialized. Architects are positioned to be part of the ongoing reconciliation of information associated with the current era of big data and automation.

Though Bernstein acknowledges that "change happens slowly and discontinuously in construction, building, and architecture," he points to some progress: Practitioners today have gone from hand drafting drawings to writing code for parametric design and artificial intelligence. Robots can now perform surgeries, he says, so it is hardly a stretch to imagine that code compliance—the most cogent argument for the licensure of architects—will inevitably be automated. "When computers can learn to do stuff, knowledge workers get eliminated," Bernstein says. And that means that the role of a typical architect has to be redefined. "We need to design our future," he warns, "and learn how to control the system before the system controls us." —E.K.


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THE CAREER COUNSELORS

WHEN ARCHITECTS EXPAND THEIR SKILL SET BEYOND OUTDATED CONVENTIONS, THEY BECOME UNIQUELY POSITIONED TO TACKLE SOCIETY'S BIGGEST CHALLENGES, SAY GEORGIA TECH'S DENNIS SHELDEN AND SCOTT MARBLE.

Digital Building Laboratory (DBL) director Dennis Shelden, AIA, and School of Architecture chair Scott Marble, AIA, exemplify the interdisciplinary skill set they proselytize at Georgia Tech. Trained in architecture, civil engineering, and design computation, Shelden was one of the masterminds behind Gehry Technologies (acquired by Trimble in 2014). Meanwhile, Marble tackled digital design, fabrication, and research as an associate adjunct professor at Columbia University, and as a founding partner of Brooklyn, N.Y.'s Marble Fairbanks, where he still works. At the DBL, an interdisciplinary program that brings together AECO practitioners and researchers, Shelden and Marble found kinship in crafting curricula intended for quintessentially 21st-century practitioners.

The post-professional M.S. architecture program, the duo's crown jewel, includes specializations in building information and systems (think software development as well as supply chains and systems engineering), and in advanced production (drones, robotics, augmented and virtual reality, and the like). Couple this with Georgia Tech's much-touted entrepreneurial resources, such as the business incubator Advanced Technology

Development Center, and, Shelden says, architecture graduates can have career trajectories that were unfathomable just a decade ago.

If the application of technology to improve design and delivery inefficiencies has been disappointing to date, Shelden wants architects to hold the line. "All the weight of opportunity has been building and something's changing now," he says. First, the technology that has streamlined other industries, such as automobile manufacturing, has come down to a price point and an ease of use acceptable to the AEC industry. Second, he says, "other markets are getting interested

in the built environment." If architects don't broaden their capabilities and revamp the design and construction process, "then the whole economy is going to come into this industry ... and [innovate] for us."

Data collection, analysis, and interpretation offers one opportunity for architects to lead the innovation charge. "Form, construction, and fabrication are central to our [work]," Marble says. "Now we're into a phase of data, and we're just starting to figure out what to do with that. The possibilities are much, much broader."

Shelden and Marble tell their students to think entrepreneurially and broadly. Marble notes that the reliance of architecture education on other disciplines to make real progress is greater than what he once expected. Driving the industry forward "simply is not possible anymore without having meaningful collaborations and interdisciplinary work going on with other [sectors]."

"The more you can engage in thinking creatively about what you can do with an architecture degree, the more opportunities you're going to have," Shelden adds. Legacy firms, he says, would be wise to hire "young architects coming out of this new context to transform their business." —W.L.


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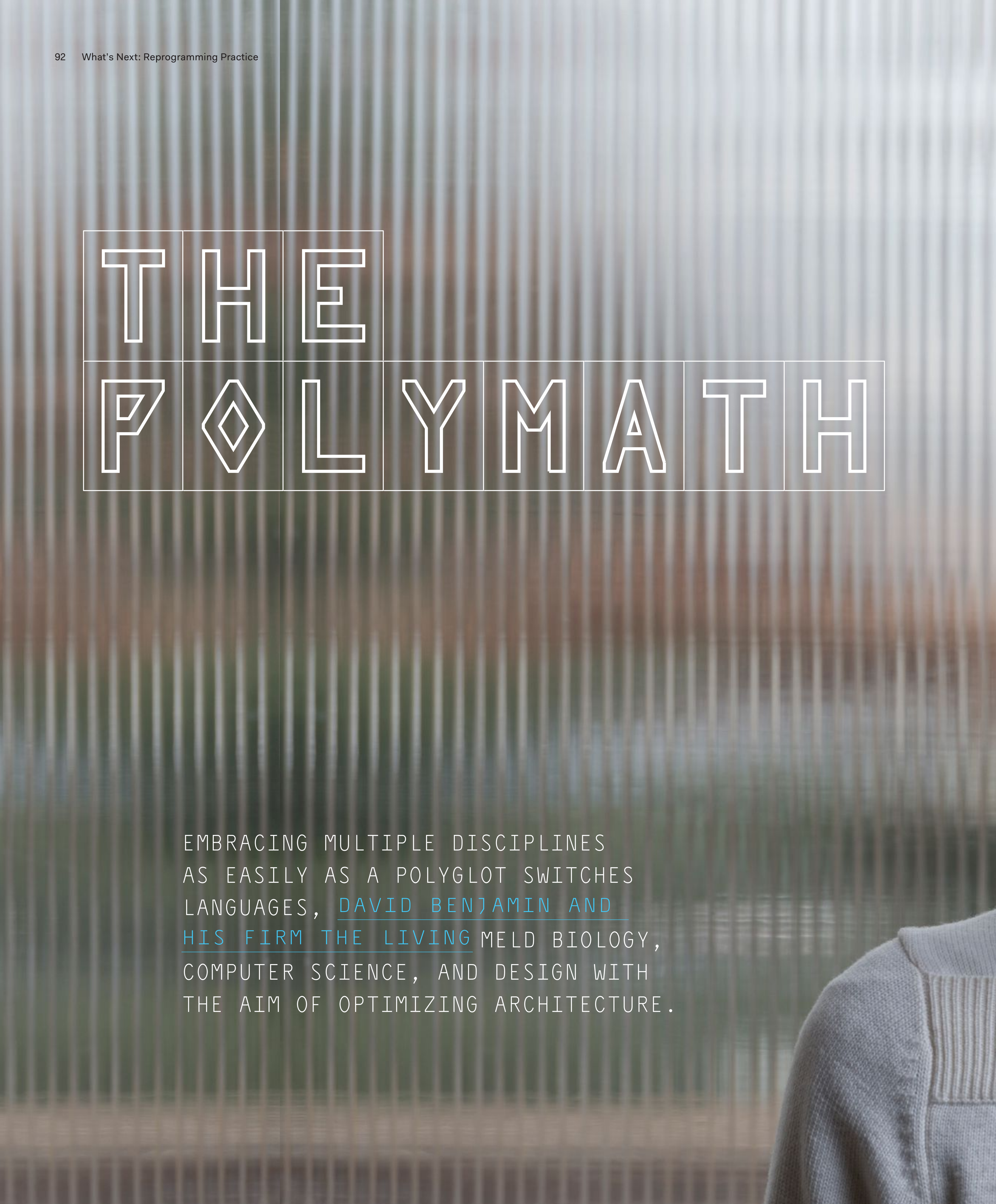


THE POLYMATH

EMBRACING MULTIPLE DISCIPLINES AS EASILY AS A POLYGLOT SWITCHES LANGUAGES, DAVID BENJAMIN AND HIS FIRM THE LIVING MELD BIOLOGY, COMPUTER SCIENCE, AND DESIGN WITH THE AIM OF OPTIMIZING ARCHITECTURE.

INTERVIEW BY KATIE GERFEN
PORTRAIT BY ROBERT CLARK
IMAGES COURTESY THE LIVING

What were your goals when starting your practice, The Living, back in 2006?

David Benjamin: In a way, the first ideas of the practice are related to the name. I was interested in creating a version of interactive or responsive architecture, and that has connected over time to an interest in examining architecture through biology and actual living organisms.

Those research topics are really related to ideas about expanding the definition of architecture. Maybe buildings are not just static inert objects, but can be dynamic systems. Maybe they are not just dug into one site, but are actually connecting many different places.

When I came to architecture school [at Columbia University in New York], I was very interested in the combination of art and science that architecture has traditionally represented, but I was also aware of and interested in a changing world that might suggest more blurring of disciplines and new possibilities for architecture.

Going into practice, although we were starting small and our prototypes were very small, we were interested in thinking big and connecting to the world. It was natural to be doing experiments that, although they fell toward the limits of what we typically think of as architecture, had at least a hypothesis about how it could impact bigger collections of buildings in cities.

How is your firm structured? Who works at The Living?

Our core team is about 10 people. Most are trained as architects but also have an interest in other types of research including computation and biology. We have one team member who is a computer scientist—that's an important and unique role for us to have. But we are organized and operate in such a way that we have great collaborators on almost all of our projects who are outside of our core team, such as biologists or material scientists—even artists and musicians.

Research is such a driver for your practice. How do you prioritize it?

We're probably more known for research methods and threads than for any specific formal approach to a project. And that's interesting, that maybe in some version of the future, architects will be known more for their research approach, or their concepts about materials and sustainability, than for a formal signature.

We've been lucky to find a way to do self-initiated research projects, write papers, present at conferences, and make prototypes that have a life of their own. But we also do research while working for clients, using creativity to respond to their needs and those projects' specific requirements. Operating between those worlds creates a nice feedback loop. So, rather than see that as a tension, we are able to see each as lending insights to the other.

Tell me about the relationship that you have with Autodesk, which acquired The Living in 2014. That's a unique setup for a firm. How did it come about?

It was a hypothesis about collaboration of the future, on both of our parts: a hypothesis from Autodesk that an experimental design studio could be part of an R&D department in a big company, and a hypothesis from The Living that this connection could allow us to do more of what we were already doing in a high-powered way.

Autodesk has a connection to a broader ecosystem of research on a variety of interesting topics with super-high-powered researchers. The Living works on commissions and applied research for outside clients like any firm, but to be connected to this bigger community of research in a big company that is thinking about the cities and design processes of the future in ways that are similar to us—and in some ways that are different than us—is valuable.

Our mission is to create interesting designs in the built world, and Autodesk's mission is to make software tools for people to design and build things. At first glance it seems pretty different, but we share a lot in our thinking about new materials, new workflows, and new ways to balance creativity with processes of computation.

One of the areas you've been exploring for years is generative design: using computer algorithms to create thousands of possible solutions to a design problem. How have you been furthering this research?

It is connected to some of my work teaching at Columbia, and some of our early prototypes, including our work for Airbus, where we used generative design to design airplane parts (see page 104).

But I was excited to apply generative design on a larger scale in our recently completed MaRS office space for Autodesk in Toronto (see page 106), because I've always believed that generative design is best at solving multidimensional problems that are difficult for a human with linear thinking to solve with intuition. Autodesk knows the value—they have a variety of researchers in this exact building working on generative design.

I was also interested in exploring how to take some of the qualitative aspects of architecture like human experience and preference, and to see if we could put those into a computational workflow—to combine them with the quantitative aspects.

How is the industry reacting to generative design? Aren't architects concerned that it heralds an age of "letting the computer design for us"?
I've been surprised by the number of potential clients who have responded super positively. People who are designing everything from office spaces to factory layouts to urban design saw the way we applied a generative design approach for an office space and were able to read their own problem into it, and say, "Hey, that's pretty much what we do when we're trying to lay out a neighborhood and balance global concerns and those that will benefit an individual housing unit." We've also had a number of architecture firms say, "We're doing parts of this as well, but what you're showing seems to be offering a comprehensiveness that we're interested in. Could we talk more?" We've had a lot more positive response than negative—even more than I expected.

But I myself am suspicious of any trend of people saying, "The computer gave us this result, and it must be right since it's based on data." A misuse of this technology could allow us to just hit the repeat button and crank out unthoughtful architectural responses in a lot of different conditions. But I think that's actually unlikely. The more people understand the technology, the more they will see that it may require us to rethink the way we design, but it doesn't replace the designer.

It's still very important to be able to define the goals of the project, to think through the geometric system, and to interpret the 10,000 results later on in the process. The computer can tell you what the mathematically best designs are, but it can't tell you a single best design if you have more than one objective. There are a lot of important inputs for human values, judgment, and creativity. In a strange way, the process of generative design might lead us in the direction that design with biology leads us, which is design at a slightly higher level. You design systems rather than jumping immediately to final forms. It's a new process, and an exciting one, to design in a more open-ended way that can lead to unexpected and valuable outcomes.

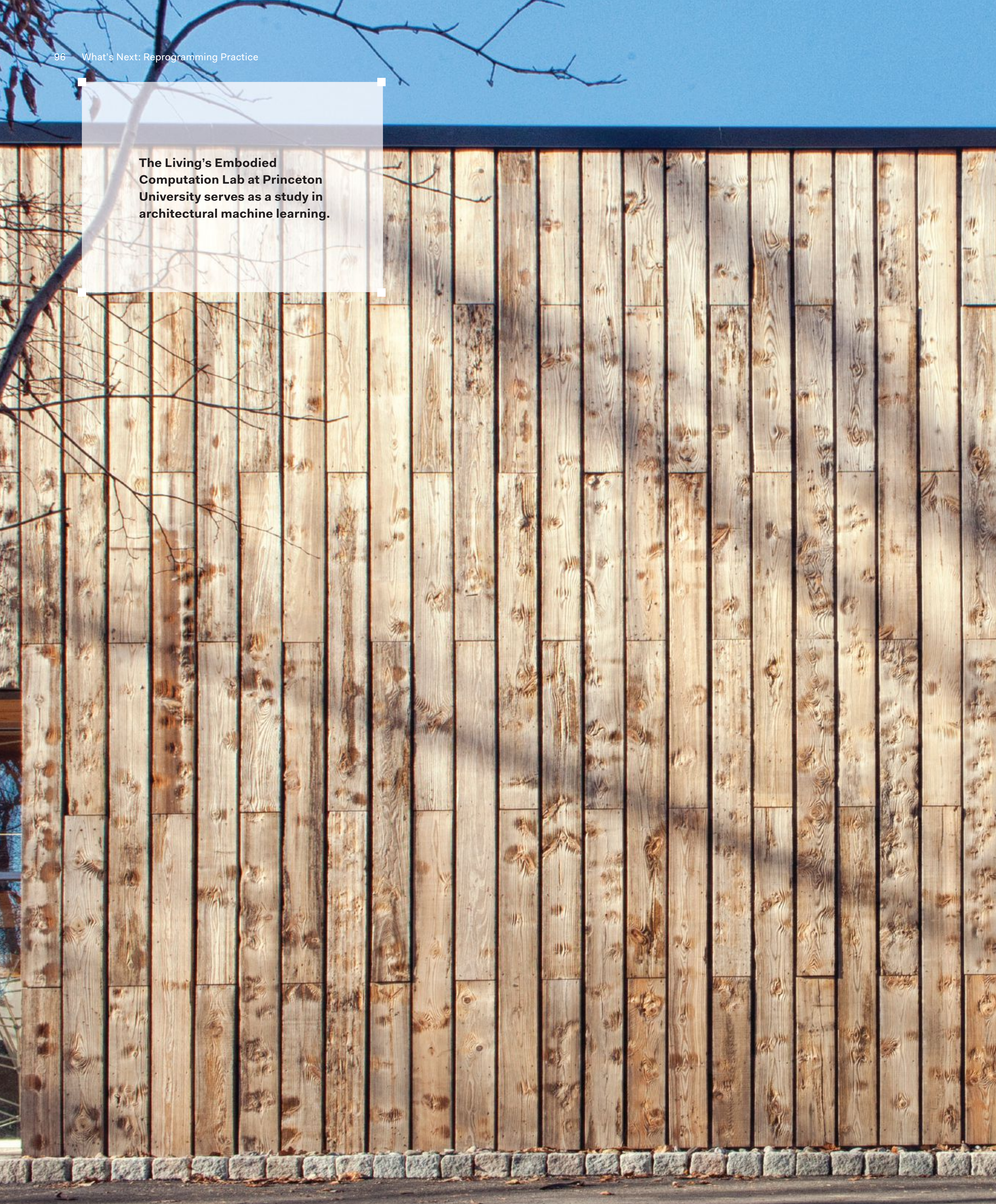
You've also been exploring machine learning in recent projects—the same types of algorithms that serve up targeted ads—but with applications for architecture.
Yes, we used it first for the Embodied Computation Lab at Princeton (see page 96) to detect knots in wood. But after working with it, we realized that there's something really interesting and important—and even a little bit dangerous or cautionary—about using machine learning and all of this data to make decisions. We explored that in a project called Twin Mirror for the 2017 Seoul Biennale (see page 120), where we tried to create an installation that would reveal some of the bias that sometimes goes on in the use of these technologies. We use new technologies, and are interested in how things like machine learning or generative design can open up new possibilities for design and for architecture. But we want to explore both the possibilities and the drawbacks. Let's use the computer to detect patterns that a human can't discover, but also be aware of how it derived that answer, and what we need to double-check before accepting that recommendation.

Yours is a very different practice model than a lot of others in the industry. Are there lessons that other, more traditional, practices can learn from firms like yours?
I do think that already, a variety of firms are interested in both the approach and projects of an experimental firm like mine. Some of it may be generational. The generation that's graduating from architecture school now is thinking about the magnitude of some of our sociopolitical and environmental world problems, and of the technologies available, and about where we are now in relation to the outdated idea of an architect being a lone genius who just sketches a brilliant solution in his or her notebook.

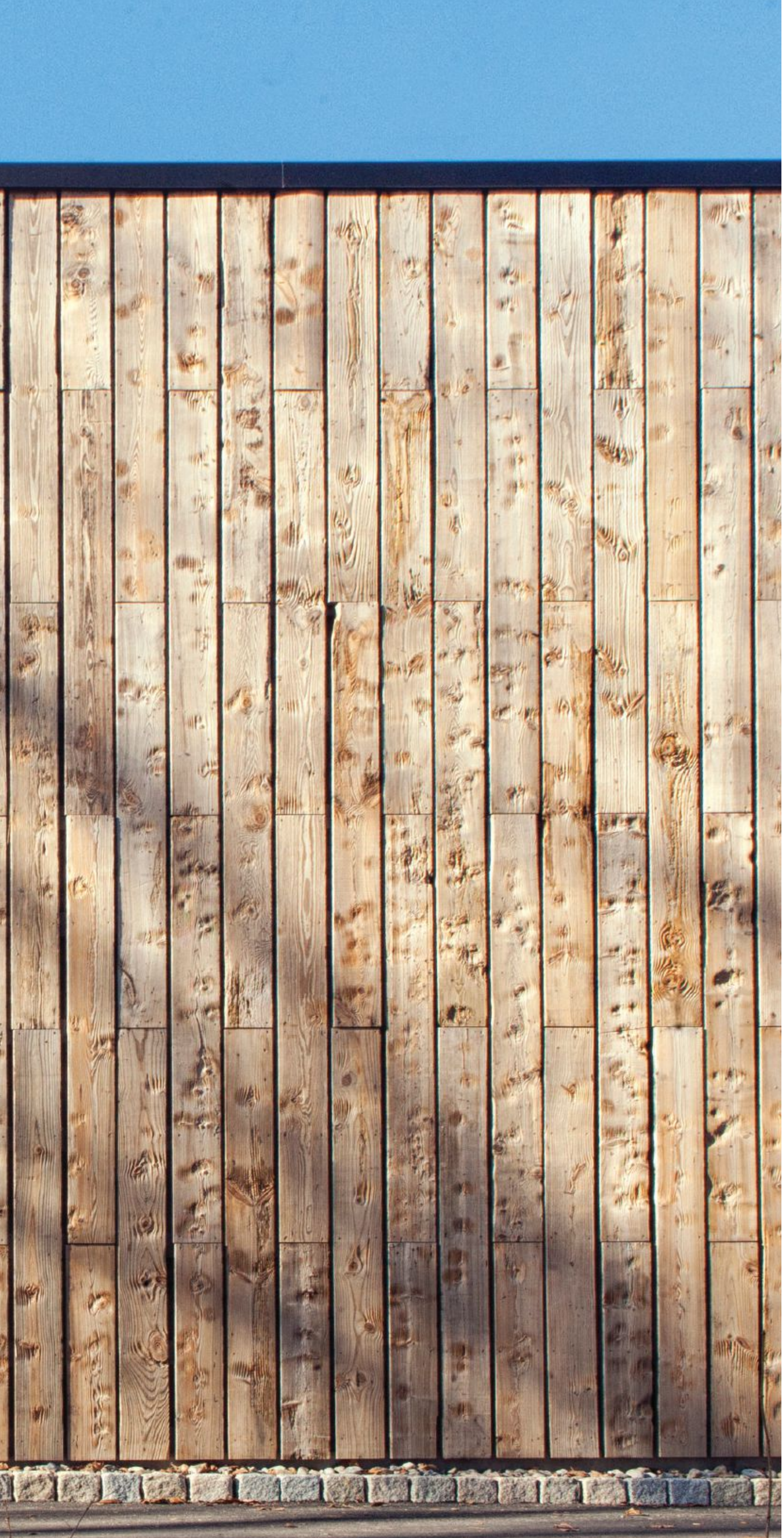
There's a possibility that our disciplines as we've defined them for many years—both in academia and out in practice—might be slightly outdated, and are under a pressure to be more interdisciplinary. I'd like to think that our firm is part of that dialogue.

You said that when you started your firm you were looking for a new definition of architecture. Have you found it?
I'm still operating more through questions than answers. But there are a number of hypotheses that interest me now—like expanding the definition of sustainability, and thinking of buildings and cities in terms of their impact. Not just as static fixed objects that are only relevant on the day that construction is completed and the photographs are taken, but that have a life both before and after that that architects can't completely control, but can influence.

I'm not sure I'm after a single new definition. I'm not alone in these interests: in terms of using a biological approach, or using computation in an exploratory way. I'm not trying to be someone who is off on their own far-out exploration. I think these trends are of interest to a variety of people inside and outside of architecture, who are coming together and starting to suggest approaches to buildings and cities that are slightly different.



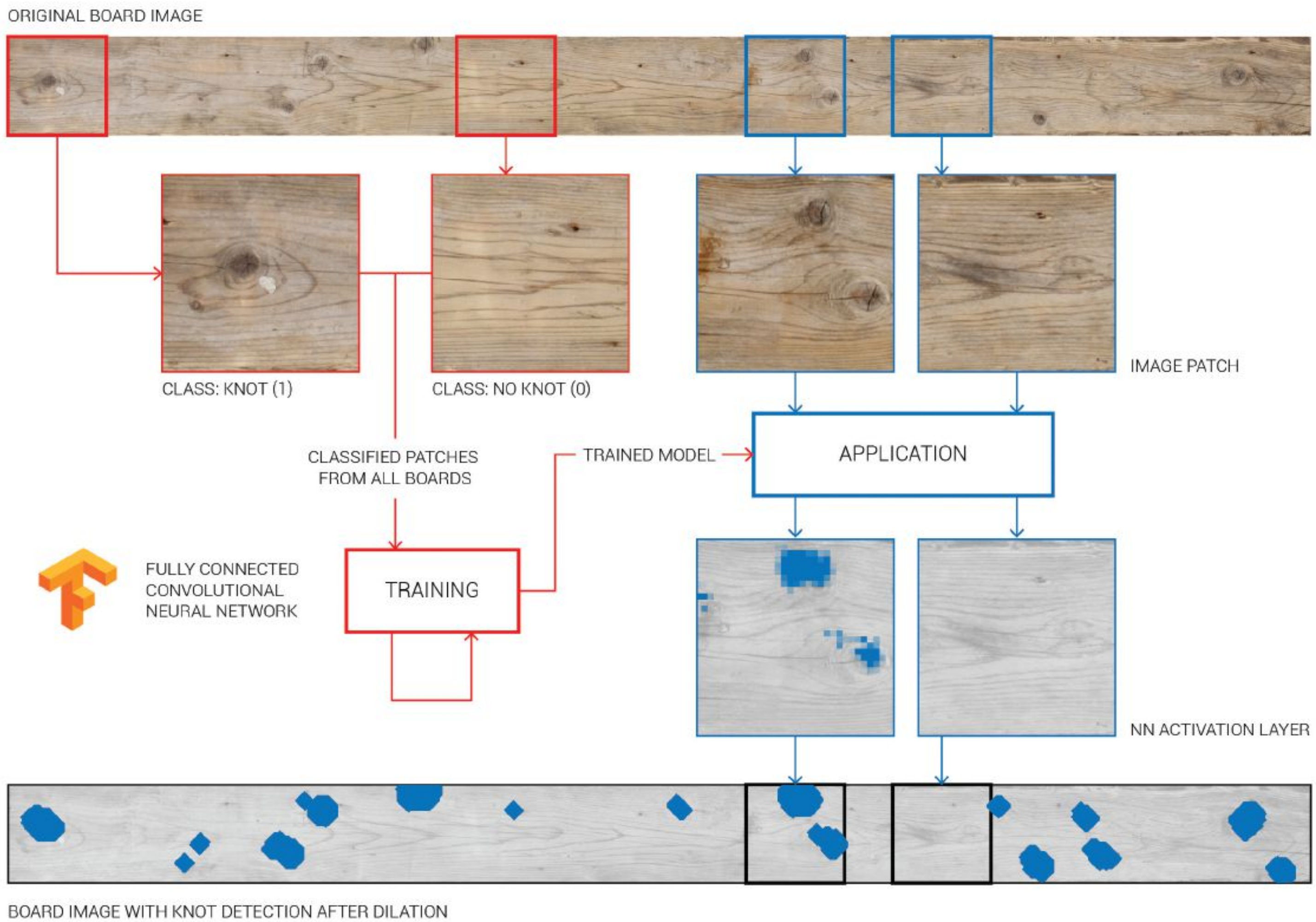
The Living's Embodied Computation Lab at Princeton University serves as a study in architectural machine learning.



The new Embodied Computation Lab is a fabrication space for the School of Architecture at Princeton University, but it's more than just a home for CNC milling machines and the like. The glulam structure is clad in reclaimed scaffolding boards from construction sites in New York. Usually used for a year and then thrown out, The Living decided this would be a great base material "for a variety of reasons, many of them having to do with sustainability, but also with pushing the limits of wood as a construction material," Benjamin says.

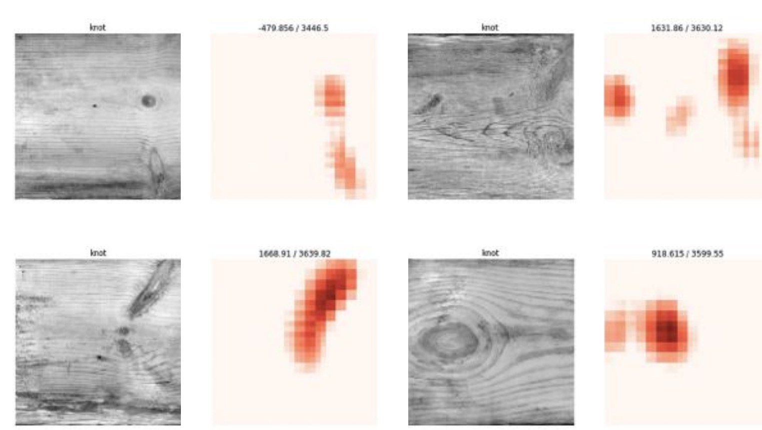
The team paired up with assistant professor Forrest Meggers, one of the lab's constituents, who is researching the potential thermal benefits of wood—specifically of warm air trapped near the surface by micro-contours in the grain. What's more, could specific geometries of that grain change the thermal performance? "Normally, equations for heat transfer assume a fixed coefficient for surface roughness," Benjamin says. "But maybe that doesn't have to be just a fixed coefficient. It's one of those rules of thumb that's passed down for so long, but nobody says: 'What if it could be different?'"

■ Knot Identification Machine-Learning Process

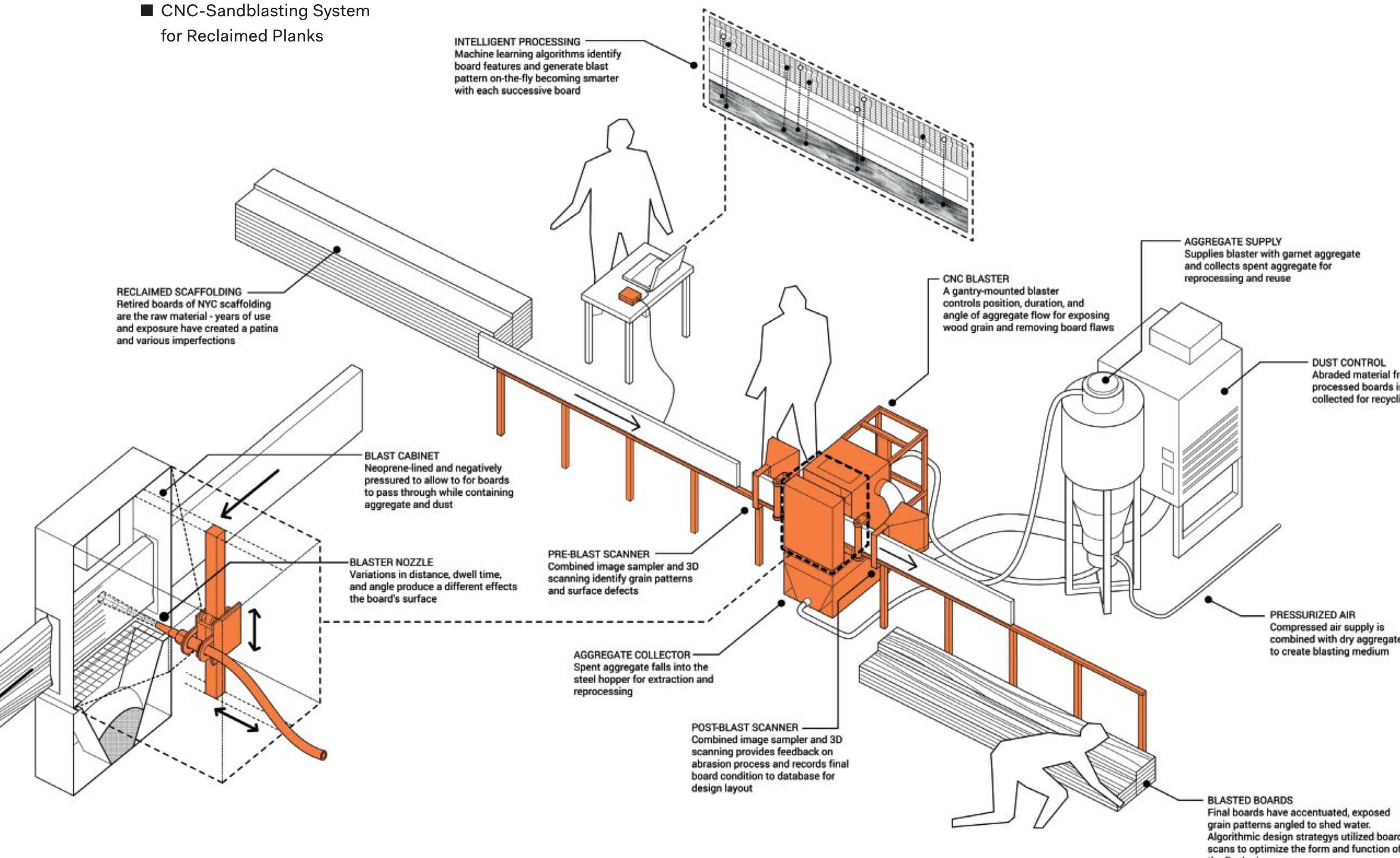


Since wood grain is most densely spaced near a knot, that is where the team focused its efforts. But faced with the task of analyzing roughly 380 reclaimed boards, the team decided to see if the computer could learn to identify the knots for them. "It was still a hypothesis," Benjamin says. "We set up a simple website for humans to indicate whether a picture of wood had a knot or not. Once we fed that data into a computer, even in the initial test, the machine-learning algorithm was able to detect not only if there was a knot in a new image of wood, but where it was."

■ Computer Identification of Knots

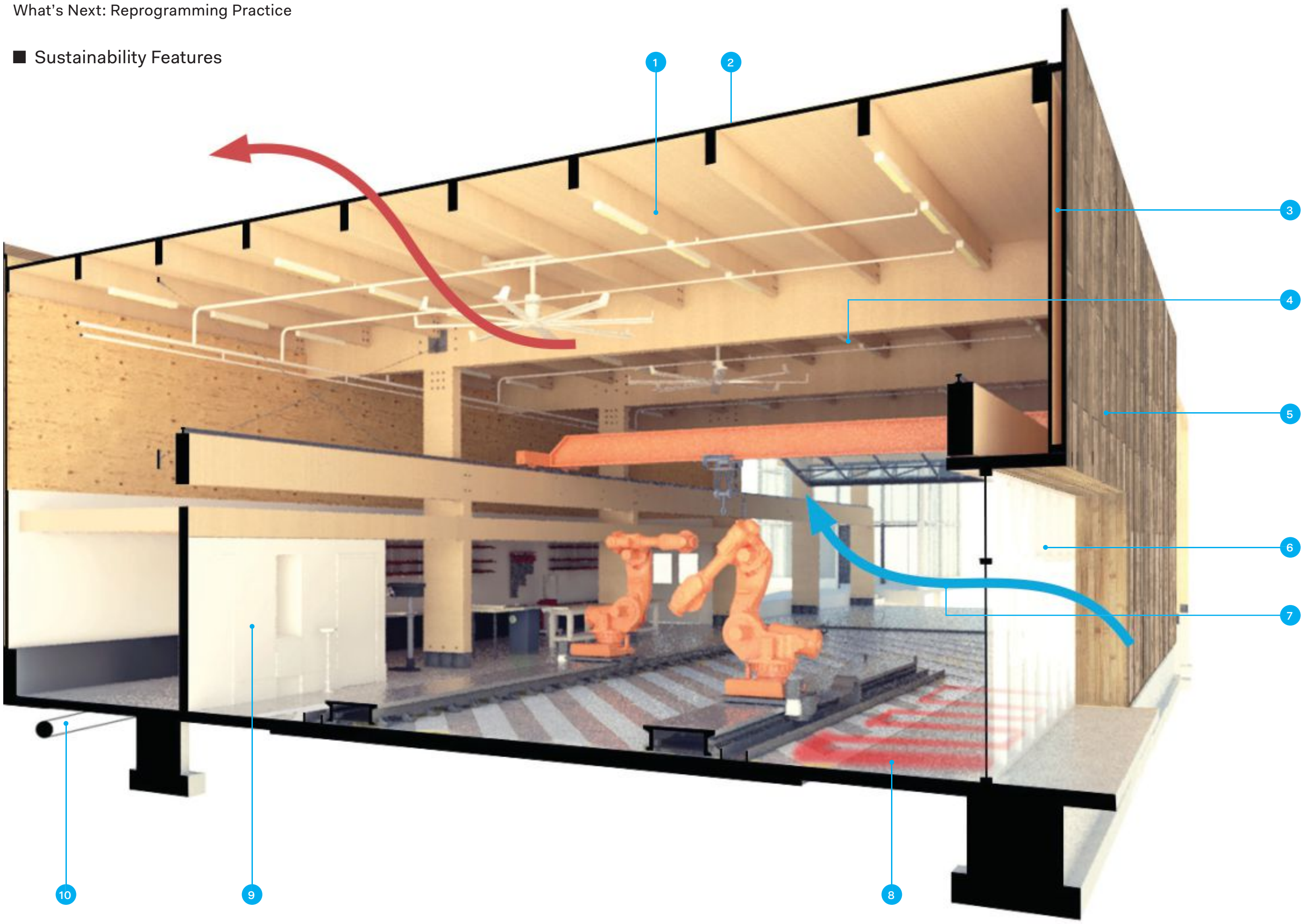


■ CNC-Sandblasting System for Reclaimed Planks



The team settled on sandblasting as a way to emphasize the micro-contours of the grain, because "as you eat away the soft material, the grain gets emphasized," Benjamin says. With the mapping of the knots from the computer, which could be translated to files for a CNC machine, the team had all the ingredients for fabrication. The only problem? There was no such device as a CNC sandblasting machine. So, partnering with Evan Eisman and his Brooklyn-based design and fabrication studio, they built one, and fed each board through it individually.

■ Sustainability Features



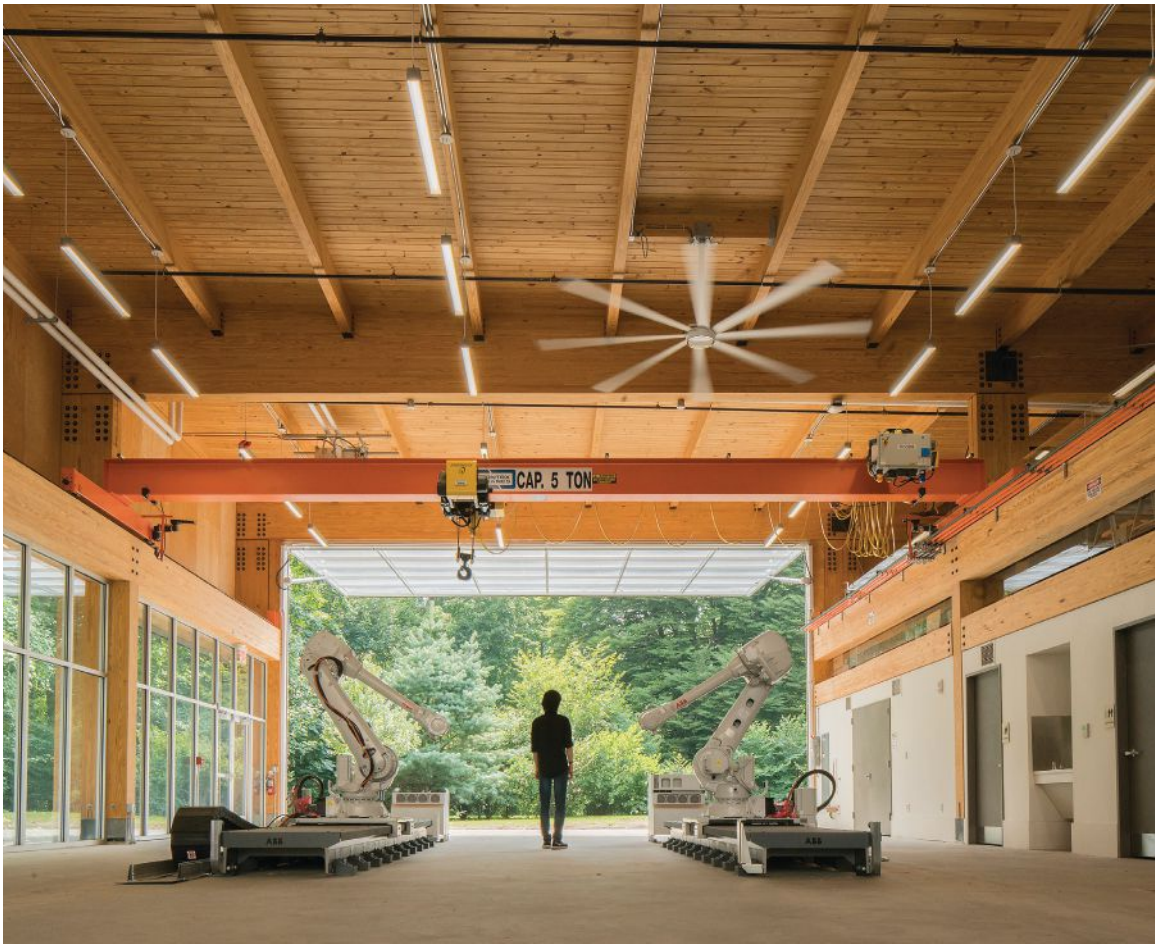
1. WOOD GLULAM CONSTRUCTION
The glulam structure used 8,352 cubic feet of timber. U.S. and Canadian forests grow as much wood in 40 seconds. The material sequesters 54 metric tons of carbon dioxide, avoiding 196 metric tons of carbon dioxide emissions. The total potential carbon benefit is 250 metric tons of carbon dioxide, equivalent to the carbon sequestered by 205 acres of U.S. forest in one year, or annual greenhouse gas emissions from 52 cars. Another benefit is the low embodied energy of timber: 8 MJ/kg compared to 38 MJ/kg for steel.

2. SOLAR PV
The roof has the capability of accommodating potential photovoltaic (PV) arrays for use in future research projects.

3. FAÇADE PANELS
A ventilated rainscreen system provides greater energy efficiency and moisture resistance. Reclaimed timber serves as the outer façade layer.

4. SENSORS
The Living incorporated advanced sensors and controls for the LED lighting and other systems.

5. RECLAIMED SCAFFOLDING BOARDS
The rainscreen is constructed from donated New York City scaffolding boards. Each reclaimed board is robotically sorted and sandblasted, exposing micro-contours between the ridges of the wood grain that facilitate water runoff and also trap air, adding a layer of thermal insulation.



Interior view, facing west

6. DAYLIGHTING
South-facing glazing allows users to work by daylight instead of artificial lights, and thereby consume less electricity.

7. NATURAL VENTILATION
The building has no mechanical cooling, and relies upon natural ventilation as an alternative. Operable openings along the south façade admit air, which then exits via the roof as it warms. Large fans supplement the natural airflow.

8. RADIANT HEATING
The building's primary source of heat comes from underslab radiant systems.

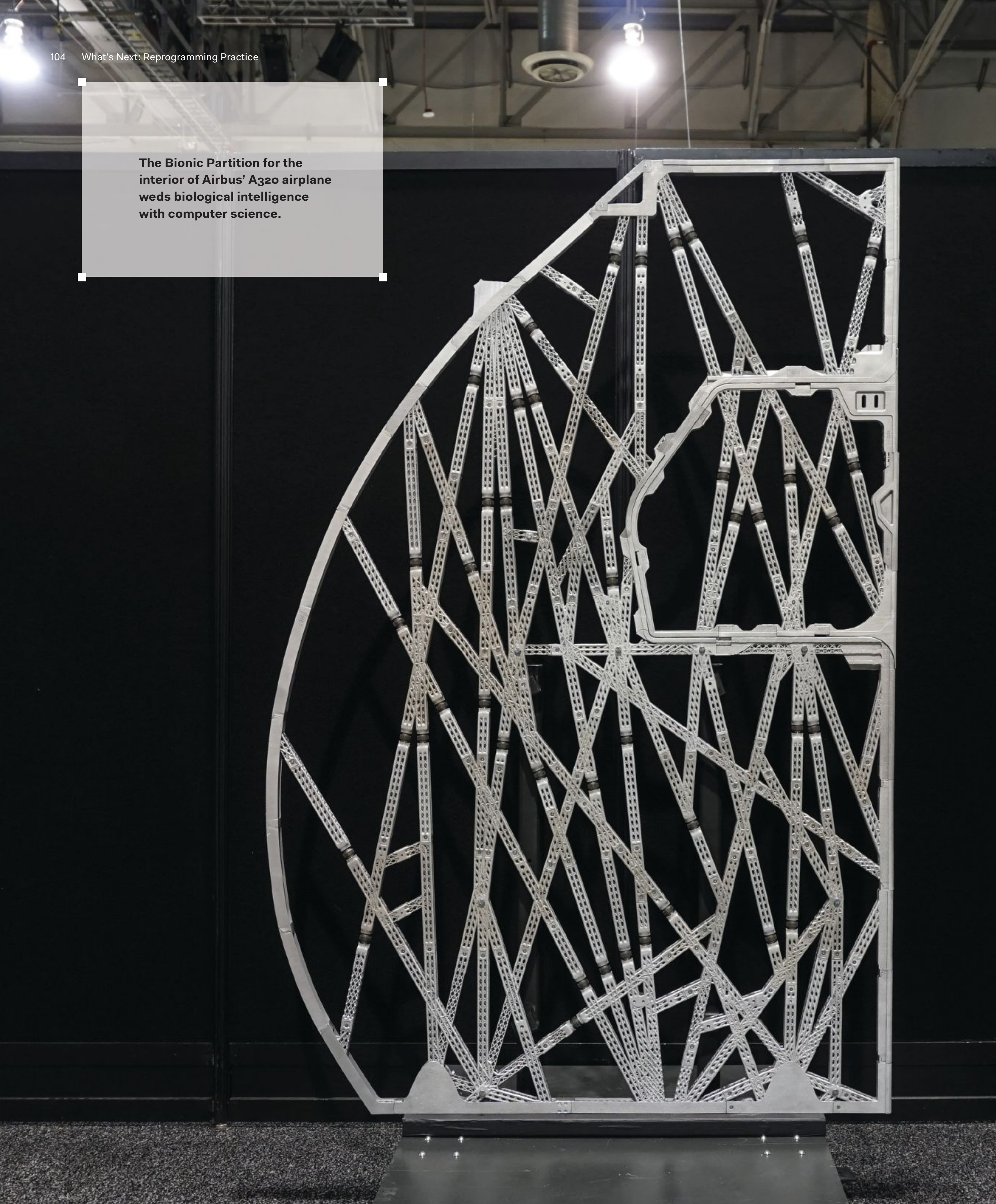
9. BUILDING MANAGEMENT SYSTEM DISPLAY STATIONS
An open-source, real-time system interface allows students and researchers to modify and collect data on environmental performance.

10. CONDENSATE RECOVERY SYSTEM
The building's radiant system is heated via waste condensate from a neighboring campus building.

PABLO MARVEL

The sandblasted boards were placed on the south façade (at left), with sensors located behind the sandblasted knots to record temperature shifts over time—in different seasons, at different times of day, and in different levels of shade—to see if the theory about the wood grain's potential for thermal performance bears out. Meggers will continue monitoring the system, relocating sensors as necessary. As for the remaining façades? They were covered in reclaimed boards as well, left in the condition they were received—some with paint as staples left as evidence of their hard use on construction sites before. As for the CNC sandblasting machine, it remains the only one—and in Eisman's studio. "We have used it for a couple of projects that were less inspired," Eisman says. "There is an efficiency to the machine that we can't accomplish by hand."

MICHAEL MORAN/OTTO

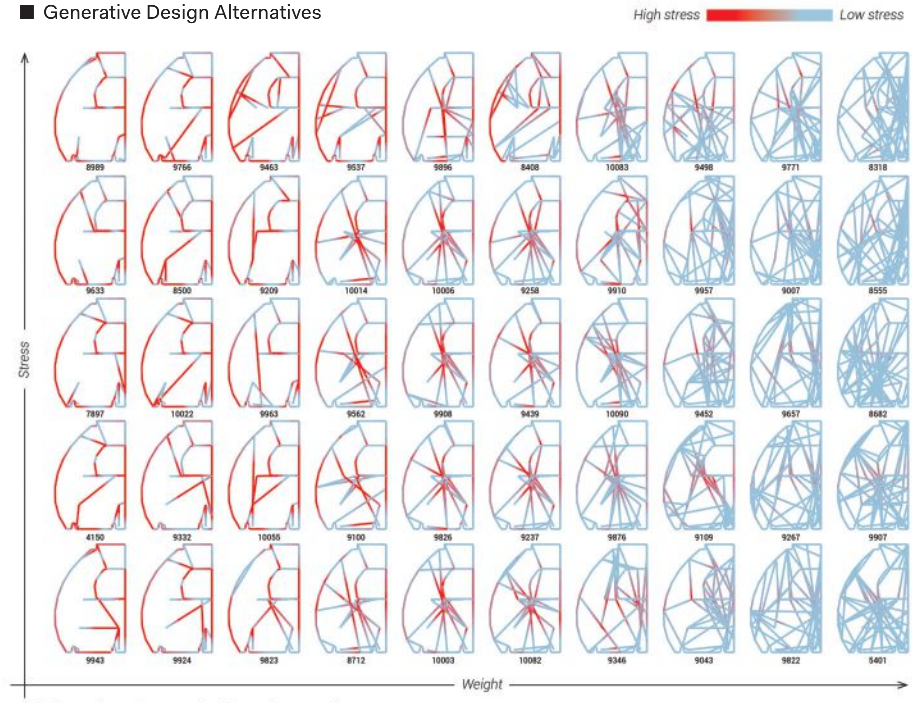


The Bionic Partition for the interior of Airbus' A320 airplane weds biological intelligence with computer science.

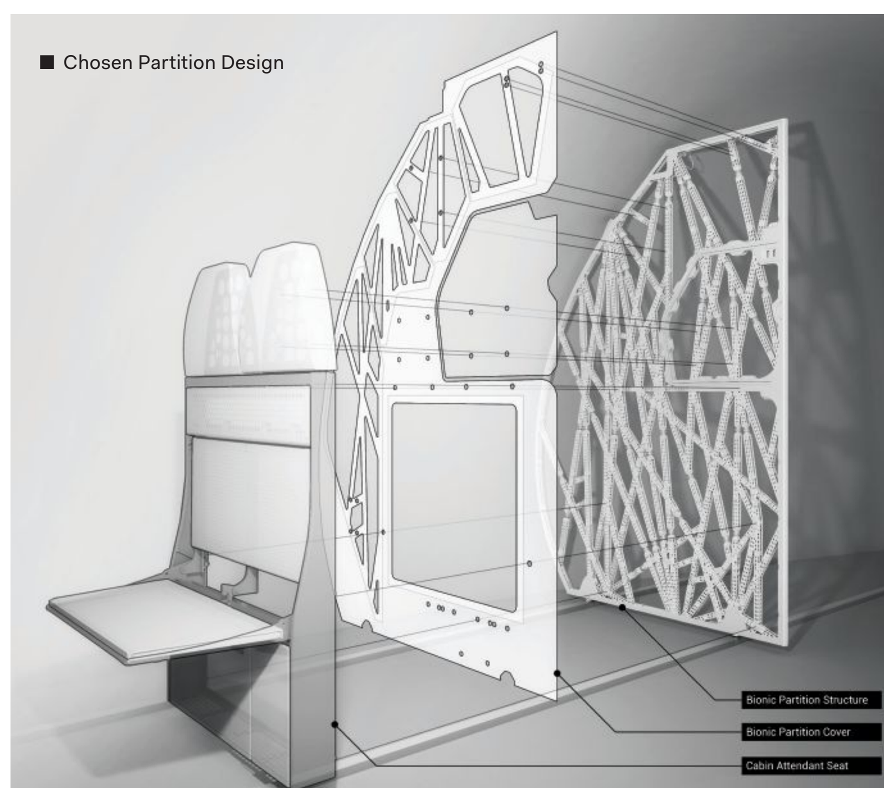
Approached by Airbus to design an interior partition for the A320 airplane, The Living balanced fixed parameters of use and physical size with a series of performance goals that included minimizing weight and maximizing the ability to withstand G-forces while supporting an unbalanced load during a crash landing. Merging biology and architecture, The Living mimicked the biological growth patterns of slime mold—a series of efficient linear structures that reinforce the whole—to optimize a new structural system for the panel.

Why a biological precedent? For self-organization, which The Living's long-time collaborator biologist Ali Brivanlou of Rockefeller University describes as "the common denominator between the different topics of biology that could have a direct influence on the way that humans design structures." In slime mold, as with all organic cells, "the knowledge of organizing a structure in the most optimum adaptive way is contained in each unit of that structure." The Living used an algorithm to generate thousands of design options for the structural system, ultimately choosing an optimized final version made from 162 3D-printed parts that is lighter and stronger than the industry's standard partition.

■ Generative Design Alternatives



High-performing results based on goals



For Autodesk's new Toronto office and research center, The Living generated 10,000 layouts to find one that was just right.

BEN RAHN/A-FRAME

Autodesk's new three-floor, 60,000-square-foot facility in Toronto's MaRS Discovery District innovation hub has all the hallmarks of a high-tech office. Game room? Check. Flexible workspaces? Check. Telepresence suites? Check. But look beyond the well-appointed interior, and it becomes clear that The Living didn't carry out your typical TI job. Instead, it used computational workflows and generative learning to optimize the design goals and create a space that takes into consideration the welfare of each of the 250-plus individual employees who work there.

■ Survey Results

Importance	Rank	OVERALL	RCE (Reputation, Consumer, and Education)	M&E (Media & Entertainment)	OCTO (Office of the Chief Technology Officer)	IPG (Information Modeling & Platform Products Group)	WWSS (Worldwide Sales & Services)
MOST	1	Adjacency	Adjacency	Privacy	Adjacency	Adjacency	Light - Bright
	2	Audio Controls	Audio Controls	Audio Controls	Ergonomics	Audio Controls	Privacy
	3	Light - Bright	Visual Controls	Visual Controls	Light - Bright	Collaboration	Audio Controls
IMPORTANCE	4	Visual Controls	Light - Bright	Light - Bright	Visual Controls	Visual Controls	Visual Controls
	5	Ergonomics	Collaboration	Adjacency	Audio Controls	Ergonomics	Adjacency
	6	Privacy	Ergonomics	Ergonomics	Privacy	Privacy	Personalization
	7	Collaboration	Personalization	Climate	Collaboration	Light - Bright	Ergonomics
	8	Climate	Desk size	Collaboration	Desk size	Climate	Climate
	9	Personalization	Privacy	Inter-team collab.	Personalization	Desk size	Desk size
LEAST	10	Desk size	Climate	Desk size	Inter-team collab.	Personalization	Light - Dark space
UNIMPORTANT		Inter-team collab.	Inter-team collab.	Personalization	Climate	Storage	Collaboration
		Storage	Storage	Light - Dark space	Storage	Inter-team collab.	Inter-team collab.
		Light - Dark space	Light - Dark space	Storage	Light - Dark space	Light - Dark space	Storage

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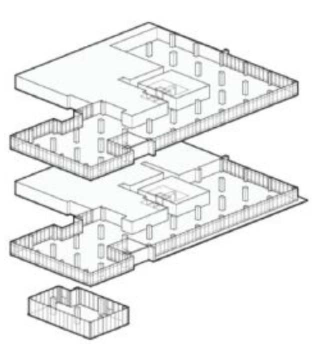
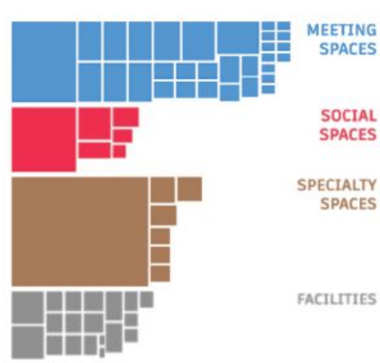
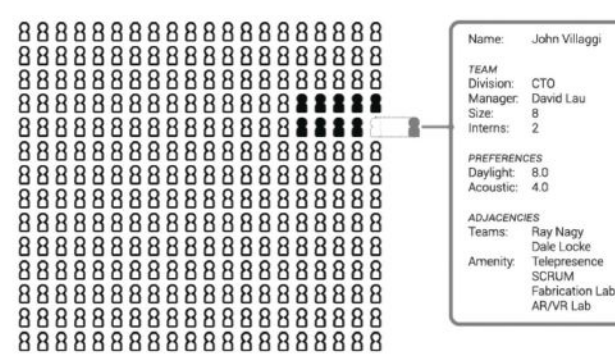
MORE IMPORTANT — DEVIATION FROM AVERAGE — LESS IMPORTANT

** GROUPS ARRANGED BY NUMBER OF RESPONSE

■ Requirements







3 floors
48,000 square feet

11 meeting rooms
6 multi-purpose rooms
11 phone booths

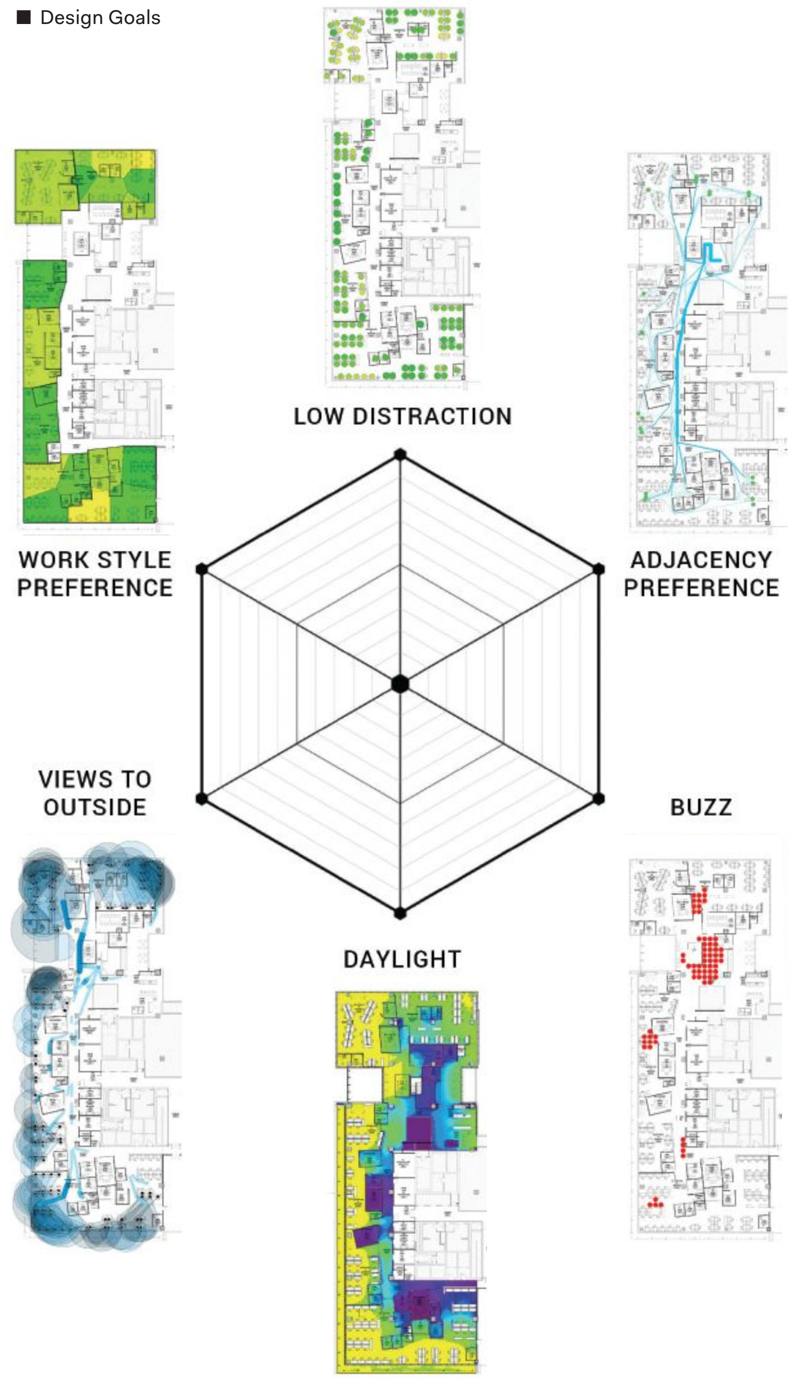
250+ people
25+ teams

The first step in the process was to define the design constraints and objectives. Some variables were fixed and obvious: the dimensions of the floor plate, the placement of the column grid, and the number of employees, for example. Others required more planning, such as the number and square footage of the conference rooms and enclosed spaces. All of these were taken into consideration when determining goals for the space, such as access to daylight and views outside, and various levels of distraction and staff interconnectivity, or "buzz."

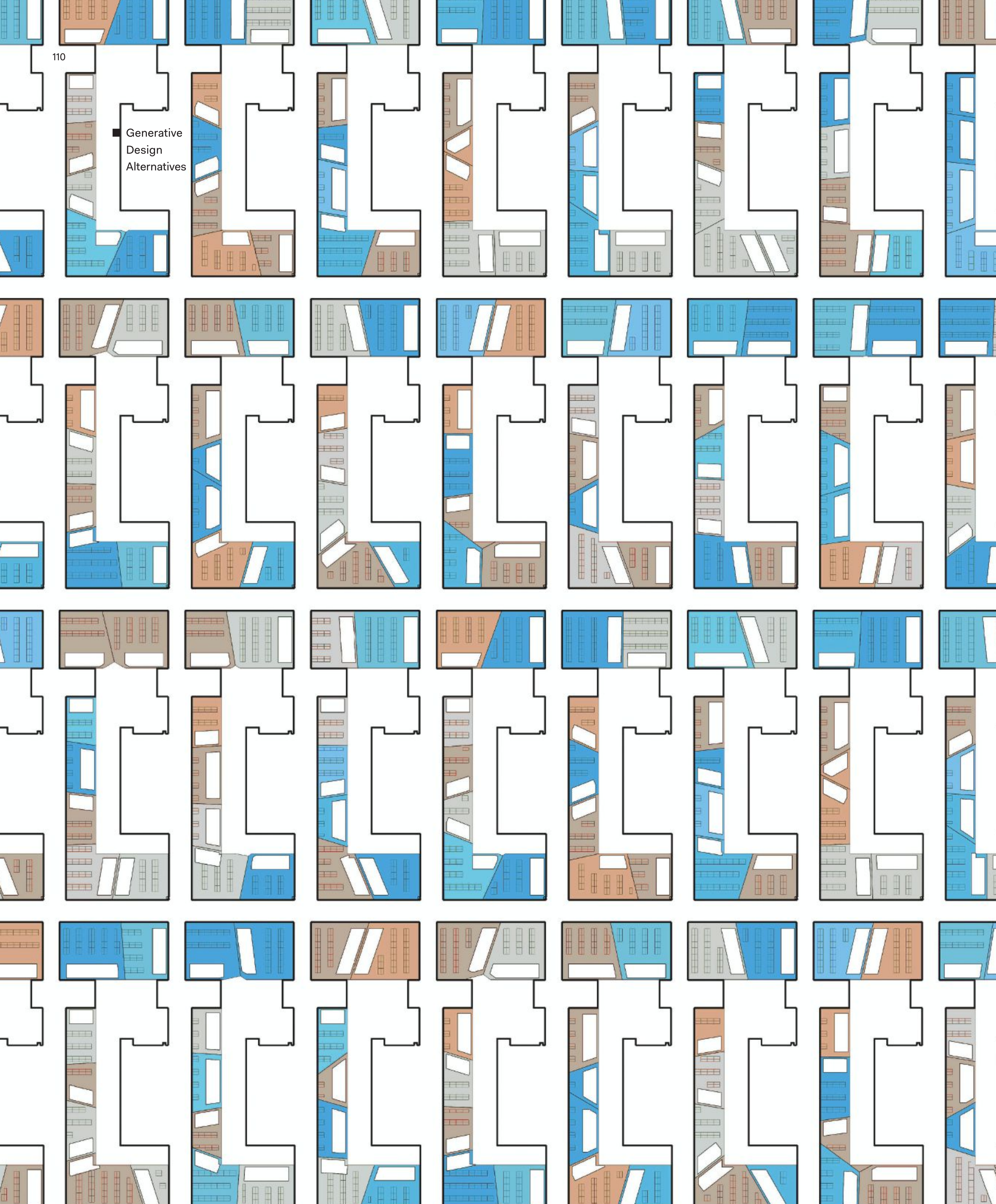
But The Living wasn't content to plug quantitative design goals alone into an algorithm. "We were really excited to combine information about what kinds of space people like, what their experience is in different spaces, into a computational workflow and that is part of a measurable design process," Benjamin says. The team designed two additional, arguably qualitative goals around adjacency preference and work style preference using data from a detailed survey distributed to every employee.

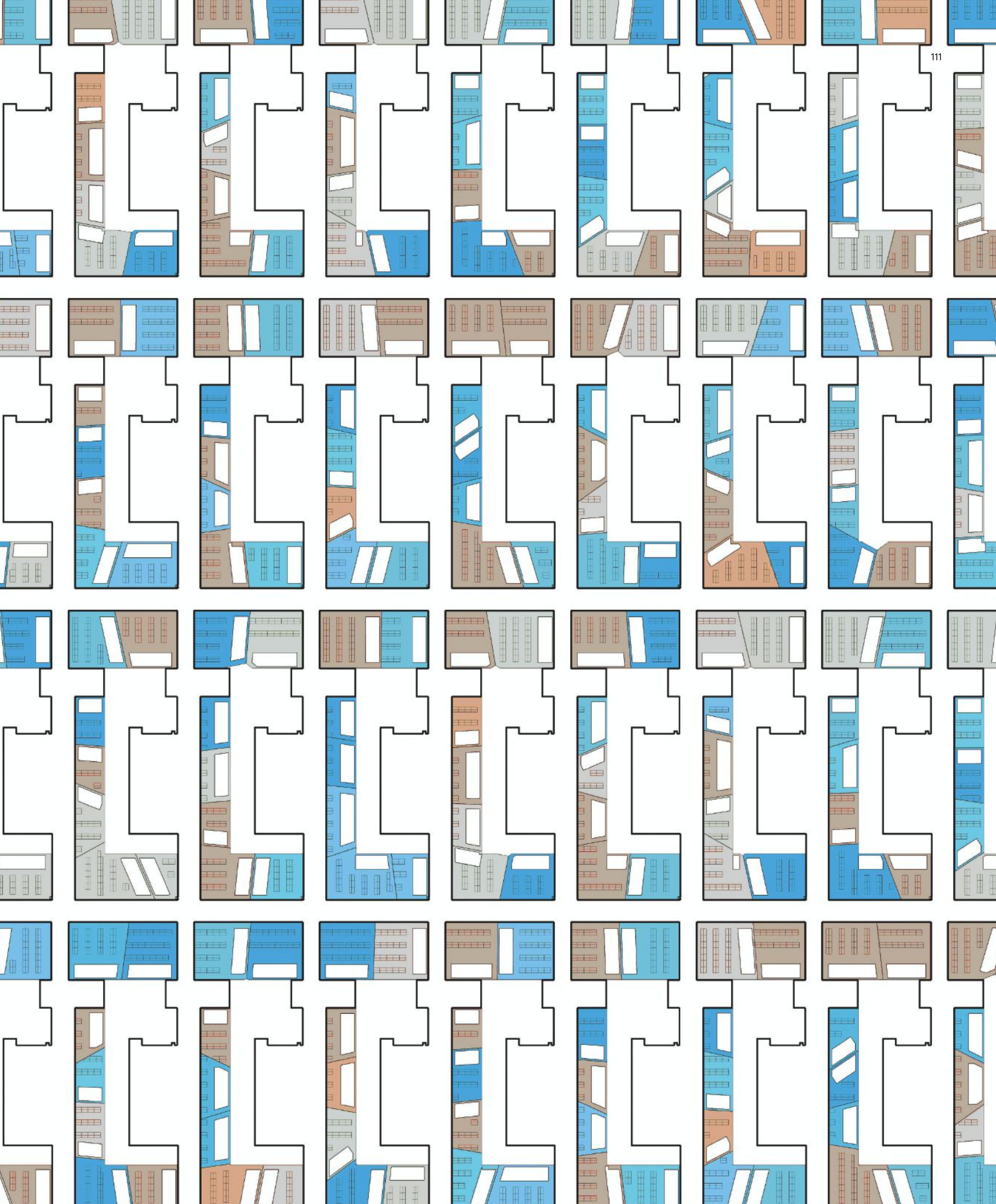
Each goal had its own algorithm. These were run through another algorithm that "evolved" the designs, creating 10,000 possible layouts for the space, each with a measurable outcome for each goal.

■ Design Goals

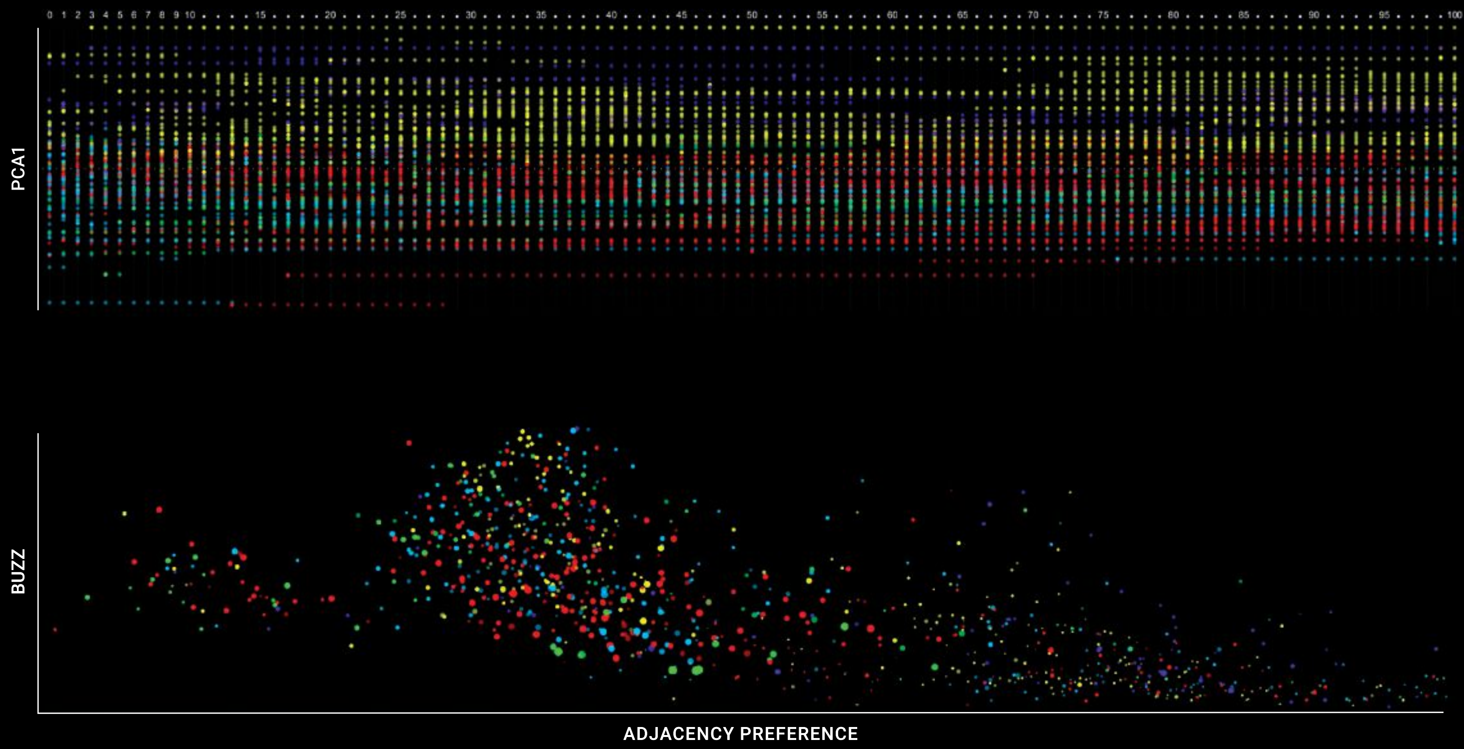


Generative Design Alternatives

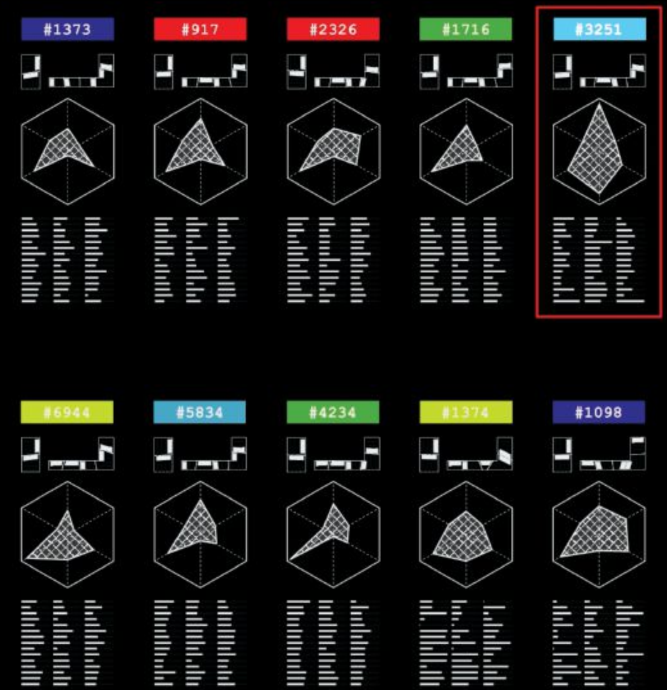




Evaluations of Design Alternatives



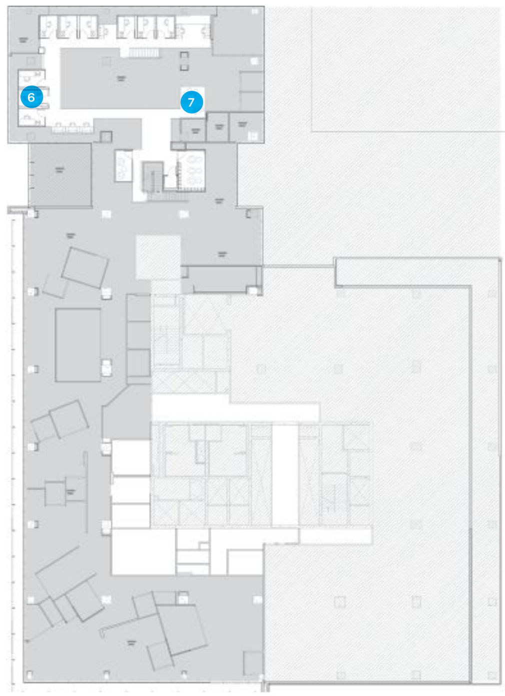
Final 10 Design Alternatives



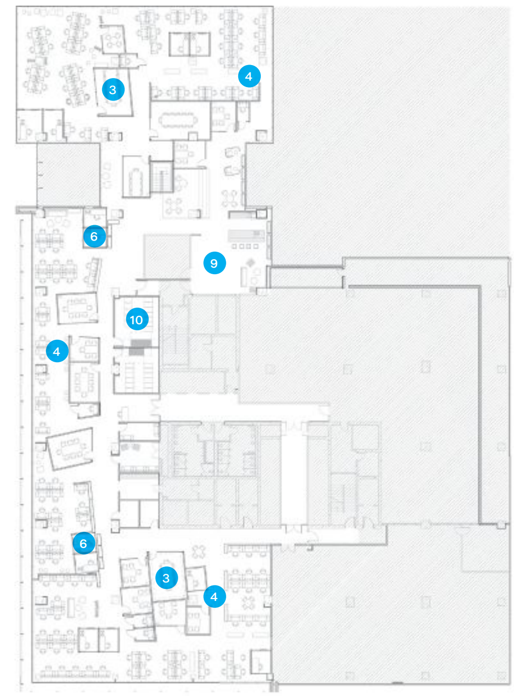
Because those thousands of design options come with data about how well they have satisfied each of the six goals, they could be compared against one another, ranked, and evaluated. The Living took 10 designs back to Autodesk to discuss with stakeholders. "We could say not only 'Here are the different ways of solving the problem,' or 'Here are design options to discuss,' but 'Here's the data behind what makes each one good according to the goals that we collectively agreed on,'" Benjamin says. "In the best case, it can make for a more inclusive decision-making process. Instead of removing us from human judgment, computation has the potential to make better debate about tradeoffs, instead of relying on vague notions of why one design is valid and another isn't."

The team chose one design alternative to use as a baseline for refinement, tweaked it based on late-stage feedback from employees, and chose finishes and graphics, evolving the scheme into the one that was actually built out. "We're not purists about using computation to optimize objective efficiency," Benjamin says. "We thought, 'This is a system that could help us manage a lot of complexity, and we'll see how far it can take us, and then we'll see if there are other things we have to do to get us to the point that it's a great design.' We're not saying computation is always better, just that it's another way."

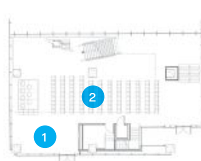
Second-Floor Plan



Third-Floor Plan

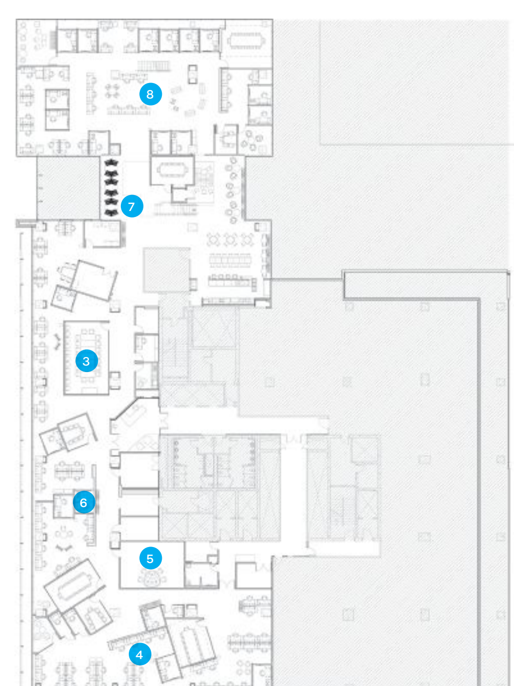


Ground-Floor Plan

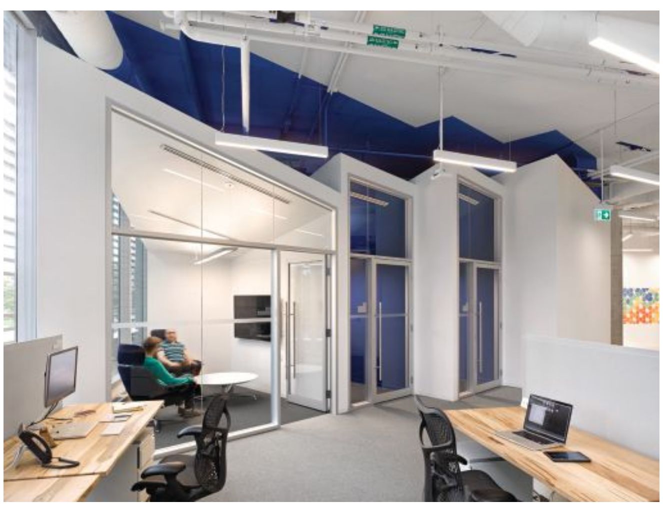


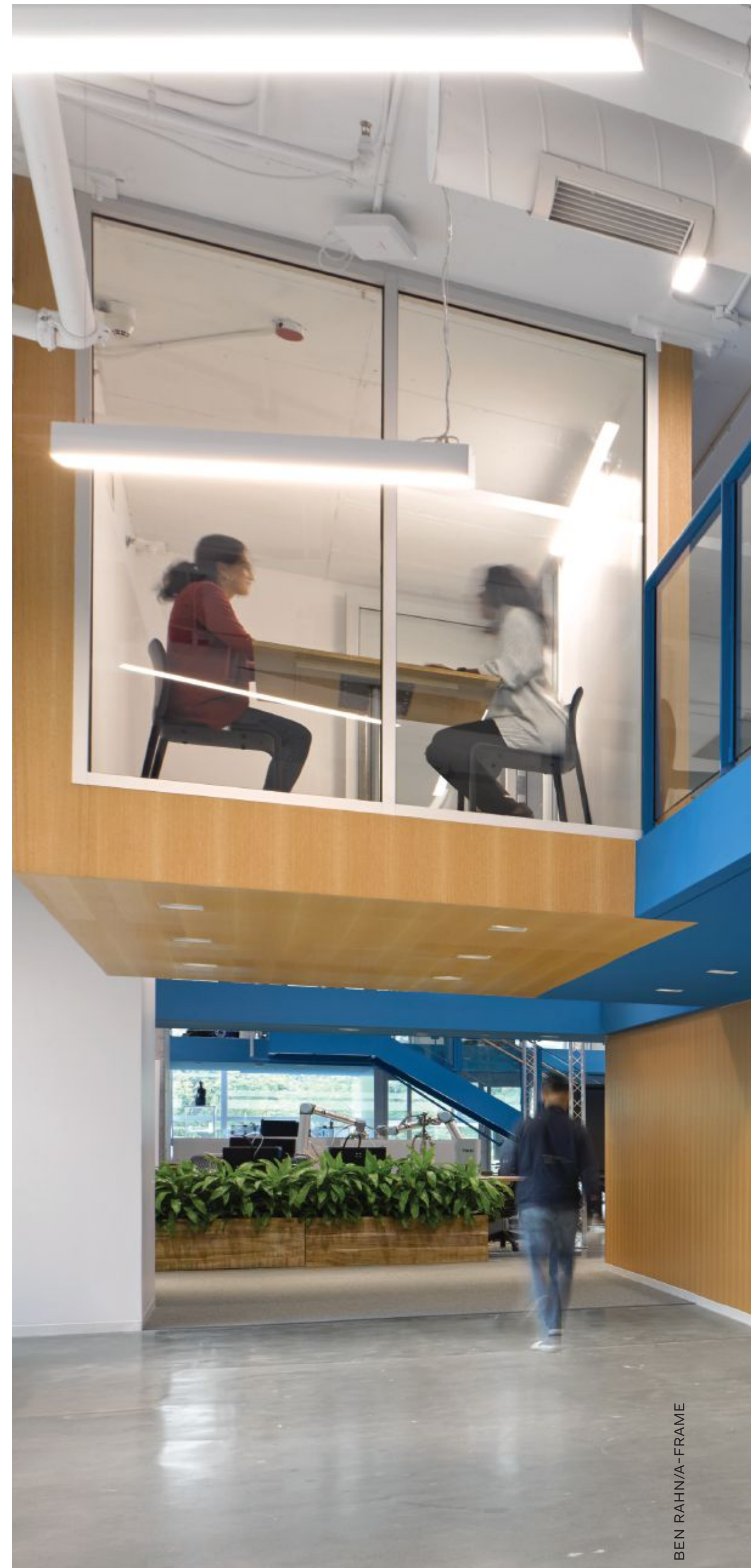
Ground-Floor Mezzanine Plan

Second-Floor Plan



1. Entry
2. Exhibition space
3. Meeting room
4. Work area
5. Telepresence room
6. Quiet workspace
7. Social space
8. Ad-hoc room
9. Game room
10. Server room





Top: View of kitchen, which doubles as a social space

Above: View of meeting pods with angled roofs to enhance daylight penetration into the space

Right: View of internal stair to mezzanine workspaces

BEN RAHN/A-FRAME

It's no surprise that Autodesk was keen to explore generative design processes for its own workspace—it's a method that the software giant has been researching for years. The ultimate goal, says the company's director of product strategy for AEC generative design, Anthony Hauck, is to make these processes available on a broad scale with its products. "We believe that there may be good design solutions that are never found because they are laborious to discover, and labor is at a premium. This is what automation is for. Can we take enough of the labor out of that exploration that we make it easy, and can we make it fun, so that we're simultaneously improving peoples' work lives and their confidence," he says.

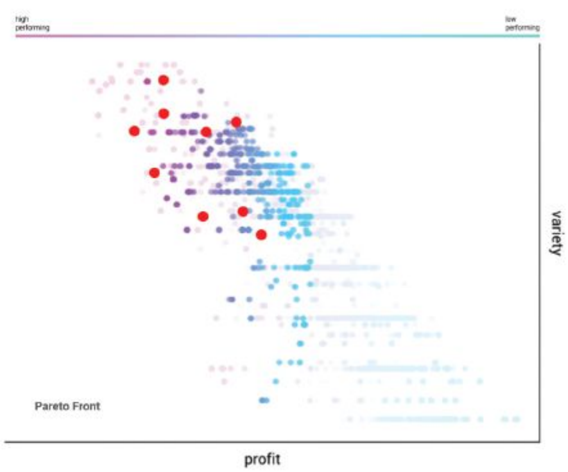
One of the advantages of having an experimental practice like The Living embedded within the company, Hauck explains, is that "not only does it give us an intellectual pipeline into a technologically advanced design practice, but also into how clients interact with that sort of practice. Because honestly, we think this is where practice is going—one way or another. So we're getting a very early look, through The Living as a proxy in the market, at what the future of design might look like."

BEN RAHN/A-FRAME


aroma espresso bar
COMING SOON
SUMMER 2017

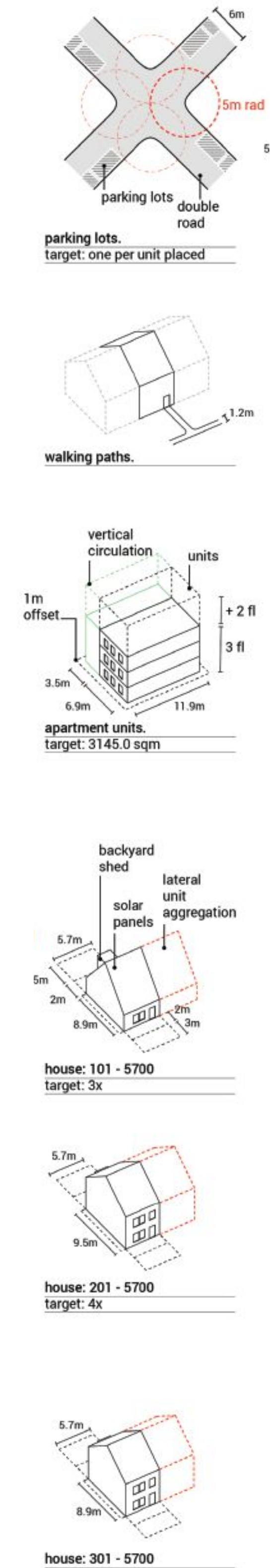
With the Alkmaar Housing development, The Living is taking a leap in physical scale and algorithmic complexity.

■ Evaluation of Design Alternatives

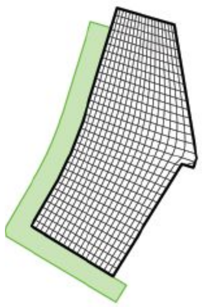


Dutch developer Van Wijnen Groep has challenged The Living to apply its generative learning process at a new scale by creating a net-zero, affordable housing master plan for a site in the Netherlands. The Alkmaar Housing commission, which is still in the design phase, requires The Living to use the client's largely prefabricated housing stock, while optimizing goals for views, variety in public space, solar gain, cost, backyard size, program, and profit. The Living is using the same basic algorithm to generate thousands of possible urban designs that it did to create the floor plans for the Autodesk office and the structural system of the Bionic Partition, but the sub-algorithms for each individual variable of this project are unique, in order to address the very specific sets of requirements. Of particular interest to Benjamin and his team was finding a way to integrate affordability and net-zero construction in the generative design process, since they usually demand their own sets of deep calculations. "It was interesting to be able to use a computational workflow to maximize both of these things, which might be thought of as opposing goals in terms of cost," Benjamin says. "Generative design is great at helping to navigate complexity and to navigate trade-offs between competing demands, so I think it's a fitting process for this type of project." The team is currently evaluating a shortlist of designs to see which will be most effective.

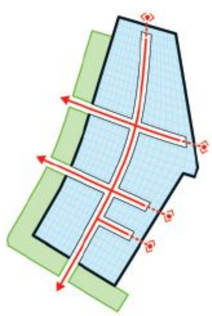
■ Requirements



■ Programming



Boundary-Aware Quad Mesh



Roads and Neighborhoods

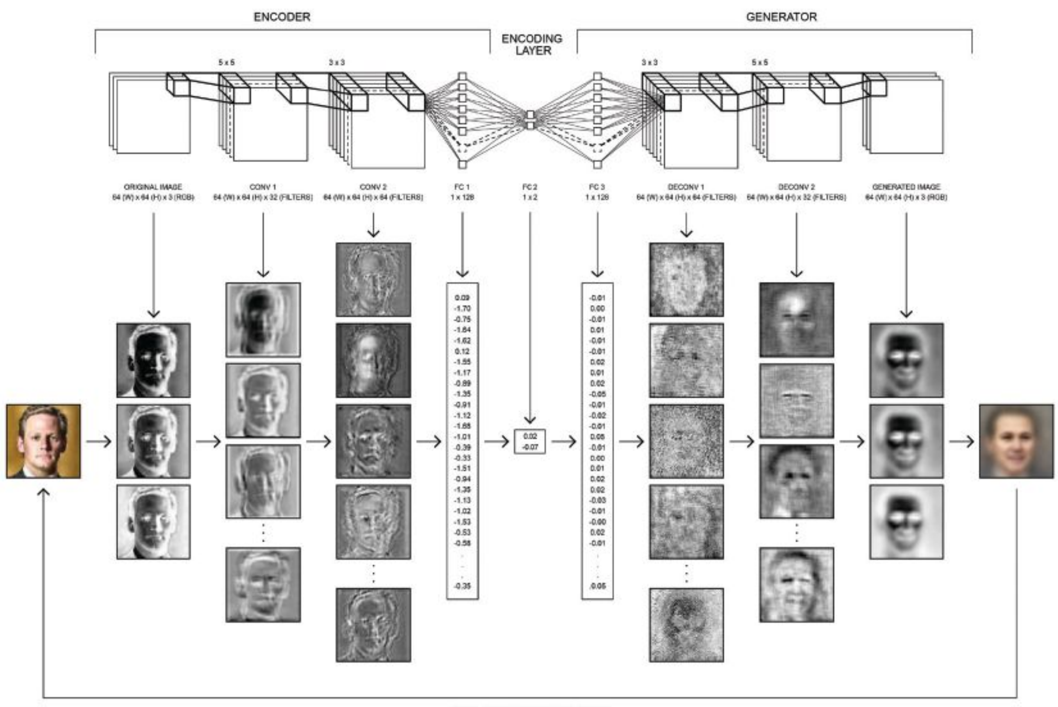
Unit Placement

Public Space

■ Generative Design Alternatives

Twin Mirror, an installation at the 2017 Seoul Biennale, exposes potential dangers of machine learning.

■ Facial Recognition Process



"We knew that any technology has assumptions built in, and we started realizing that machine learning might be particularly dangerous because the assumptions are more biased—sometimes even from their own inventors," Benjamin says. "With less direct programming or open-ended programming, the algorithm learns on its own." This aspect of machine learning is particular troubling, he notes, in certain sensitive areas such as serving up job ads or even judicial sentencing, where unintended discrimination by race, ethnicity, or gender can have far-reaching consequences.

To demonstrate these potential issues, The Living created an installation for the 2017 Seoul Biennale of Architecture and Urbanism that scans the face of a visitor and runs it through two parallel facial recognition models that are trained on different sets of stored head shots. The different models and sets of training data result in two distinct results for any given visitor. "We're basically creating two versions of reality, of machine learning, to say they're both just interpretations and neither one is objective or correct, so we have to understand a little more about properties of each one," Benjamin says.

> "We're basically creating two versions of reality, of machine learning, to say they're both just interpretations and neither one is objective or correct."
>
> —David Benjamin

Project Credits

Embodied Computation Lab, Princeton, N.J., page 96
Client: Princeton University
Project Team: The Living, New York · David Benjamin (founder and principal); John Locke, AIA, (project architect); Danil Nagy, Ray Wang, Jim Stoddart, Lorenzo Villaggi, Damon Lau, Dale Zhao
Architect of Record: NK Architects
Structural and Mechanical Engineers: BuroHappold Engineering
Material Salvage Partner: Big Reuse
Sandblasting Partner: Evan Eisman Co.
General Contractor: Epic Construction
Lead Faculty Researchers: Axel Kilian, Forrest Meggers

Bionic Partition, Hamburg, Germany, page 104
Client: Airbus
Project Team: The Living, New York · David Benjamin (founder and principal); Danil Nagy (project lead), Damon Lau, Dale Zhao, Jim Stoddart, John Locke, AIA, Ray Wang
Airbus Team: Bastian Schäfer (project lead), Jörg Schuler, Peter Sander, Jens Telgkamp, Tobias Mayer, Martial Somda, Stefan Holst
AP Works 3D Printing: Joachim Zettler, Felix Rothe, Andreas Nick
Steering Committee: Jeff Kowalski, Ingo Wuggetzer, Stefan List, Gonzalo Martinez
Simulation Consulting: Nanda Santhanam, Ian Pendlebury, Francesco Iorio, Sualp Ozel, Emmanuel Weyermann, Jonathan den Hartog, David Weinberg

MaRS Office, Toronto, Ontario, page 106
Client: Autodesk
Project Team: The Living, New York · David Benjamin (founder and principal); John Locke, AIA, (project architect); Ray Wang, Danil Nagy, Jim Stoddart, Lorenzo Villaggi, Damon Lau, Dale Zhao
User/Research Team: Jeff Kowalski, Gordon Kurtenbach, Azam Khan, George Fitzmaurice, Thomas Heermann, Ramtin Attar, Hali Larsen
Facilities Team: Joe Chen, Stephen Fukuhara, Jenny Lum, John King, Sébastien Dubien, Shalini Adhopia

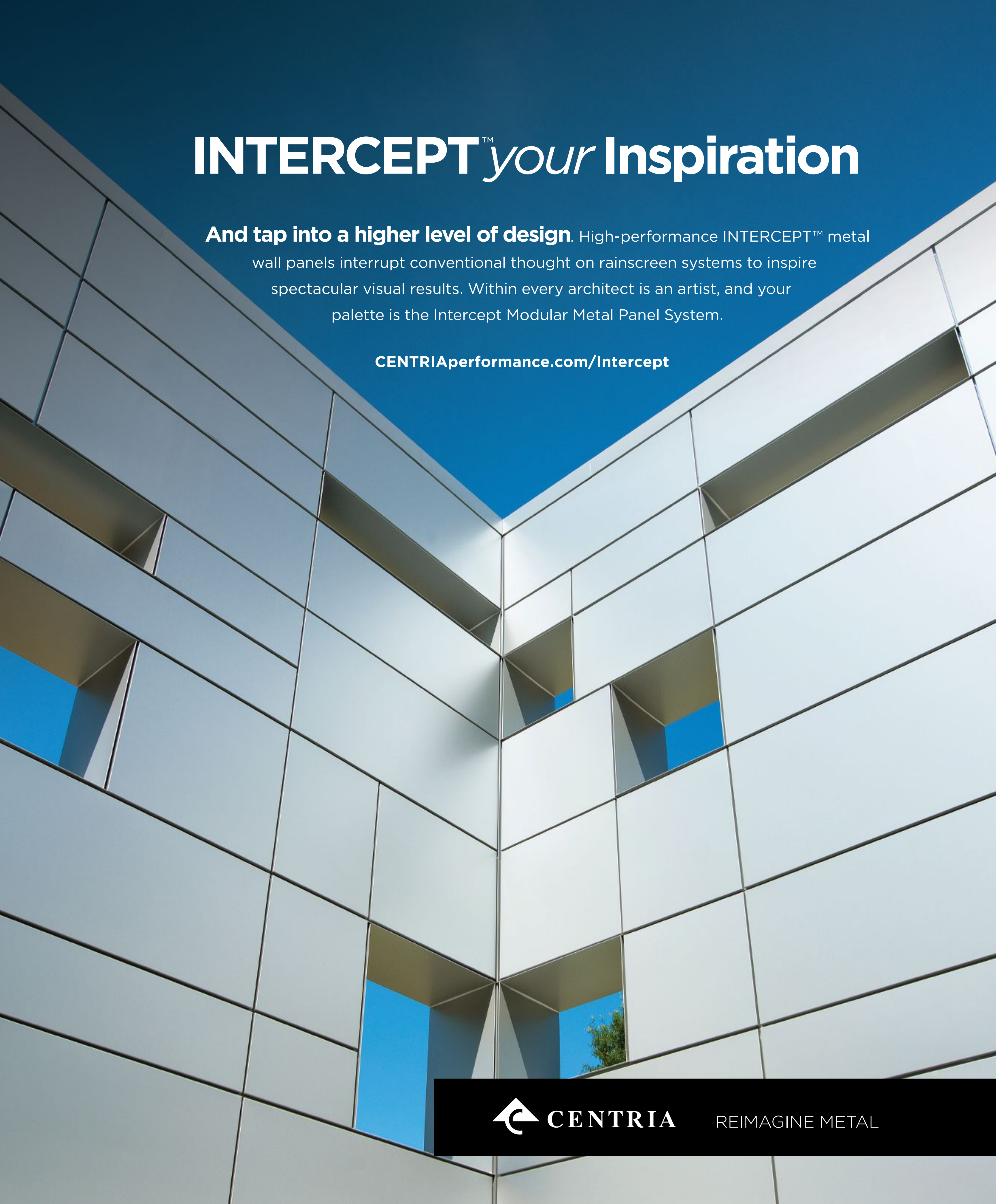
Alkmaar Housing, the Netherlands, page 118
Client: Van Wijnen Groep
Project Team: The Living, New York · David Benjamin (founder and principal); Lorenzo Villaggi (project lead), Danil Nagy, Jim Stoddart, Dale Zhao, Damon Lau, Ray Wang, John Locke, AIA
Client Team: Peter Hutten, Hilbrand Katsma, León Leeraar, Jelmer Frank Wijnia
Industry Expert: Sander Lijbers
Dynamo and Fractal Workflow: Anthony Hauck, Mike Dewberry, Colin McCrone

Twin Mirror, Seoul, South Korea, page 120
Client: Seoul Biennale of Architecture and Urbanism
Project Team: The Living, New York · David Benjamin (founder and principal); Danil Nagy, Jim Stoddart (project leads); John Locke, AIA, Dale Zhao, Damon Lau, Ray Wang, Lorenzo Villaggi
Biennale Directors: Hyungmin Pai, Alejandro Zaera-Polo
Machine Intelligence: Mike Haley
Twin Mirror was made possible, in part, by funding from Columbia University Graduate School of Architecture, Planning and Preservation. The project was also supported by Viss Display Co.

The images generated by the facial recognition software were displayed via live feed on a media façade mounted on the exterior of a building in a busy pedestrian zone. "We've done this whole line of research thinking about buildings coming to life to show environmental qualities, but we also thought we could use façade to talk about discrimination in our society or assumptions and bias in new technologies."

JIM STODDART


도시의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Residential:

Gensler Designs Sleeping Cabins for San Jose Homeless

TEXT BY SARA JOHNSON

In December, San Jose, Calif.'s city council approved a 40-unit pilot for the Bridge Housing Communities, a new city project designed by Gensler, built by Habitat for Humanity, and run by HomeFirst. Each community would include clusters of interim emergency cabins for homeless residents, centered around shared common spaces, restrooms, and dining facilities. Gensler has created two potential designs for the 80- to 140-square-foot sleeping cabins: Folding Home (top) and Better Together (below). Prototypes of each will be built to solicit feedback on the designs before selecting the final scheme.

Habitat for Humanity will construct the cabins at an existing manufacturing facility before transporting them to the site (which has yet to be determined), and estimates that the construction cost for a 40-unit project would total $2.93 million, including site development and constructing the shared buildings. The next big step is to find a location, and the city hopes to evaluate and rank potential sites in the coming months.

COURTESY GENSLER

> *View more renderings of Gensler's sleeping cabins at bit.ly/BridgeHousing.*

Architectural Hardware Fit for a Metropolitan Home

TEXT BY SELIN ASHABOGLU

City Suite, Peter Pennoyer Architects Hardware Collection, Lowe Hardware
Created by Peter Pennoyer Architects partner James M. Taylor, AIA, for Rockland, Maine–based Lowe Hardware, the City Suite line is part of a new collection that marks the historicist firm's first foray into architectural hardware. The collection—which includes two additional lines: the horseshoe- and star-adorned Country Suite and the faceted Cubist Suite—draws inspiration from the firm's portfolio of high-end residential projects. The City Suite was influenced by the grand architecture of 1920s Manhattan and comprises 13 separate pieces, including wall and floor doorstops, a ring pull, a knob, and a lever. City Suite is offered in five finishes: unlacquered brass (shown), blackened brass, nickel, brushed nickel, and copper. Custom finishes are also available. *lowe-hardware.com*

ERIC PIASEK

> *To discover more hardware, visit bit.ly/ArchitecturalHardware.*


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A Modern-Day Survey of Lutyens' Arts & Crafts Houses

TEXT BY SARA JOHNSON

While Edwin Lutyens' portfolio was thoroughly published in his lifetime, during the late 19th and early 20th century, the new *Sir Edwin Lutyens: The Arts and Crafts Houses* (Images Publishing, 2017) builds on that record by introducing 575 contemporary photographs—shot by author and architect David Cole—of 45 houses by the English architect, such as Berrydown Court (shown). Cole says he took these images "to illustrate the contemporary timelessness of Lutyens's designs a hundred years after those first images, and to celebrate Lutyens's enduring genius—safely preserved in, but never consigned to, the past."

> *See more of Lutyens' Arts & Crafts houses at bit.ly/LutyensByCole.*

Housing Tower
Winterthur, Switzerland
Wild Bär Heule Architekten

TEXT BY NATE BERG
PHOTOS BY ROGER FREI

Rental housing in Switzerland can be bleak. “Often you have a developer and he says it has to be like this, the color like this, the material like this, and at the end everything looks the same,” says Ivar Heule, partner with the Zurich-based architecture firm Wild Bär Heule Architekten. “We wanted to show how you could live if there is no developer saying how it should be.”

So in 2011, Heule and partners Thomas Wild and Sabine Bär bought a small property with an existing house in the town of Winterthur, a few miles northeast of Zurich, and designed a four-unit rental apartment building for the site where the house stood, usurping the role of the developer to build something more ambitious.

The result is a contemporary and unconventional design for the area—all glass and lines. A stark, geometrical open-air concrete stair at the northwest corner is the only exception to the otherwise jewel-box grid of floor-to-ceiling windows on the rest of the exterior. The 550-square-meter (5,920-square-foot) building is a divergence from the peaked roofs and window-pocked masonry walls of surrounding apartments, its glass façades rising straight up to a modest rooftop patio space, which is accented by a planter containing a single tree. A basement contains storage, laundry facilties, and a bike room.

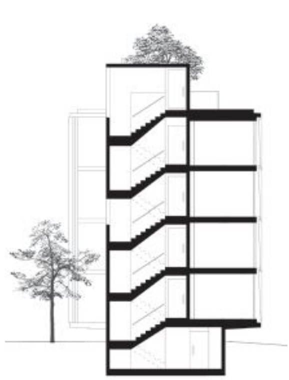
Inside each of the identical 70-square-meter (750-square-foot) full-floor units, the rooms are delineated by a freestanding shelving and storage structure built out of oiled wood. Its mass separates the kitchen from the bedroom and bathroom, and doors within the core allow zones to be cordoned off or combined. (An additional room can serve as another bedroom or an office.)

The building’s heating and cooling come from radiant floors and a geothermal system. Near one end of the kitchen and main common area, a minimal fireplace is cut into the multipurpose core structure. Every other one of the wall-sized Krapf windows is also a sliding door, and wire rope from Jakob across the openings ensures safety when the doors are open. Though interior drapes provide privacy, the almost fully transparent façade is the architects’ way of making the building stand out.

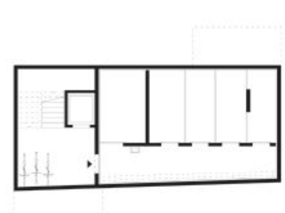
“Nothing is hidden,” Heule says. “It isn’t made out of plastic. You get what you see.” And the smooth concrete floors and ceilings, the oiled wood room separator, the wide glass walls, and the odd beam of structural steel are pretty much all there is to see. “It’s rough and it’s honest,” Heule says.

Although the architects started this project in 2011, demolition and construction didn’t begin until five years later. The design evolved, Heule says, but is very close to what was originally planned. The project, completed in July 2017, is now fully rented. “It took a lot of time,” Heule says, “but you feel the quality.”

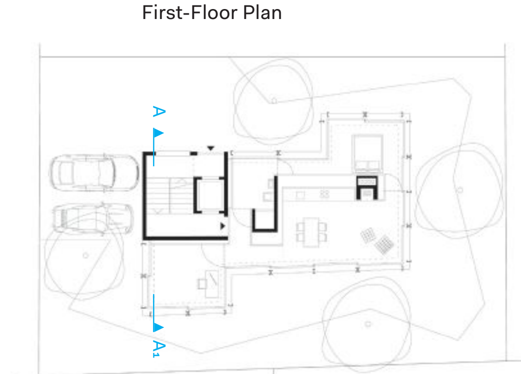
Section A–A_1



Basement Plan

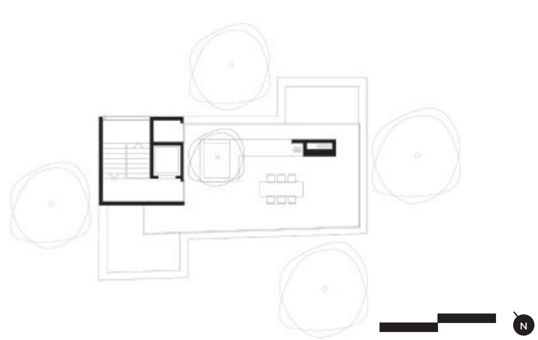


First-Floor Plan



Second, Third, and Fourth-Floor Plan

Roof Plan



Opening Page: The four-story building, shown from the southwest, is enveloped by a mostly glass façade.

Above: Every other window in the façade opens for natural ventilation, and is protected by a fixed screen of wire rope.

A dark oiled maritime pine structure divides rooms and holds kitchen appliances, storage (shown), and bathroom fixtures (opposite).

Top: The roof terrace includes a fireplace and planter.

Above: An open-air staircase on the northwest corner provides access to each unit.

Opposite: The entry is located on the building's north side.

Project Credits
Project: Housing Tower
Client: Konsortium Grenzstrasse
Architect: Wild Bär Heule Architekten, Zurich · Ivar Heule, Thomas Wild, Sabine Bär (partners)
Structural Engineer: Schärli + Oettli
Geotechnical Engineer: Gruenberg + Partner
Construction Manager: Robauen
Size: 550 square meters (5,920 square feet)
Cost: 1.9 million CHF ($1.9 million USD)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Editorial: Swords Into Plowshares

On Dec. 12, Donald Trump signed the $700 billion National Defense Authorization Act for Fiscal Year 2018 into law. Buried among the purchase approval for 13 new Virginia-class submarines and the demand for a report on expanding and privatizing childcare for service-member families is a lengthy passage defining the government position on climate change vis-à-vis the military. The language runs counter to the Trump administration's irresponsible actions on the issue to date: repealing environmental regulations, withdrawing from the Paris Agreement, and placing climate deniers and skeptics in cabinet positions and other top posts. Is it possible that cooler heads have prevailed?

Section 335 of the act, titled "Report on Effects of Climate Change on Department of Defense," includes the following declaration: "Climate change is a direct threat to the national security of the United States and is impacting stability in areas of the world both where the United States Armed Forces are operating today, and where strategic implications for future conflict exist."

Quotes from military and intelligence authorities lend considerable dramatic flair. Here's former Defense Secretary Robert Gates: "Over the next 20 years and more, certain pressures—population, energy, climate, economic, environmental—could combine with rapid cultural, social, and technological change to produce new sources of deprivation, rage, and instability."

The legislation goes on to identify areas of risk. "A three-foot rise in sea levels," for instance, "will threaten the operations of more than 128 United States military sites, and it is possible that many of these at-risk bases could be submerged in the coming years. … In the western United States, drought has amplified the threat of wildfires, and floods have damaged roads, runways, and buildings on military bases."

Section 335 concludes by calling for a report, within the year, on "vulnerabilities to military installations" and "requirements resulting from climate change over the next 20 years." Alas, the legislation does not enact climate policy or fund any action.

The Pentagon is one of the world's largest carbon polluters. According to a 2008 study of the Iraq War by the nonprofit Oil Change International, "If the war was ranked as a country in terms of emissions, it would emit more CO_2 each year than 139 of the world's nations do annually." Even more compellingly, it reported, "Projected total U.S. spending on the Iraq War could cover all of the global investments in renewable power generation that are needed between now and 2030 in order to halt current warming trends."

After World War II, our government justified the massive effort to build the interstate highway network in large part on military grounds, as a way to move troops and materiel in case of national emergency. The Pentagon seems the only agency likely to get regular spending increases in the current political milieu. So I fantasize that a sizable chunk of the defense budget gets reallocated, say through the U.S. Army Corps of Engineers, for the purpose of designing and constructing resilient, energy-efficient infrastructure nationwide. Is this a pipe dream? We certainly have the resources to combat climate change. We'll see who controls Congress—and the nation's purse strings—when the report comes due.

STEPHEN VOSS